A Framework for the Successful Implementation of Turnaround Maintenance Projects

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ABSTRACT

The manufacturing sector is of enormous economic and social significance to any state economy and its people. In the UK, the manufacturing sector accounts for about 13% of GDP and employs about four million people representing approximately 14% of the working population. Manufacturing processes depend on the performance of the facility (machines, equipment and tools) and the human resource (labour). These machines and equipment degrade with age and usage and, therefore, require maintenance.

Despite the strategies adopted for their maintenance, there comes a time due to age, operating/environmental conditions and statutory requirements when the entire facility had to be shut down for necessary repairs, maintenance and project works. This is called Shutdown Maintenance also known as Turnaround Maintenance (TAM).

Although several works have been carried out by organisations and professionals in recent times to optimize TAM projects, organisations are still struggling with TAM projects with reported alarming rates of failure.

A preliminary literature review and pilot studies identified that the major cause of TAM project failures are attributed to the use of Engineering, Procurement and Construction (EPC) project management methodologies to manage TAM projects without considering their unique features.

Findings from a comprehensive literature review, questionnaire survey and case studies in major process plants in the UK, were used to develop a unique best practice framework (and its components parts) which were validated by very experienced, proactive and industry-based hands-on TAM professionals.

The conclusions which are drawn from this research study includes establishment of TAM evaluation criteria, TAM critical success factors, TAM manager selection criteria, TAM management methodologies and the TAM project implementation framework.

This best practice framework which is a major contribution to knowledge in this area is recommended for all operators of engineering facilities to ensure the successful implementation of their TAM projects. The findings from the study are also of significant importance to contract organisations, TAM managers and aspiring TAM professionals, government bodies, training organisations and tertiary institutions who are involved in maintenance management in engineering facilities.

DEDICATION

- *This Research Study is dedicated to*

ALMIGHTY GOD.

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ABBREVIATIONS

APM:	Association for Project Management
APMBOK:	Association for Project Body of Knowledge
BSI:	British Standards Institution
CPM	Critical Path Method
CBM:	Condition-based maintenance
CM:	Corrective maintenance
EPC:	Engineering, Procurement and Construction.
FMEA:	Failure Modes and Effect Analysis
GDP:	Gross Domestic Product
GERT	Graphical Evaluation and Review Technique
IM:	Improvement maintenance
ISO:	International organisation for Standardisation
KPI:	Key performance indicator
NDT:	Non-destructive test
PdM:	Predictive maintenance
PERT	Program Evaluation and Review Technique
PM:	Preventive maintenance
PMBOK:	Project Management body of knowledge
PMI:	Project Management Institute
RBM:	Risk-based maintenance
RCM:	Reliability-centred maintenance
TA:	Turnarounds
TAM:	Turnaround Maintenance
TM:	TAM project manager
TPM:	Total Productive maintenance

GLOSSARY OF TERMS

Availability: is the measure of the percentage (or fraction) of time that a plant is capable of producing its end product at some minimum acceptable level.

Breakdown: - failure resulting in the non-availability of an item.

Clean: - to reduce contamination to an acceptable condition.

Condition-based maintenance: - preventive maintenance initiated as a result of knowledge of the condition of equipment from routine or continuous checking.

Corrective Maintenance - is the performance of unplanned (i.e. unexpected) maintenance tasks to restore the functional capabilities of failed or malfunctioning equipment or system.

Emergency maintenance: - maintenance wherein it is necessary to put the item on hand immediately to avoid serious consequences.

Failure: the termination of the ability of equipment to perform its required function.

Inspection - a careful and critical scrutiny of an item carried out without dismantling, by using the senses of sight, hearing, smell, taste and touch.

Maintainability: is the relative ease and economy of time and resources with which an item can be retained in, or restored to, a specified condition when maintenance is performed by personnel having specified skill levels, using prescribed procedures and resources, at each prescribed level of maintenance and repair.

Maintenance: - a combination of any actions carried out to retain an item in, or restore to, an acceptable condition. (Note that the actions referred to are those associated with initiation, organization and implementation).

Maintenance Program - a list allocating specific maintenance to a specific period.

Maintenance Schedule: - a comprehensive list of maintenance and incidence.

Overhaul: - a comprehensive examination and restoration of an item or a major part thereof, to an acceptable condition.

$$\textbf{Output index} = \frac{\text{Planned output per period - lost output per period}}{\text{planned output per period}}$$

Planned Maintenance: - maintenance organized and carried out with forethought, control and the use of records to a predetermined plan.

Predictive Maintenance - is a conditioned-based maintenance that attempts to evaluate the condition of equipment by performing periodic or continuous (on-line) equipment monitoring. The ultimate goal is to perform maintenance "just in time", before the equipment fails in service.

Preventive maintenance- maintenance carried out at predetermined intervals, or to other prescribed criteria, and intended to reduce the likelihood of an equipment or system not meeting an acceptable condition.

Rehabilitation: - extensive maintenance intended to bring property or building up to current acceptable conditions often involving improvements.

Reliability: is the probability that a device will satisfactorily perform a specified task (function) for a specified period of time under given operating conditions.

Repair: - to restore an item to an acceptable condition by the renewal, replacement or mending of decayed or damaged parts.

Restoration - maintenance actions intended to bring an item back to its original appearance or state.

REVAMP - to revise, renovate equipment or system with the aim of improvements; predominantly modernization or refurbishment of existing facilities.

Running Maintenance: - maintenance which can be carried out while the equipment is in service

Servicing - the replenishment of consumables needed to keep an item in operating condition (Note this was sometimes used in broader context of maintenance but this is not now a recommended practice.

Shutdown maintenance: - maintenance which can be carried out while the equipment system is out of service.

Test: - to compare the response of an item with a suitable or defined application of a stress, energy or measurement.

MTBF *(mean time between failure) - a measure of how long on average, a plant (or Equipment) will perform before an unplanned failure occurs. - a measure of Reliability*

MTTR *(mean time to restore) - a measure of how long on average, it will take to bring the plant (or equipment) item back to normal serviceability when it fails - a measure of Maintainability.*

$$\text{Availability } A = \frac{MTBF}{MTBF+MTTR}$$

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1.0: PROJECT INTRODUCTION

1.1 AIMS OF THE CHAPTER

This chapter aims to familiarise the reader with the purpose and the subject area of this research. The chapter presents an overview of manufacturing industry, identifying the importance of manufacturing to a state economy. It then introduces the research subject area, identifying its importance to manufacturing. The aims and objectives of this research are also outlined together with the significance of the study. The chapter highlights an overview of research methodology and concludes with the chapter guide of the thesis.

1.2. BACKGROUND OF STUDY

Manufacturing is of immense importance to the populace. Virtually everything on earth today is manufactured; from clothing to the food and drink that sustains the human race. Even the construction industry depends on manufacturing as most construction materials pass through a manufacturing process. The manufacturing sector is of enormous economic and social significance to any state economy and its people.

According to the U.S Department of Commerce report on Manufacturing in America, (2004):
"Manufacturing is crucial to the U.S economy. Every individual and industry depends on manufactured goods. In addition, innovations and productivity gains in the manufacturing sector provide benefits far beyond the products themselves."
The report also explained that the manufacturing sector accounts for 14% of U.S Gross domestic product (GDP) and 11% of total US employment.
Manufacturing has been, and continues to be critical to the success of the UK economy. Britain's strength as a prosperous trading nation over the past three centuries was built on manufacturing. According to the former UK Prime Minister, Gordon Brown,
"...for this government manufacturing not only has been, but remains and will always be, critical to the success of the British economy" (BERR, 2008).
According to recent reports by the Department for Business Enterprise & Regulatory Reform and Department of Innovation, Universities & Skills (BERR, 2008) titled

"Manufacturing: New Challenges, New Opportunities", and The Engineering Employers' Federation (EEF, 2009) titled "Manufacturing Performance", the UK manufacturing sector accounts for about 13% of UK GDP and about 50% of the UK's exports are manufactured goods.

The following provides a snapshot of the continued importance of UK manufacturing according to BERR (2008):

- The UK is the world's sixth largest manufacturer measured by output
- UK manufacturing contributes £150 billion per annum to the economy
- Half of UK exports is from the manufacturing sector
- UK manufacturing accounts for 50% productivity growth since 1997
- 75% of business of Research & Development is for manufacturing
- UK manufacturing is consistently in top rankings of high-tech exports
- Manufacturing accounts for more foreign direct investment than any country apart from the USA.

In addition, this sector employs about four million people representing approximately 14% of the working population of UK (BERR, 2002).

Manufacturing is the use of machines, equipment, tools and labour to transform raw materials into finished goods. The success of manufacturing therefore depends on the performance of the facility (machines, equipment and tools) and the human resource (labour). Machines and equipment degrades with age and usage and ultimately becomes non-operational. The rate of degradation depends on decisions made during the design and manufacturing stages, the operating conditions, the usage intensity and the operators' skills (Murthy, *et al.* 2002). Adequate maintenance management strategies are therefore required to avoid failure of equipment and to ensure that the right volume is sustained.

Maintenance is an important support function for the business processes with significant investment in physical assets which plays important role in achieving organisational goals. However, the cost of maintenance and downtime is too high in many industries. The cost of maintenance in a highly mechanised mine can be 40 - 60% of the operating cost (Kumar & Parida, 2008). Also 15 - 40% of the total cost of finished goods can be attributed to maintenance activities (Mobley, 1990; Dunn, 1987). These show that as the cost of maintenance in a given manufacturing industry increases, all other things being equal, the unit price of the products will rise. Effective maintenance management therefore forms an important approach towards reducing total manufacturing costs and improving productivity of the production process as failure to manage maintenance can lead to high penalty cost due to downtime.

Maintenance costs range from 12 - 23% of operating costs in UK manufacturing and the spending on maintenance in the UK is around £15 billion a year (Cross, 1988). Analysing maintenance performance across Europe, Cross (1988) affirmed that though, in absolute terms, maintenance performance (costs) has improved in the UK; it still lags behind its European counterparts. Evidence from case studies of four UK manufacturing firms shows, that none of them has adopted the third (nor the recent) generation of the maintenance philosophy in its true sense yet (Cooke, 2003). The study according to Cooke (2003) found that there is:

- too little maintenance planning and too much fire-fighting
- insufficient use of measurement of maintenance efficiency and long-term planning
- inadequate budgetary control in maintenance
- a lack of appreciation of the direct costs of maintenance, e.g., the cost of loss of asset availability
- a low level of awareness of modern maintenance techniques of the third and recent generations of maintenance philosophy; and
- limited connection (if any) between maintenance strategy and business strategy.

Therefore to secure the UK's future wealth, manufacturing maintenance management has to become more productive, efficient and innovative to cope with the changing business environment (Cholasuke, *et al.* 2004).

1.3. RESEARCH FOCUS

The importance of facility maintenance management within the manufacturing environment has increased rapidly as many organisations aspire to become world class (Cholasuke, *et al.* 2004). Hence industries need to devise different maintenance strategies to ensure efficient performance of their facilities. There are two major forms of maintenance; Unplanned (or reactive) maintenance and Planned maintenance. Reactive (or run-to-failure) maintenance includes emergency and breakdown maintenance, while planned maintenance includes Preventive, Predictive and corrective maintenance. These planned maintenance strategies are later aligned with proactive strategies such as Total productive maintenance (TPM), Reliability-centred maintenance (RCM) and more recently Risk-based maintenance (RBM). Despite these maintenance strategies there comes a time due to age, operating/environmental conditions and statutory requirements when the entire facility (especially Process industries) had to be shut down for necessary repairs, maintenance and project works. This is called Turnaround Maintenance (TAM) or Turnaround, (TA).

All the major process industries (refining, petrochemicals, power generation, pulp & paper, Beer breweries, Soap manufacturers and fertilizer) and oil production facilities have their own nomenclature for this maintenance project. For the purposes of this research work, TAM is intended to encompass all types of industrial projects for existing process plants including: I&Ts (Inspection & Testing), Shutdowns, Planned outages, Debottlenecking projects, Revamps where an operating plant must be shut down until the work is completed and then re-started - thus "turning around" the plant (Ertl, 2005).

In reality, failures of Turnarounds are common in industries (Ertl, 2005) and most organisations are now resorting to comparative performance metrics to gauge the success or otherwise of a Turnaround. Some metrics according to Oliver (2003) includes; duration, total cost, turnaround costs, safety, start-up incidents, unscheduled downtimes, environmental incidents and savings. The major cause of TAM project implementation failures, as identified from literatures, is that organisations are still implementing TAM as EPC (Engineering, Procurement & Construction) projects. There are obvious differences between EPC project and Turnaround projects (Ertl, 2005; Oliver, 2002, 2003; Levitt, 2004; Lenahan, 1999). Consequently, TAM projects require specialized project management methodology in order to be successful (Ertl, 2005).

Taking scope management for instance, the scope of work is dynamic in Turnaround unlike EPC projects. This is because the entire scope is partially known until the Turnaround execution (Oliver, 2001; Ertl, 2005). Although there have been considerable improvements (especially in the area of risk-based inspections) for predicting the condition of equipment, there still remains elements of discovery when the equipment is opened and cleaned for inspection. This is one of the major problems of Turnaround management. If the Turnaround Management team does not have

adequate skills to handle this with their attendant issues like changes in cost, time, materials, spares and personnel, the TAM is bound to fail.
Other scope-related problems arise because of multiple sources of work items such as capital projects, process needs, inspection requirements, operational needs and maintenance. For a Turnaround to be successful, these work items should be integrated to form an integrated plan and scope (Oliver, 2003; Williams, 2004; Motylenski, 2003). Clark & Hayes (2003) maintained that if this is not done, significant sum of money will be wasted on TAM through; redundant scope, labour inefficiencies, multiple mobilisations and demobilisations, and schedule issues.

Ertl (2005), identified specific management methodology like; Scope, Time, cost, Quality, Human Resources, Communication and Risk management as essential to the success of a TAM project. This implies that inadequacies in any of these areas mentioned can lead to TAM failure.

For a successful TAM project, the organisation should set up a long range business plan to establish long-term plan to control schedules and budgets for the TAM (Krings, 2004; Mclay, 2003; Oliver, 2001, 2002 & Williams, 2004). This should be integrated into the overall corporate plan (Oliver, 2002). Without long-range plans, (Krings, 2004), major repairs and inspections often do not get adequate attention until it is too late to properly prepare for their executions.

Duffuaa & Daya (2004), Gupta, *et al.* (1997) and Oliver (2001), insist that the most suitable people should be selected with great care to forge the strongest possible organisation (management or core team) for controlling the event. According to Mclay (2003), the TAM team should represent all areas of responsibility: administration, operations, engineering, and maintenance; health, safety, and environment (HSE); quality assurance (QA); procurement, planning, and scheduling; and turnaround supervision. In addition the contractor representatives should also be included in this TAM team (Lenahan, 1999).

Materials procurement is further area of concern. Materials here refer to the entire process of bidding, purchasing, delivering and storing supplies needed for the turnaround. The received item must be of good quality and conforms to all pre-determine specifications at a competitive price. Materials can account for 25-35% of a total TAM cost. Therefore, effectiveness of this activity is vital to achieve a successful Turnaround (Motylenski, 2003).

Not including support services such as safety training and management, industrial hygiene monitoring, lead and asbestos testing, and environmental monitoring as part of a turnaround can have a serious impact on scheduled activities as unanticipated delays push the completion date further and further (CAM, 2003). In the domain of nuclear power plants; risk and safety management are very critical and therefore the planning and scheduling system has to enforce safety constraints guaranteeing that the state of the plant is safe at any time during the outage (Gomes, *et al.* 1997).

In view of the above issues, this research intends to identify and establish the factors that affect the implementation of TAM projects and develop an operational framework to assist operators of engineering facilities in TAM projects.
The set objectives of this research work will be achieved using appropriate research methodology. It is envisaged that the research findings and inferences will provide engineering facilities with the operational guide to reduce if not eliminate TAM project failures.

1.4. RESEARCH AIMS

The aims of this research work are to determine the critical success factors that affect TAM implementation projects and to develop a framework to ensure the successful implementation of TAM projects.

1.5. RESEARCH OBJECTIVES

In line with the aims of this research, the objectives of the project are:

1. To identify and establish success measurement criteria of TAM projects.
2. To identify and establish critical success factors of the implementation of TAM projects.
3. To evaluate and establish how these critical success factors can be efficiently managed using TAM management specific methodology.
4. To investigate and establish the management skills/knowledge and personal attributes of the TAM project manager required for a successful TAM project.

5. To develop and validate a framework for the successful implementation of TAM projects.

1.6. SIGNIFICANCE OF THE RESEARCH STUDY

The importance of successful TAM implementation cannot be overemphasised; unsuccessful implementation affects the organisation and the economy adversely. The cost of TAM projects is enormous and can represent up to 40% of the annual maintenance budget of a process plant (Foy, 1999). Shell's report on the TAM project at their refinery in Athabasca, Canada put the cost of their TAM in 2006 at $100-125 million and was extended beyond the planned eight-week duration (Pokharel & Jiao, 2008). TAM performance statistics show that there is still significant improvement required to achieve predictably competitive results. According to Vichich (2008), the average high complexity turnaround exceeds cost and schedule targets by more than 20% and

- 83% of turnarounds do not satisfy all performance expectations; and
- 1 in 4 turnarounds significantly under-perform in more than one success criteria dimension; and are deemed a failure.

In some third world countries, such as Nigeria, the inability to carryout successful Turnarounds in their refineries is one of the causes of petroleum products scarcity despite being a major OPEC oil producer. This is because TAM failures can reduce the capacity of the oil refinery and can also make it difficult to recover its productivity and efficiency (Pokharel & Jiao, 2008). 'Catastrophic failure' which may arise from inadequate Turnaround (or no Turnaround/ scheduled maintenance at all) in the power sector can be a major disaster in the developed countries (2003 London Blackout). Snow (2007) reports that oil prices can be affected by shutdown maintenance of a major oil refinery. This means that TAM activities impacts negatively on the economy of a nation and the populace and hence the need for its successful implementation. Failures of TAM management can also result in loss of revenue, cash, and market share of the organisation and increased routine maintenance costs and reduced reliability/availability of equipment - increasing the cost of production.

Evidence from the literatures reviewed revealed that despite the importance of TAM projects, most of the works in this area are still based on the experiences of individual practitioners. Organisations are still finding it very difficult to carry out these projects successfully. Turnaround failures (budgets blown by millions of dollars, target dates missed by days) are still as prevalent as ever (Ertl, 2005). This implies that there is the need to carry out a robust empirical research to reveal the causes of failures of TAM projects in engineering facilities.

Also it has been shown that management methodology applicable to EPC projects (which organisations are using) are not effective in managing TAM projects and is a major contributor to the failures of TAM projects. Ertl (2005) identified that the maturity of the project management discipline in process industries for turnarounds is still very poor and stagnant. This has resulted in poor TAM project management, evaluation and appointment of the TAM Management team. This research work will however address these issues by identifying and establishing:

- The success measurement criteria to evaluate the TAM project implementation
- The critical success factors of TAM projects
- The management skills/knowledge needed for TAM project management
- And management methodologies applicable to TAM projects to ensure that the TAM implementation success.

Finally, the Turnaround Maintenance Project Implementation, (TMPI) best practice framework to be developed intends to be a benchmark to serve as a reference for averting the TAM project implementation failures.

1.7 OVERVIEW OF RESEARCH METHODOLOGY

Considering the nature of the research aims and objectives, a mixed-method approach has been adopted in this research. The research methodology includes quantitative and qualitative research technique. Following the analysis of the literature review, pilot studies were carried out which included a presentation at Association of Researchers in Construction Management (ARCOM) workshop. Based on these, questionnaires were developed and distributed to hands-on TAM professionals across 160 continuous process plants in UK. Following the preliminary findings from the data collected from the survey, the literature review and the pilot studies, case studies were carried out in six organisations operating continuous process plants in the UK.

The aims of the research have been achieved by identifying and establishing the critical success factors and the development of a framework for the successful implementation of TAM projects based on the analysis of the literature, survey and case studies.

1.8. GUIDE TO THE THESIS

This section presents a brief guide on the contents of each chapter of the thesis. These are as follows:

Chapter 2 presents an insightful literature on the basics of maintenance in engineering facilities. The definition and the reasons for carrying out maintenance are outlined. The developmental changes in maintenance philosophy from First generation (period up to World War II) to the Fourth or Recent generation (Year 2000 to the present) are explained. The chapter also presents the objectives of carrying out maintenance as well as factors affecting them. This is followed by a brief explanation of the benefits of a good maintenance system. Further, the chapter outlines the types of maintenance and briefly explains the various forms of maintenance strategies. Turnaround Maintenance (TAM) or Shutdown maintenance is identified as a proactive maintenance strategy and is a common feature in manufacturing organisations.

Chapter 3 focuses on the main theme of this thesis, Turnaround Maintenance (TAM). Definitions and explanations of TAM and the reasons for this maintenance strategy are presented in details. This chapter also shows that TAM can be considered as project, since it exhibits the characteristics of a typical project. The various phases of TAM project are outlined. This chapter also identifies the real problems of successful implementation of TAM projects. These problems are elaborated in this chapter.

Chapter 4 gives the details of the management problems associated with TAM projects implementation. These were identified as the selection of the wrong TAM project Manager and the use of wrong project methodologies to manage TAM projects. First, the chapter outlines the duties of a TAM Manager across the phases of the project. It then identifies the possible errors that can lead to a wrong choice of a TAM manager. Next, the chapter presents the desirable personal qualities, management skills, knowledge and competencies that a TAM manager requires to manage a TAM project successfully. The chapter also covers TAM project specific management methodologies identifying the areas that need special attention. Finally, the chapters outlines the various innovations embarked upon by various organisations and professionals to optimize TAM project implementation.

Chapter 5 presents the research methodology adopted for this research. Different methodological approaches are explained in details. The chapter covers in detail research process, different methodological concepts and approaches for research, strength and weakness of the different methods. The chapter explains how the methodological approach was chosen for the research and explains its justification. The details of the pilot studies carried out in this study are also presented. This is followed by an outline of the conceptual theoretical framework which guided this research. Finally, the chapter presents the research design which outlined the structure for data collection and analysis.

Chapter 6 reports on the quantitative data collected and the analysis. The chapter presents the data collection methods including the analysis of respondents. It then highlights the methods employed for analysing the quantitative data from the questionnaire survey. The analysis of the data constitutes the major part of this chapter. The chapter presents both descriptive and inferential statistical analysis using SPSS 16.0.

Chapter 7 presents the qualitative data collection and analysis involving the case studies of six continuous process plants in the UK. The chapter starts with selection criteria of the cases and then the profiles of the case organisations. Analyses of typical TAM activities of the organisations are presented outlining their TAM intervals, labour input and duration of the project. The methods of data collection are also outlined with the details of TAM experience of the main staff interviewed. Then the tools used for the analysis of the case studies data are provided. Finally, the data analysis of the case studies is presented.

Chapter 8 reports on the development of the TAM project implementation framework based on the analysis of the literature review, questionnaire survey and the case studies. The chapter presents the framework which is elaborated in five detailed areas; the TAM concept, Leadership Team, Implementation process, Post implementation and Improvement strategies.

Chapter 9 presents the industry validation of the TAM Implementation framework. The chapter outlines the process of the validation, identifying the objectives of the framework validation. It further shows the profiles of the verifiers. The response received from the industry is then presented. Analysis of the feedback from these verifiers is also presented. Finally, a summary of the findings from the validation are outlined.

Chapter 10 is the final chapter of the thesis. It presents the summary of the research work highlighting the methods of data collection and analysis. This section is followed by the summary of findings from the literatures and the research findings section which summed up the main research findings. Also the chapter outlines the main conclusions and the significance of the framework which explained the novelty and contributions this research makes to the body of knowledge and its benefits to organisations for TAM projects implementation. The chapter also covers the recommendations to various parties that will benefit from the TAM framework. Further this chapter highlights the limitations of this research and their applicability to other engineering facilities. Finally, the chapter is concluded with the identification of some areas for further research work.

1.9 SUMMARY OF THE CHAPTER

This is the first chapter of the thesis. It started with the background of this research. This presented the importance and contributions of manufacturing to economy and wellbeing of the populace. It then introduced maintenance as a major contributor to manufacturing cost. The chapter further explained the position of maintenance in the UK which is under-performing compared to her other European counterparts. The chapter introduced Turnaround maintenance as one of the maintenance strategies that organisations adopt to ensure the efficient performance of their facilities. Further, the chapter highlighted some issues that are currently affecting the implementation of this maintenance strategy. The research aims and objectives were presented as well as the significance of the research study. An overview of the research methodology for this research was presented. Finally, the guide to the thesis, which outlined the content of each chapter, was presented.

2.0: MAINTENANCE IN ENGINEERING FACILITIES

2.1 AIMS OF THE CHAPTER

This chapter begins with the introduction of maintenance and how maintenance has developed different philosophies from pre-World War II to the present. It presents the objectives of maintenance in engineering facilities and the factors affecting them. A review of the benefits of effective maintenance and how it affects the profitability of the organisation is presented. The chapter also presents the different types of maintenance, identifying shutdown maintenance as one of the proactive maintenance strategies. The chapter concludes with a chapter summary.

2.2 WHAT IS MAINTENANCE?

The objective of forming and operating an industrial company is to make a profit (Clifton, 1974). Modern industrial societies are characterised by their dependence on technology to produce goods and services. Every business (mining, processing, manufacturing, and service-oriented businesses such as transport, health, utilities, and communications) need equipment to deliver its outputs. Intense competition, coupled with rapid changes in technology has resulted in improvements to equipment so that the output has increased dramatically. Equipment degrades with age and usage and ultimately becomes non-operational. Murthy, *et al.* (2002) stated that the rate of degradation depends on decisions made during the design and manufacturing stages, the operating conditions, the usage intensity and the operators' skills. Adequate maintenance strategies are therefore required to avoid complete failure of the equipment and to ensure that the right volume is produced.

Moubray (1997) identified that maintenance and modification are the two elements to the management of any physical asset and stated that maintenance is carried out towards *'ensuring that physical assets continue to do what their users want them to do'.*

The British Standard Glossary of terms (BS 3811:1993) defined maintenance as:

'Combination of all technical and administrative actions, including supervision actions, intended to retain an item, or restore it to, a state in which it can perform a required function'.

From the aforementioned definitions it can be seen that maintenance is a set of organised activities that are carried out in order to keep an item in its best operational condition with minimum cost required.

With the increasing complexity, sophistication and cost of modern equipment, maintenance has become an indispensable part of a manufacturing system.

Manufacturing organisations are depending more and more upon the skills and organisation of the maintenance function and is growing in importance and size as a specialised function (Clifton, 1974).

2.3. DEVELOPMENT OF MAINTENANCE PHILOSOPHIES

The nature of maintenance work has changed in recent decades as a result of a huge increase in the number and variety of physical assets to be maintained, increasing automation and complexity, new maintenance techniques and changing views on maintenance organisation and responsibilities (Moubray, 1997). Cholasuke, *et al.* (2004) stated that the importance of the facility maintenance management in the manufacturing environment has increased rapidly as many organisations aim to become world class. For many organisations it is important to respond to global competitive pressure by seeking to increase their productivity, maximising the overall equipment effectiveness and pursing an effective and efficient maintenance program.

There has been a very remarkable change in the perceptions and approaches of maintenance since the World War II. This evolution of maintenance philosophies is categorised into four generations as shown in Table 2.1.

2.3.1 First Generation

The first generation covers the period up to World War II (Moubray, 1997, Arunraj & Maiti, 2007). According to Moubray (1997), at this time industries were very highly mechanised, so downtime did not matter much. Murthy, *et al.* (2002) explained that during this period maintenance was considered an unavoidable cost and the only maintenance was corrective maintenance. Whenever an equipment failure occurred a specialised maintenance workforce was called on to return the system to operation. Maintenance was neither incorporated into the design of the system, nor was the impact of maintenance on system and business performance dully recognised. During this period, most equipment was simple and much of it overdesigned, and this made them reliable and easy to repair.

Table 2.1 The development of Maintenance Philosophies

Generation	Time	Background and characteristics of equipment	Maintenance techniques and philosophy
First Generation	Before World War II	•Equipment simple, over-designed, easy to repair	•Basic and routine maintenance •Reactive breakdown service('fix it when it broke') • Corrective maintenance
Second Generation	World War II - 1970s	•More complex, greater dependence of industry on machinery •Higher maintenance cost relative to other operating cost	•Planned preventive maintenance •Time-based approach
Third Generation	1980-2000	•Continued growth in plant complexity and acceleration use of automation •Downtime very costly •Just-in-time systems more common •Rising demand for standard of product and service quality •Tightening legislation on safety	•Condition monitoring, hazard studies, failure modes and effect analysis •Reliability-centred maintenance (RCM) as corner stone •Computer-aided maintenance mangement information system •Work force multi-skilling and teamworking •Emphasis on reliability and availability •Proactive and strategic
Recent Generation	2000 - Present	• Same as above • Increase the profitability of the operation •Optimise the total life cycle cost • Safety & environmental issues	• Risk-based inspection •Risk-based Maintenance • Risk-based life assessment •Condition monitoring, hazard studies, failure modes and effect analysis •Reliability-centred maintenance (RCM) as corner stone •Computer-aided maintenance mangement information system

(Source: Adapted from Cooke, 2003; Arunraj & Maiti, 2007).

Machines were operated until they broke down and there were no way to predict failures. The typical maintenance practices according to Arunraj & Maiti (2007) were:

1. basic maintenance
2. reactive breakdown service (fix it when it broke); and
3. corrective maintenance.

2.3.2. The Second Generation

Due to pressures, during the World War II, there was increased demand for goods of all kinds while the supply of industrial manpower dropped sharply (Moubray, 1997). This led to increased mechanisation and by 1950's machines of all types became more numerous and more complex. This brought the idea that equipment failures could be prevented, and hence the concept of *preventive maintenance.* The maintenance strategy during this period is mainly equipment overhauls done at fixed intervals. This was usually time-based approach of planned maintenance management. Moubray (1997) noted that there was a relative increase in the cost of maintenance compared to other operating costs. This resulted in the growth of *maintenance planning and control* which greatly helped to bring maintenance and its cost under control. The maintenance polices adopted were (Arunraj & Maiti, 2007):

1. Planned preventive maintenance
2. time based maintenance; and
3. system for planning and controlling work.

2.3.3 The Third Generation

Considering the amount of capital committed to fixed assets and the sharp increase in the cost of the assets, the need to maximise the life of the assets became a very big challenge. By mid-seventies till 1990's the process of change in the industry has gathered even greater momentum. Moubray (1997) identified *new expectations, new research and new techniques* as the classes of these changes. During this third generation, the *new expectations* include:

- Higher plant availability
- Greater safety
- Better product quality
- No damage to the environment
- Longer equipment life
- Greater cost effectiveness.

Quite apart from greater expectations, *new research* is changing many of the most basic beliefs about age and failure. In particular, it is apparent that there is less and less connection between the operating age of most assets and how they are to fail.

There has been explosive growth in new maintenance *concepts and techniques.* The new developments according to Moubray (1997) include:

- *decision support tools,* such as hazard studies, failure modes and effects analyses and expert systems
- *new maintenance techniques*, such as condition monitoring
- *designing equipment* with a much greater emphasis on reliability and maintainability
- *a major shift in organisational thinking* towards participation, team-working and flexibility.

2.3.4 Recent Generation

In the 1990s, risk based inspection and maintenance methodologies started to emerge and gain popularity beyond 2000. This generation is highly characterised by the inception of risk-based inspection and maintenance in addition to RCM and Condition-based maintenance (CBM). Up till 2000, maintenance and safety were treated as separate and independent activities. The overall objective of the maintenance process is to increase the profitability of the operation and optimise the total life cycle cost without compromising safety or environmental issues. Inspection and maintenance planning based on risk analysis minimises the probability of system failure and its consequences. It helps management in making correct decisions concerning investment in maintenance and related fields (Arunraj & Maiti, 2007).

Effectively, according to Moubray (1997), the key challenges facing modern maintenance management include:

- to select the most appropriate techniques; and
- to deal with each type of failure process

These are done in order to fulfil all the expectations of the owners of the assets, the users of the assets and the society as a whole:

- in the most cost-effective and enduring fashion; and
- with the active support and co-operation of all the people involved.

2.4 MAINTENANCE OBJECTIVES

The objectives of a maintenance service vary to a great extent and are dictated by the nature of the enterprise (Priel, 1974). Generally, the objective might be considered as being to achieve the optimum balance between the allocations of maintenance resources and the achievement of the plant outputs. The formulation of a maintenance objective is more complex than this and it usually involves the users, owners and the safety department specifying what they want from the maintenance function. Only then can the maintenance function be able to decide how best to maintain the plant (the maintenance strategy) in order to achieve the requirements at minimal maintenance cost (Kelly, 1997).

The main factors that should be taken into account in the formulation of maintenance objective are shown in Figure 2.1. These factors according to Kelly (1997) are:

1. *Maintenance Resources (men, spares and tools)* - can be considered as inducing the direct cost of maintenance. The level of maintenance resources can easily be changed in the case of contract arrangements, much more slowly if the resources are in-house.
2. *Maintenance resources and plant longevity* - A proportion of the maintenance resources is necessarily devoted to ensuring that the machineries and equipments survive up to or beyond the design operating life. The maintenance work involved here is mainly 'protective', e.g. preventing the corrosion of structures, but can also be a major part replacement.
3. *Maintenance resources and desired plant safety (equipment integrity)* - Here again there will usually be no clearly appropriate level or frequency of maintenance. The sensible approach here is to set safety standards by process of engineering judgement based on experience and wherever possible, analyses of plant failures. The extent to which such standards have been compiled with should then be periodically audited.
4. *Maintenance Resources and product output* - Product output can be expressed in various ways, but the most useful of these is usually the *output index* because it combines several other parameters.

Considering these factors, Kelly (1997, pg.88) stated that the general maintenance objective is: '*to achieve the agreed plant operating pattern, product output and quality, within the accepted plant condition and safety standards*'.

Dekker (1996) stated that maintenance objectives can be summarized under four headings - ensuring system function (availability, efficiency and product quality); ensuring system life (asset management); ensuring safety and ensuring human well-being. For production equipment, ensuring the system function should be the prime maintenance objective. Here, maintenance has to provide the right (but not the maximum) reliability, availability, efficiency and capability (i.e., producing at the right quality) of production systems, in accordance with the need for these characteristics (Dekker, 1996).

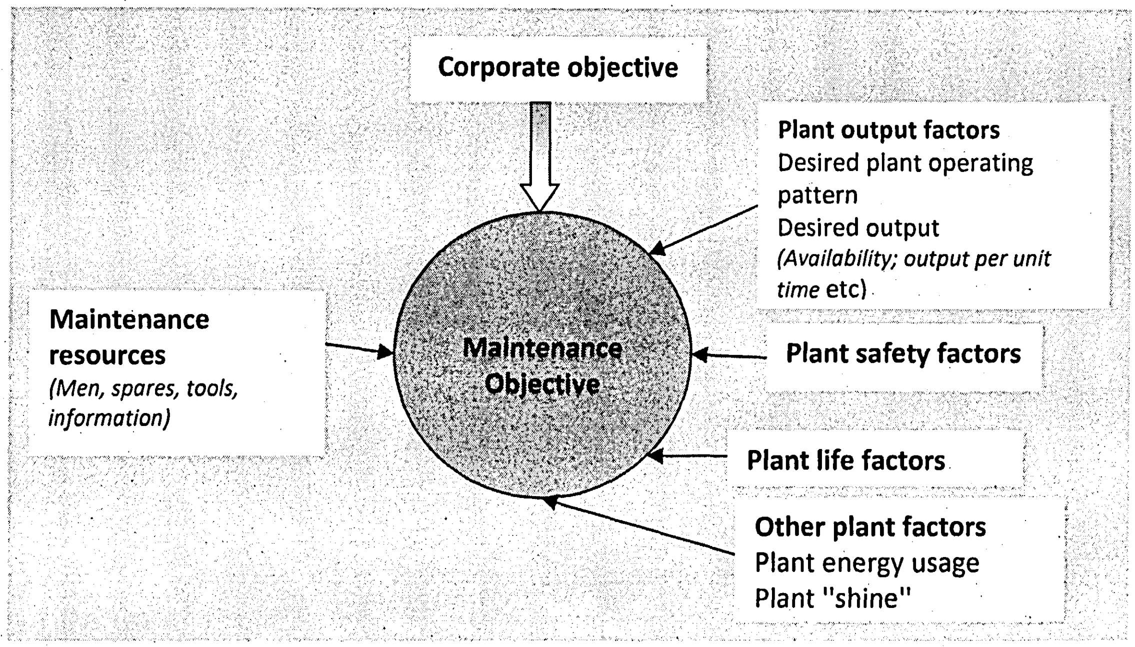


Figure 2.1: Factors affecting maintenance objective setting (Source: Kelly, 1997)

Generally, the maintenance objectives should be consistent with and subordinate to production goals. The relationship between maintenance objectives and production goals is reflected in the action of keeping production machines and facilities in the best possible condition.

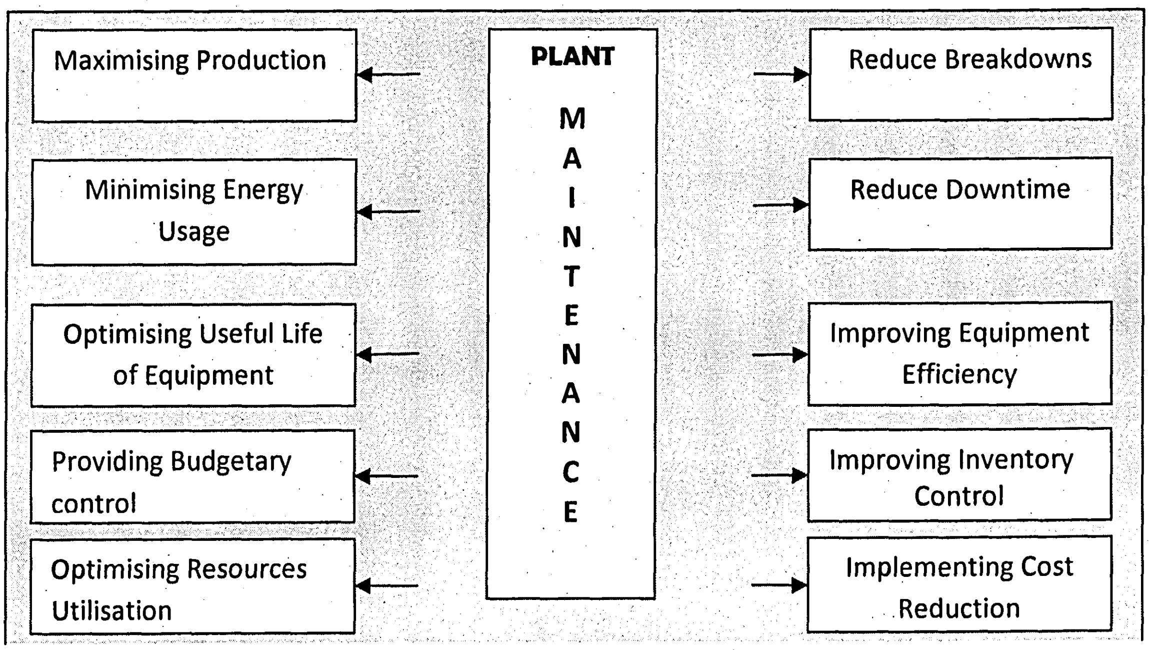


Figure 2.2 Maintenance Objectives

Figure 2.2 shows the summary maintenance objectives which include:

- Improving efficiency and reducing scrap rate
- Minimising energy usage
- Optimising the useful life of equipment
- Providing reliable cost and budgetary control
- Identifying and implementing cost reductions.

Table 2.2. A checklist of maintenance objectives

I *Operational Objectives*

1. To maintain equipment (a) in top operating conditions
   (b) in acceptable condition
2. To ensure maximum availability for plant and equipment at reasonable cost
3. To provide service that will avert breakdowns at all times and at any cost
4. To extend plant life to the last limit
5. To maintain plant and equipment with maximum economy and to replace at predetermined periods
6. To ensure high-quality performance
7. To ensure safe and efficient operation at all times.
8. To maximise output over a certain period of time
9. To maintain a reasonably good appearance of plant
10. To maintain a plant spotlessly clean at all times

II *Cost Objectives*

1. To minimise maintenance expenditure and to maximise profits
2. To provide maintenance service within the limits of a budgeted amount
3. To provide funds as a ratio of sales volume production investment
4. To have maintenance expenditure on the amount of service required by plant and equipment in view of its age and its rate of utilisation
5. To allow a certain amount of contingencies, tooling and incidentals at the discretion of maintenance executive.

(Source Priel, 1974).

In most companies the objectives of maintenance function are assumed to be clear and self-evident. Mostly it is in the midst of disagreement that people discover that a gap exists between what is believed to be objectives of this function. It is therefore very important and advisable to spell out the objectives in clear terms (Kelly, 1997; Priel, 1974; Clifton, 1974). Priel (1974) identified cost objectives and operational objectives as the main areas that needs clear definition which are explained in the checklist in Table 2.2.

2.5. BENEFITS OF GOOD MAINTENANCE SYSTEM

With the change in manufacturing processes emphasising lean manufacturing, the reliability and availability of plant are vitally crucial (Cholasuke, *et al.*, 2004). Ineffective plant maintenance leads to poor machine performance, loss of market share, loss of production which ultimately leads to loss of profit.

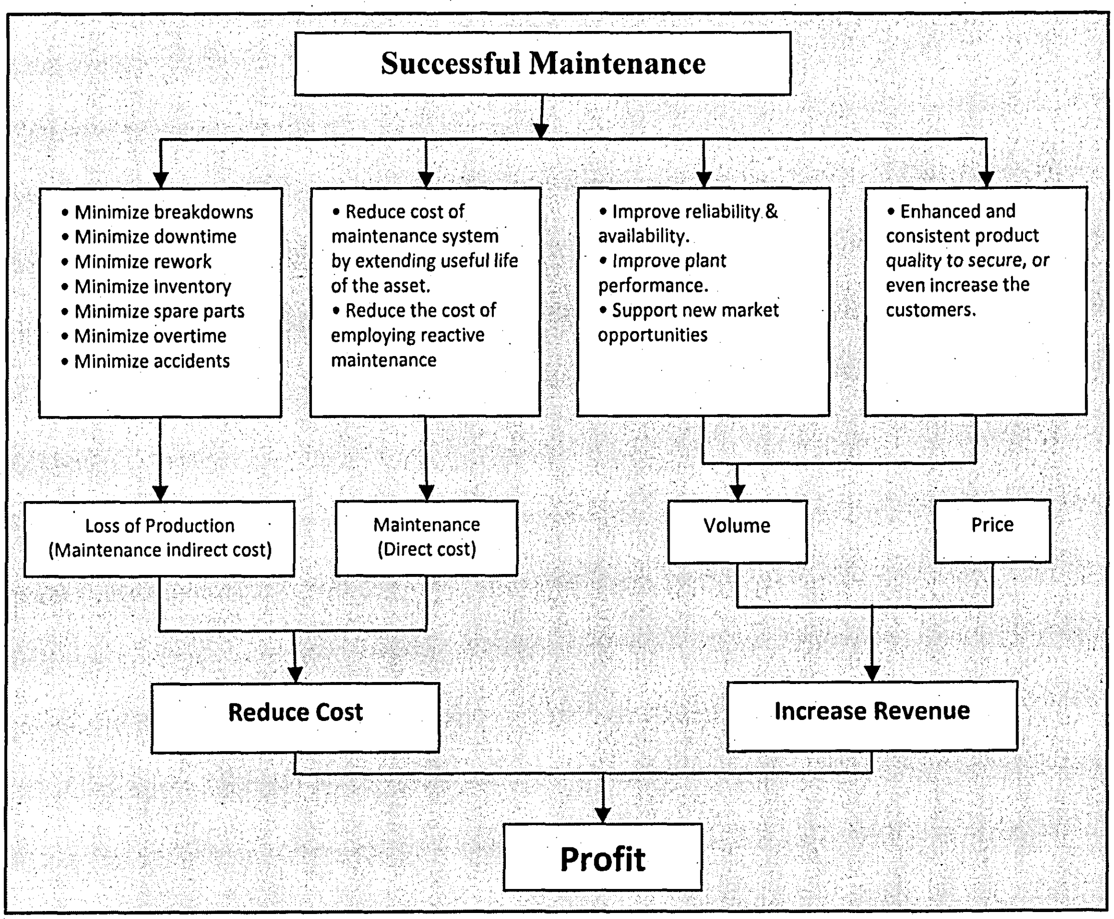


Figure 2.3: How successful maintenance management can maximise organisation profit. (Source: Cholasuke, *et al.*, 2004).

Any loss or reduction of production results in a loss or reduction of profit (Clifton, 1974). Based on the above it can be stated that the ultimate reason for instituting a good maintenance management is to maximise profit and offer competitive advantage (Cholasuke, *et al.*, 2004). Figure 2.3 explains how maintenance can maximise the organisational profit.

Table 2.3 Benefits of good Maintenance.

Group No	The Factors	Expressed in terms of	Important for
a.	***Financial Benefits***		
	1. Extended plant life	Book value	Utilisation capital
	2. Uninterrupted production	Higher plant availability	Utilisation of capacity
	3. Improved quality of production	Reduced scraps and inferior grades	Value of output
	4. Reduced production delays	On-time deliveries, less delay penalties	Customer relations
	5. Reduced cost of repairs	Maintenance costs	Maint. economy
	6. Less stand-by plant and spares	Inventory carrying costs	Capital utilisation
	7. Improved equipment replacement	Lower plant cost per unit of product	Unit costing
b.	***Organisational advantages***		
	1. Co-ordination between production and maintenance	Improved understanding	Internal planning
	2. Manpower planning	Unproductive time	Manpower utilisation
	3. Planning deliveries	Cost of delays	Plant utilisation
c	***Technical Advantages***		
	1. Improved equipment suitability	Better choice of machines	Optimum production facilities
	2. Build up of technical data	Better and more accurate information	Standard of technical services
	3. Improved maintenance schedules	Minimum maintenance costs	Plant availability
	4. Improved Plant condition	Performance and reliability	Operating efficiency
d	***Human considerations***		
	1. Increased safety	Losses due to claims and less production costs.	Production economy
	2. Improved housekeeping	Tidiness of shop floors	Workers' morale
	3. Less friction, better relations	Harmonious relationships	Staff relations
e.	***Customer Relations***		
	1. Reliable delivery dates	Improved reputation	Sales promotions
	2. 'Showcase' housekeeping	Better public image	Company image.

(Source: Priel, 1974).

According to Priel (1974) the benefits to be obtained from a good maintenance service fall into the following five groups:

1. Financial benefits
2. Organisational advantages
3. Technical advantages
4. Human considerations

5. Customer Relations.

Some assessment of the benefits of good maintenance is very difficult as not all the advantages gained can be expressed in figures (Priel, 1974), the list in Table 2.3 shows only practical advantages.

2.6. TYPES OF MAINTENANCE

As explained above, the nature of maintenance work has changed in recent decades as a result of the huge increase in the number and variety of physical assets to be maintained, increasing automation and complexity, new maintenance techniques and changing views on maintenance organisation and responsibilities (Moubray, 1997). In order to cope with these complexities and achieve the maintenance objectives, maintenance philosophy has evolved from reactive to preventive and later to a proactive approach. This means different types of maintenance have evolved (see Figure 2.4). Basically there are two major forms of maintenance strategies:

1. Planned Maintenance
2. Unplanned or Reactive Maintenance.

2.6.1 UNPLANNED MAINTENANCE

Unplanned maintenance (sometimes called Run-to-failure maintenance) as the name implies refers to a set maintenance activities without any previous plan. It is the required repair, replacement or restoration performed on a machine or a facility after the occurrence of a failure in order to bring the machine or facility to at least its minimum acceptable condition.

There are two forms of unplanned maintenance:

Emergency maintenance:

This form of unplanned maintenance is carried out as fast as possible in order to bring failed machine or facility to a safe and operationally efficient condition.

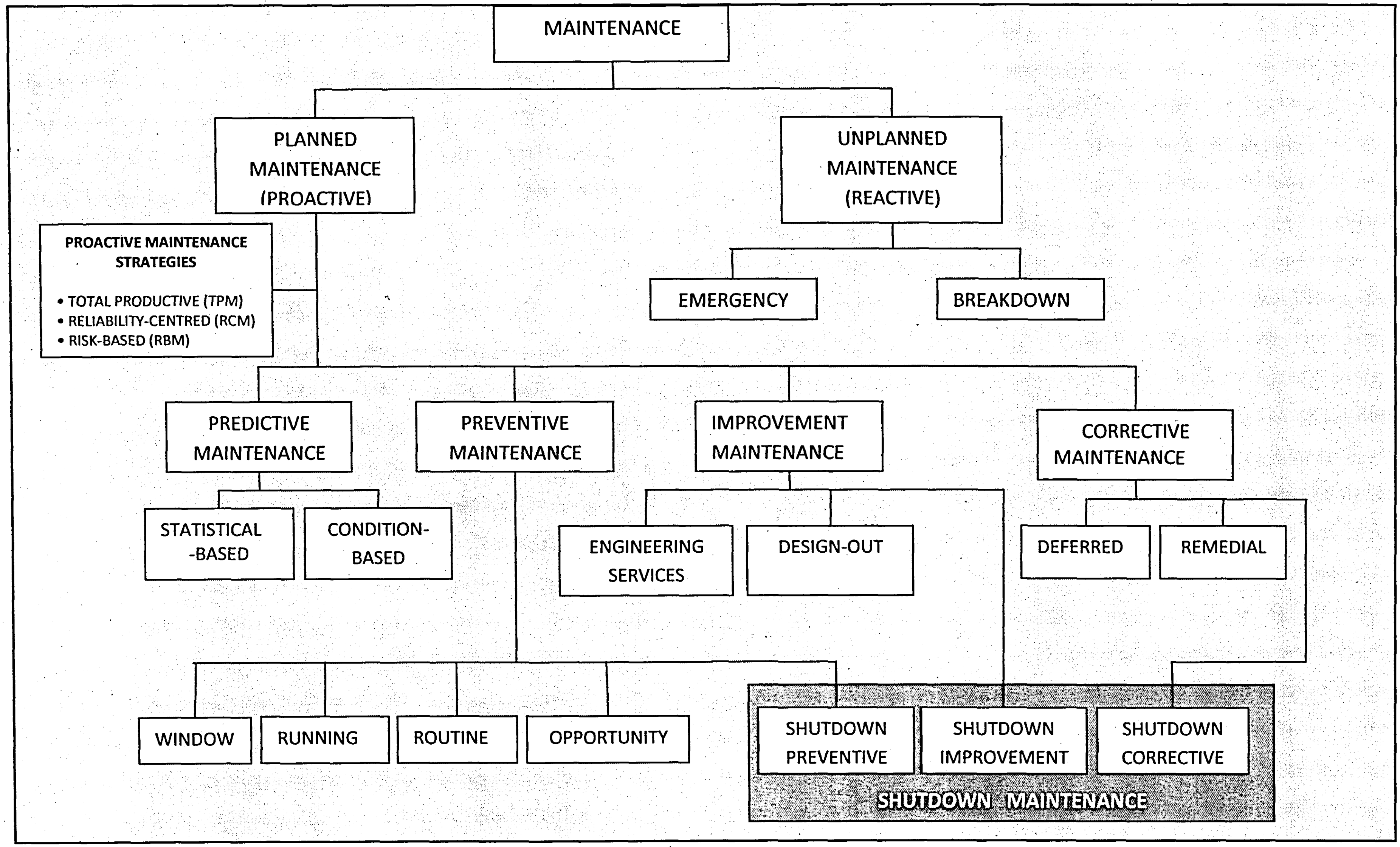


Figure 2.4. Types of Maintenance (Source: Adapted from Clifton, 1974)

Breakdown maintenance

This maintenance is performed after the occurrence of an advanced considered failure for which advanced provision has been made in the form of repair method, spares, materials labour and equipment. This form of maintenance is usually applicable to many items in the plant and equipment that operate as individual units, or are separate to the actual manufacturing process. So their failure would not immediately or greatly affect the overall production process or constitute a safety hazard, the cost of preventing failure may be more than the cost of the breakdown. In these situations, it may be justifiable financially to allow the machine to breakdown before carrying out any maintenance (Clifton, 1974).

The disadvantages of unplanned maintenance include:

- Its activities are expensive in terms of both direct and indirect cost
- Using this type of maintenance, the occurrence of a failure in a component can cause failures to other components in the same equipment, which leads to low production availability
- Its activities are very difficult to plan and schedule in advance.

However, unplanned maintenance can be useful under the following situations:

1. If the failure of a component in a system is unpredictable
2. The cost of performing run-to-failure maintenance activities is lower than performing other activities of other types of maintenance
3. The equipment failure priority is too low in order to include the activities of preventing it within the planned maintenance budget.

2.6.2 PLANNED MAINTENANCE

Planned maintenance involves the repair, replacement and maintenance of equipment in order to avoid unexpected failure during use. Mirghani (2001) explained that the primary objective of planned maintenance is the minimization of total cost of inspection and repair, and equipment downtime (measured in lost production capacity or reduced product quality). It provides service function without which major business interruptions could take place. Planned maintenance can be time- or use- based or could be condition- based. There are different types of planned maintenance as detailed below.

2.6.2.1 Predictive Maintenance (PdM)

Predictive maintenance is a set of activities that detect changes in the physical condition of equipment (signs of failure) in order to carry out the appropriate maintenance work for maximising the service life of equipment without increasing the risk of failure. Predictive maintenance is mainly based on the study of the variations of the system status in terms of pertinent information or data materialising from the degradation and the drift behaviour of the system (Leger, *et al.*, 1999).

PdM, or condition-based maintenance, attempts to evaluate the condition of equipment by performing periodic or continuous (online) equipment condition-monitoring. The ultimate goal of PdM is to perform maintenance at a scheduled point in time when the maintenance activity is most cost-effective and before the equipment loses optimum performance.

This is in contrast to time- and/or operation count-based maintenance, where a piece of equipment gets maintained whether it needs it or not. Time-based maintenance is labour intensive, ineffective in identifying problems that develop between scheduled inspections, and is not cost-effective.

Predictive maintenance is classified into two according to the method used in detecting the signs of failure.

1. Condition-based predictive maintenance depends on continuous or periodic condition monitoring of equipment to detect the signs of failure. This is founded on the principle that wear is responsible for a vast number of mechanical breakdowns and even where not directly responsible; some element of the phenomena is usually present. Wear is a gradual process which affects components at varying rates. The process will not cause sudden mechanical failure, but rather, wear is preceded by changes in the machine's sensible behaviour. Condition-based monitoring revolves around examination of these wear processes in mechanical components (Edwards, *et al.*, 1998). One of the major benefits of this policy is that the resulting corrective maintenance can, in most cases, be scheduled in the short term without production loss (Kelly, 1984).

2. Statistical-based predictive maintenance depends on statistical data from the meticulous recording of the stoppages of the in-plant items and components in order to develop models for predictive failures. Information generated then facilitates

development of statistical models for predicting failure and thus enables preventive measures to be undertaken via a planned maintenance policy (Clifton, 1974).
The major drawback of predictive maintenance is that it depends heavily on information and the correct interpretation of the information.

2.6.2.2 Preventive Maintenance (PM)

Preventive maintenance is maintenance carried out at pre-determined intervals, or corresponding to prescribed criteria, and intended to reduce the probability of failure or performance degradation of an item (Kelly, 1997). It is a set of activities that are performed on plant equipment, machinery, and systems before the occurrence of a failure in order to protect them and to prevent or eliminate any degradation in their operating conditions. Mann (1976) identified the following as potential benefits of a Preventive maintenance program:

i. *Minimum maintenance cost*: Maintenance can be planned, standards can be used and materials can be obtained prior to the start of the work order.
ii. *Maintenance can be performed when it is convenient to the operations and to maintenance:* Decisions can be made as to when, in the production cycle, it is most advantageous for equipment to be removed from service. In addition, the work can be done when it is most convenient to maintenance from the standpoint of availability of materials, equipment and personnel.
iii. *Ability to contract maintenance:* When a number of preventive maintenance jobs can be "packaged," it becomes feasible for maintenance management to have the alternative of contracting the work.
iv. *Less downtime:* If the job can be engineered prior to the removal of the equipment from service, the time that the equipment is out of service can be minimised.
v. *Minimum spare parts inventory:* If it is possible to maximize preventive maintenance, the work can be anticipated and spares can be obtained from the supplier. This minimizes the number of spares that must be purchased and stored in anticipation of emergency maintenance
vi. *Less disruption through emergency maintenance:* Where the work order is anticipated, the sequence of operations can be better documented so that future

work orders, of similar nature, can be written with more knowledge than if the job had been an emergency one which was not documented.

vii. *Less standby equipment is needed:* When it is possible to anticipate maintenance, equipment can be taken out of service at a time convenient to operations and standby equipment need not be used.

viii. *Less overtime is needed:* Preventive maintenance makes it possible to plan and schedule maintenance jobs with a greater degree of accuracy, and knowing how long the job should require reduces overtime.

ix. *Increased safety:* Rules of safety can be better applied to anticipated work than to work which is emergency in nature.

x. *Less pollution:* Many of the emergency problems that result in flaring of smoke-producing chemicals are eliminated by preventive maintenance.

Researchers subdivided preventive maintenance into different kinds according to the nature of its activities:

1. Routine maintenance includes those maintenance activities that are repetitive and periodic in nature. It usually involves day to day operational activities to keep the plant operating such as lubrication, cleaning and small adjustments (Srivastava, 2009).

2. Running Maintenance is a planned preventive maintenance activities that can be carried out whilst the facility is in service (Clifton, 1974). It includes those maintenance jobs that are done while the machine or equipment is running and they normally represent those activities that are performed before the actual preventive activities take place.

3. Opportunity maintenance is a set of maintenance activities that are performed on a machine or a facility when an unplanned opportunity exists during the period of performing planned maintenance activities to other machines or facilities.

4. Window maintenance is carried on a machine or equipment when it is not required for a definite period of time.

5. Shutdown preventive maintenance is a preventive maintenance in which set activities are carried out when the production is in total stoppage situation.

2.6.2.3. Improvement Maintenance (IM)

This type of maintenance aims at reducing or eliminating the need for maintenance entirely. These include:

1. Design-out maintenance is a set of activities that are used to eliminate the cause of maintenance, simplify maintenance tasks, or raise machine performance from the maintenance point of view by re-designing those machines and facilities which are vulnerable to frequent occurrence of failure and their long term repair or replacement cost is very high. According to Kelly (1984), design-out aims to eliminate the cause of maintenance. Clearly, this is an engineering design problem but it is often part of the maintenance function's responsibility. Design-out is appropriate for items of high maintenance cost which arises either because of poor maintenance, poor design or operation outside design specification.

In many cases design-out is aimed at items that were not expected to require any maintenance. Therefore such a policy can only be implemented effectively if an information system exists which facilitates the identification of such items (Kelly, 1984).

2. Engineering services involves the use of engineering services such as construction, construction modification, removal and installation and rearrangement of facilities in order to reduce or eliminate maintenance.

3. Shutdown improvement maintenance is a set of improvement maintenance activities that are performed while the production line is in a complete stoppage situation.

2.6.2.4. Corrective Maintenance (CM)

British Standard 3811:1993 Glossary of terms defined corrective maintenance as: *"the maintenance carried out after recognition of failure and intended to put an item into a state in which it can perform a required function."*

Patton (1994) defined corrective maintenance as *'unscheduled maintenance or repair actions, performed as a result of failure or deficiencies, to restore items to a specific condition'.*

In this type of maintenance, actions such as repair, replacement, or restore are carried out after the occurrence of a failure in order to eliminate the source of the failure or reduce the frequency of its occurrence. Corrective maintenance arises not only when an item fails but also when indicated condition by condition monitoring. It is only after the maintenance causing event that the influencing factors (cause of failure, cost of replacement or repair, availability of resources, cost of availability, etc) can be assessed and the type of repair determined (Kelly, 1984).

The main objectives of this type of maintenance are:

- to maximise the effectiveness of all critical plant systems
- the elimination of breakdowns
- the elimination of unnecessary repair; and
- the reduction of the deviations from optimum operating conditions.

There are basically two forms of Corrective maintenance:

1. Remedial maintenance is the set of activities that are performed to eliminate the source of failure without interrupting the continuity of the production process. Remedial maintenance is usually carried out by taking the item to be corrected out of the production line and replacing it with reconditioned item or transferring its workload to its redundancy.

2. Deferred maintenance is a set of corrective maintenance activities that are not immediately initiated after the occurrence of a failure but are delayed in such a way that will not affect the production process.

3. Shutdown corrective maintenance in this form of corrective maintenance, the activities involved is only performed when the production line is in total stoppage situation.

Corrective maintenance defers from preventive maintenance in that maintenance can only be carried out after a failure has occurred, but its activities are usually planned and regularly performed to keep plant's machines and equipment in optimum operating condition. Corrective maintenance activities usually follow four important steps:

1. Fault detection
2. Fault isolation
3. Fault elimination
4. Verification of fault.

The fault elimination and verification stages involve several actions such as adjusting, aligning, calibrating, reworking, removing, replacing or renovation. In order to achieve an effective corrective maintenance, the following prerequisites should be adhered to:

1. Accurate identification of incipient problems
2. Effective planning which depends on:
    - the skills of the planners
    - the availability of well developed maintenance database about standard time to repair
    - a complete repair procedures
    - the required labour skills; and
    - specific tools, parts and equipment.
3. Proper repair procedures
4. Adequate time to repair
5. Verification of repair

2.6.2.5. Total Productive Maintenance (TPM)

Total Productive Maintenance (TPM) is a maintenance program, which involves a unique concept for maintaining plants and equipment. The goal of the program is to markedly increase production while, at the same time, increasing employee morale and job satisfaction (Venkatesh, 2007). Bamber, *et al.* (1999) explained that TPM is a company-wide approach to plant, equipment or asset care that involves the active participation of more than just the maintenance department working on maintaining and improving the overall equipment effectiveness. Swanson (2001) dubbed TPM as an aggressive maintenance strategy as it goes beyond efforts to avoid equipment failures through preventive and predictive maintenance strategies.

TPM is a maintenance philosophy of maintenance management developed in Japanese manufacturing plants to support the implementation of just-in-time manufacturing, advanced manufacturing technologies and to support efforts at improving product quality. According to Swanson (2001), TPM activities focus on eliminating the "six major losses". These losses include equipment failure, set-up and adjustment time, idling and minor stoppages, reduced speed, defects in process and reduced yield.

Venkatesh (2007) identified the following below as the most important objectives for introducing TPM:

- Avoid wastage in a quickly changing economic environment.
- Producing goods without reducing product quality.
- Reduce cost
- Goods send to the customers must not be defective.

According to Nakajima (1988), the concept of TPM includes:

1. maximizing equipment effectiveness (overall efficiency)
2. establishing a thorough system of preventive maintenance for the equipment's entire life span.
3. implementing it by various departments in a company
4. It is based on the promotion of preventive maintenance through motivation management involving small-group activities.

Table: 2.4 Features of Total Productive Maintenance

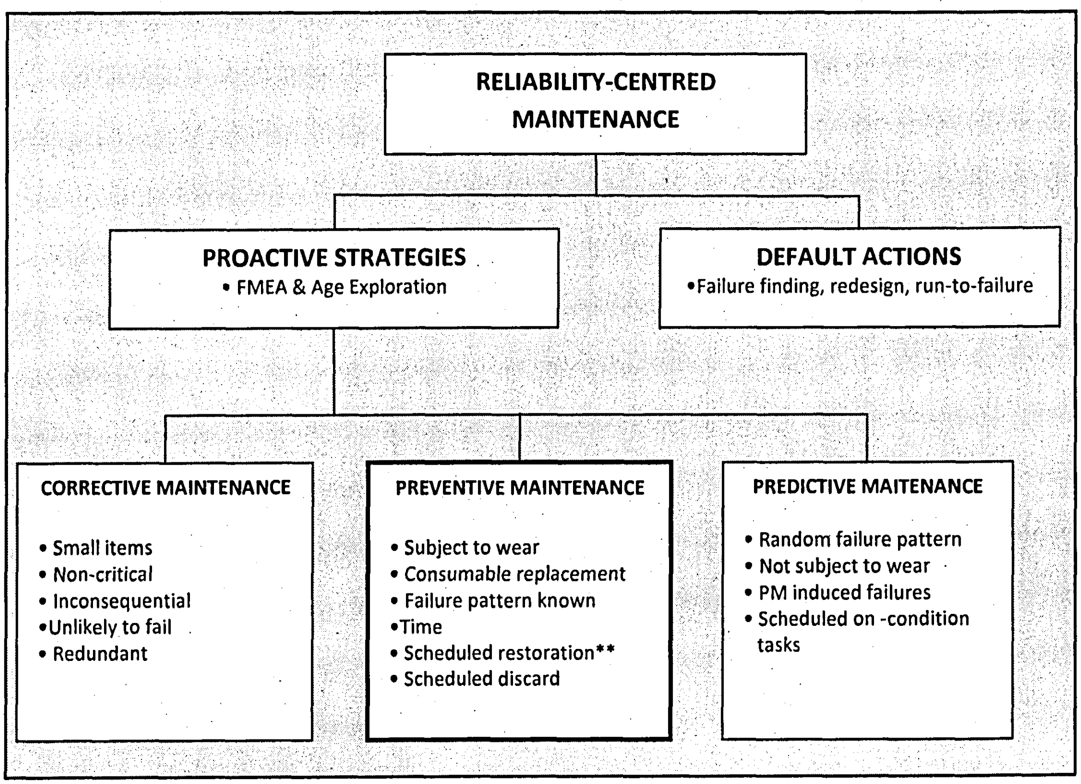
Motives of TPM	1. Adoption of life cycle approach for improving the overall performance of production equipment 2. Improving productivity by highly motivated workers, which is achieved by job enlargement 3. The use of voluntary small group activities for identifying the cause of failure, possible plant and equipment modifications.
Uniqueness of TPM	The major difference between TPM and other concepts is that the operators are also made to involve in the maintenance process. The concept of "I (production operators) Operate, You (maintenance department) fix" is not followed
TPM Objectives	1. Achieve Zero Defects , Zero Breakdown and Zero Accidents in all functional areas of the organisation 2. Involve people in all levels of the organisation. 3. Form different teams to reduce defects
Direct benefits of TPM	1. Increase in productivity 2. Reduction in customer complaints 3. Reduction in the manufacturing cost by 30% 4. Satisfying the customers needs by 100% (Delivering the right quantity at the right time, in required quality). 5. Reduce accidents
Indirect benefits of TPM	1. Higher confidence level among the employees 2. A clean, neat and attractive work place 3. Favourable change in the attitude of the operators. 4. Achieve goals by working as a team. 5. Horizontal deployment of new concept in all areas of the organisation. 6. Sharing knowledge and experience. 7. The workers get a feeling of owning the machine.

(Source: Venkatesh, 2007)

Table 2.4 gives a summary of the motives, uniqueness, objectives, benefits of TPM Maintainability improvement and maintenance prevention are two team-based TPM activities (Swanson, 2001). In maintenance prevention teams work to improve equipment performance through improved equipment design. The maintenance function works with engineering department during the early stages of equipment design. This ensures that the equipment designed and installed are easy to maintain and operate.

2.6.2.6. Reliability-centred Maintenance (RCM)

Moubray (1997 pg.7), defined Reliability-centred maintenance as *"a process used to determine the maintenance requirements of any physical asset in its operating context."* Gurumeta (2007) defined RCM as "series of activities generated on the basis of a systematic evaluation to develop or optimize a program of maintenance. It incorporates logical decisions to find the operational and safety consequences of failures and identifies the mechanisms responsible for the above mentioned failures."



**overhaul

Figure 2.5 RCM and other maintenance types. (Source: Adapted from Gurumeta, 2007)

Generally speaking RCM is a process used to determine what must be done to ensure that any physical asset continues to do whatever its users want it to do in its present operating context. RCM consists of structured processes to determine the equipment maintenance strategies required for any physical asset to ensure it continues to fulfil its intended function(s) in present operating conditions. The goal of RCM according to Eti, *et al.* (2006) is to determine what is critical components in any process are and, based on this information, design a customised preventive/predictive maintenance strategy as shown in Figure 2.5. The analysis of RCM bases on a detailed Failure Mode and Effect Analysis (FMEA) and according to Gurumeta (2007) includes:

- Probability of failure
- Reliability system calculations.

Most traditional lists of failure modes include:

- Deterioration due to wear and tear
- Human error (on the part of operators and maintainers)
- Equipment or component design flaws.

A detailed analysis of these modes in an industry will yield an enormous number of failure modes. Each of these failures affects the organisation in one way or the other. They also affect the operations, the product quality, customer service, safety or the environment. According to Moubray (1997), a great strength of RCM is that it recognises that consequences of failure are far more important than their technical characteristics. In fact it recognises that that the only reason for doing any kind of proactive maintenance is not to avoid failures *per se,* but to avoid or reduce the consequences of failure. These failures are classified as follows:

- *Hidden failure consequences:* Hidden failures have no direct impact, but they expose the organisation to multiple failures with serious, often catastrophic, consequences.
- *Safety and environmental consequences:* A failure has direct safety consequences if it leads to injury or fatality. It has environmental consequences if it could lead to a breach of any corporate, regional, national or international environment standard.
- *Operational consequences:* A failure has operational consequences if it affects production (output, product quality, customer service or operating costs in addition to the direct cost of repair).

- *Non-operational consequences:* Evident failures which fall into this category affect neither safety nor production, so they involve only the direct cost of repair.

Moubray (1997) identified the following failure management techniques to avoid failure:

- *Proactive tasks:* These are tasks under taken before failure occurs, in order to prevent the item from getting into a failed state. They embrace what is traditionally known as 'predictive and preventive' maintenance. These also involve *scheduled restoration and scheduled discard and scheduled on-condition tasks.* Scheduled restoration entails remanufacturing a component or overhauling an assembly at or before a specified age limit, regardless of its condition at the time.
- *Default actions:* These deal with failed state and chosen when it is not possible to identify an effective proactive task. Default actions include *failure-finding, redesign and run-to-failure.*

It should be noted that RCM is not necessarily a type of maintenance but a strategy which is used to avoid maintenance using the core maintenance types like preventive and predictive maintenance.

2.6.2.7 Risk-based Maintenance (RBM)

For a facility to extend operating life of aging equipment safely and cost effectively, implementing the latest inspection and maintenance strategies is a must (Anderson, 2002). Risk based inspection has its roots in process safety management and mechanical integrity programs and is gradually becoming accepted as good engineering maintenance practice for implementing inspection and maintenance programs.

Risk-based maintenance methodology is based on integrating a reliability approach and a risk assessment strategy to obtain an optimum maintenance schedule and aims to reduce the overall risk of the operating facilities (Khan & Haddara, 2004, McCalley *et al*, 2003; Arunraj & Maiti, 2007). According to McCalley, *et al.* (2003), RBM is considered a form of RCM with the following attributes:

- The condition information is used to estimate equipment failure probability
- Failure consequences are estimated and utilised in the prioritization of the maintenance tasks
- Equipment failure probability and consequence at any particularly time are combined into a single metric called risk.

- Equipment risk may be accumulated over time interval (e.g., a year or several years) on an hour-by-hour basis to provide a cumulative risk associated with each piece of equipment
- The prioritization (and thus selection) of maintenance tasks is based on the amount of reduction in cumulative risk that is achieved by each task.
- Scheduling and selection of maintenance tasks is performed at the same time since the amount of reduction in cumulative risk depends on the time a task is implemented.

Risk-based maintenance framework according to Arunraj & Maiti (2007) comprises of two main phases:

1. Risk assessment
2. Maintenance planning based on risk.

Anderson, (2002) defined risk assessment *'as the process of gathering data and analysing information to develop an understanding of the risk of a particular process'.* The major aim of RBM is to reduce the overall risk that may result as a consequence of unexpected failures of operating facilities. The inspection and maintenance activities are prioritised on the bases of quantified risk caused due to failure components, so that the total risk can be minimised using risk-based maintenance. The high-risk components are inspected and maintained usually with greater frequency and thoroughness and are maintained in a greater manner, to achieve tolerable risk criteria (Arunraj & Maiti, 2007).

Arunraj & Maiti, (2007), suggested that RBM methodology consists of six modules:

1. *Hazard analysis.* Hazard analysis is done to identify the failure scenario. The failure scenarios are developed based on the operational characteristics of the system, physical conditions under which operations occur, geometry of the system and safety arrangements.
2. *Likelihood assessment.* The objective here is to calculate occurrence of the undesired event. The frequency of failure or failure probability for defined period of time is calculated in this step.
3. *Consequence assessment.* The objective here is to quantify the potential consequences of the credible failure scenario. The consequences are production loss (performance loss and operational loss), asset loss, environmental loss and health and safety loss.

4. *Risk estimation.* Based on the result of consequence analysis and the probabilistic failure analysis, the risk is estimated for each unit.
5. *Risk acceptance.* The computed risk is compared against the risk acceptance criteria. If any unit/component risk exceeds the acceptance criteria, maintenance is required to reduce the risk.
6. *Maintenance planning.* Maintenance planning is adopted to reduce the risk

2.6.2.8 SHUTDOWN MAINTENANCE

Figure 2.4, shows three forms of shutdown maintenance: preventive, improvement and corrective shut down maintenance. This is the form of maintenance that can only be carried out when the equipment or facility is out of service. It is a planned maintenance strategy that can be carried out on a unit (usually called overhaul) or the entire production facility commonly called Turnaround maintenance.

Turnaround maintenance (TAM) is a common feature in continuous process plants. TAM is essential to maintain consistent productivity, increasing reliability, reducing maintenance costs due to corrective maintenance and managing resources more effectively (Pokharel & Jiao, 2008). Plant maintenance is becoming increasingly sophisticated as techniques for optimising when and precisely what maintenance work in a plant is being adopted. Achieving improved levels of equipment reliability/availability and reducing costs is a key objective of maintenance function. Achieving a cost effective plant shutdown is an integral part of the focus on reducing routine maintenance costs.

2.7. SUMMARY OF THE CHAPTER

The chapter presented insightful literature on maintenance in manufacturing industry. The manufacturing industries depend on some fixed assets (machines and equipment) to transform raw materials to finished products. These fixed assets degrade with age, usage, environmental conditions, and operators' skills and so on. The maintenance function is required therefore not only to avoid complete failure of the unit but also to ensure it continues to do what their users want them to do. The chapter also explained how the various types of maintenance strategies evolved from reactive maintenance to proactive maintenance. Maintenance objectives were identified. Apart from profit (financial benefits), this chapter showed organisational and technical advantages, human and customer relations issues are also benefits of a good maintenance system to the organisation. Finally, the chapter identified and explained the various types of maintenance.

In a typical manufacturing organisation, however, the various maintenance types are combined to develop a strategy that will be most cost effective and ensure the other benefits of a good maintenance system are achieved.

From this chapter, it is evident that shutdown maintenance is a proactive maintenance strategy and a common feature in manufacturing organisations. It is also apparent that irrespective of the proactive maintenance type used, a time will come when the equipment will need an overhaul. In continuous manufacturing, to overhaul major equipment calls for the total stoppage of the plant, this is the essence of Turnaround Maintenance (TAM).

3.0: TURNAROUND MAINTENANCE IMPLEMENTATION

3.1 AIMS OF THE CHAPTER

In chapter 2, Turnaround maintenance (TAM) is identified as one of the maintenance strategies in process plants to maintain consistent productivity, increasing reliability, reducing maintenance costs due to corrective maintenance and managing resources more effectively. This chapter introduces the main research area. It starts with the explanation of the concepts of TAM projects, outlining the need for carrying out TAM and relating TAM management to project management. Also this chapter presents the problems associated with TAM implementation. It will also address the issues of TAM success measurement criteria and identify the critical success factors of TAM project implementation. The chapter concludes with the chapter summary.

3.2 TURNAROUND MAINTENANCE

To achieve corporate performance - whether measured in terms of shareholders value, revenue growth, profitability or customer satisfaction - companies must maximize the performance of fixed, or capital assets that have a direct and significant impact on achieving corporate objectives (Duffuaa & Daya, 2004).These fixed assets which include: plant; equipment and machinery deteriorate due to their use and exposure to environmental conditions. If these conditions are allowed to impact unchecked, a facility can become unserviceable and even brings the facility to a standstill. We have seen in Chapter 2 that organisations devise different maintenance strategies involving different maintenance types to ensure that physical assets continue to do what their users want them to do. One of these maintenance strategies is Turnaround maintenance (TAM) or Turnarounds.

3.2.1 What is Turnaround Maintenance (TAM)?

TAM is mainly concerned with the engineering activities (maintenance and projects) that are carried out when all the operations of an engineering facility is shut down. According to Duffuaa & Daya (2004), TAM is '*a planned general outage of equipment and assets that are an enterprise's major means of production or service delivery for the* *purpose of essential maintenance and statutory checks that cannot be done while the equipment or assets are in operation'.*

Lenahan (2006) on the other hand defined a TAM as *'an engineering event during which new plant is installed, existing plant overhauled and redundant plant removed'.*

Generally, Turnaround maintenance is a planned periodic shutdown or outage of a plant to perform maintenance, overhaul and repair operations and to inspect, test and replace process materials and equipment and project jobs which can only be done while the facility is shutdown.

According to Duffuaa & Daya (2004) and Lenahan (1999), during turnaround maintenance, the following jobs are carried out:

1. work on a facility which cannot be done unless the whole plant is shutdown
2. work which can be done while the equipment is in operation but requires a lengthy period of maintenance work and a large number of maintenance personnel; and
3. defects that are pointed out during operation, but could not be repaired, are maintained during turnaround maintenance.

Other jobs done during this period include; electrical power distribution system inspections, re-calibration of controls and pneumatic systems for optimum performance and projects. The project jobs are usually in the form of Plant upgrades; tie-ins of new facilities or lines and modification jobs. TAM projects are the most expensive and time consuming maintenance projects because during this period there is loss in production as well as the cost of the turnaround itself. The positive impacts are obvious; though they are often overlooked. These positive impacts according to Mclay (2003) are:

- Increase in equipment asset reliability
- Continued production integrity
- A reduction in the risk of unscheduled outages or catastrophic failure.

3.2.2 Need for Turnaround Maintenance

There are several business reasons for a TAM project; they include operator safety, environmental regulation compliance, capacity increase, yield enhancement, feed stock changes and debottlenecking (Buckner, 2005).

By statutory requirement some equipment in most process plants need to be inspected and some safety units tested and certified periodically. Such equipment are mainly pressure units such as boilers, heat exchangers, piping, reactors, compressed air receivers and even storage tanks. This regulatory requirement is usually administered by a local government authorised inspector who may stipulate an internal inspection frequency as a condition of maintaining the operating permit (Mclay, 2003).The turnaround maintenance in most cases is planned around this exercise. In glass manufacturing and other similar plants however the turnaround is planned during the re-lining of refractory on the furnace and refuelling in the case of Nuclear power plants.

Levitt (2004) identified six categories of reasons for carrying out a TAM project which are basically down to improved performance of the plant (in one form or another) or compliance with law:

1. *Market demand;* One reason for a TAM is changes in market demand (new products or need for increased capacity) in order to:
    a. Meet a competitive challenge
    b. Meet an expanding market
    c. Open a new market.

2. *Profit enhancement* -This involves efficiency improvements to save money or reduce the cost of making the existing products
    a. Operational efficiency
    b. Energy efficiency
    c. Reduced scrap or increased yield.

3. *Maintenance need;* Maintenance need (replacing worn out assets) is one of the most common drivers for TAMs. These needs might be based on PM inspections, Non-destructive tests (NDT), maintenance history and in some situations manufacturers' specifications. In these circumstances TAM is used to:
    a. Increase reliability
    b. Increase repeatability
    c. Increase or augment life span.

4. *Customer's request;* Customer's requests can lead to a need for the plant's up-grade (process improvements like automation to reduce the number of operators) for increased production might drive a TAM to:
    a. Increased throughput
    b. Increase quality.

5. *Technological Advances;* TAM can be used to up-grade the plant facility by integrating technological advancements. This will lead to process improvements; (to improve yields, improve quality, and increase efficiency) which ultimately creates significant profit opportunities.

6. *Laws change:* Changes in government administrations (different ruling party, different agency directors) can lead to changes in legal requirements. These changes like regulatory changes, safety improvements and consent decrees can change quickly. For instance many process plants in recent times have had multiple TAMs to adapt the plant to new air, water or land pollution rules (Levitt, 2004).

McQuillan, *et al.* (2003); explained that turnarounds are an accepted feature in operation in Process plants and that turnarounds have direct impact on the overall plant reliability. The benefits of optimizing the work done during a turnaround include:

- Reducing the probability of breakdowns between turnarounds
- Protecting future process performance at design throughput/energy efficiency.
- Increasing the interval between shutdowns
- Reducing the duration of each shutdown.

Continuously postponing turnarounds will eventually result in a failure and safety incidents. Such failures results to unplanned shutdowns, which would take more time to repair and will be extremely expensive (Bijvank, 2004; Mclay, 2003). To avoid such scenario, turnarounds are usually scheduled in advance.

3.3 TURNAROUND MAINTENANCE IMPLEMENTATION

Turnaround maintenance implementation encompasses all the processes involved in getting all the engineering activities (maintenance and projects) including installation, repairs, running, testing, and making necessary changes and projects jobs carried out as expected.

Due to the complexity of the process and the resources involved, the tools and techniques of project management is uniquely adaptable to activities associated to TAM (Brown, 2004; Whittaker, 1992; Pokharel & Jiao, 2008).

3.3.1 TAM as a Project management strategy

The main difference between project management and general management relates to the definition of a project and what it tends to deliver to the client and stakeholders. According to PMBOK, a project is: "*... a temporary endeavour undertaken to create a unique product or service. Temporary means that every project has a definite end. Unique means that the product or service is different in some distinguishing way from all similar products or services."*

APMBOK however stated that a project is: "*... a unique, transient endeavour undertaken to achieve a desired outcome".*

Stated differently, it means that a project is a *temporary* endeavour with a finite completion date undertaken to create a unique product or service. There are basically two major characteristics of a project.

- *Temporary Endeavour*; To be temporary signifies that there is a discrete and definable commencement and conclusion; the management of a project requires tailored activities to support this characteristic, as such, a key indicator of project success is how it performs against its schedule—that is, does it start and end on time.

- *Unique Deliverable*; The uniqueness of the deliverable, whether it is a product, service, or result, requires a special approach in that there may not be a pre-existing blueprint for the project's execution and there may not be a need to repeat the project once it is completed. Uniqueness does not mean that there are not similarities to other projects, but that the scope for a particular project has deliverables that must be produced within constraints, through risks, with specific resources, at a specific place, and within a certain period; therefore, the process to produce the deliverable as well as the deliverable itself is unique.

Considering the above definitions and characteristics of a project, it is evident that TAM is a project with;

- *Temporary endeavour* - starting when the plant is shutdown and ends with the plant start-up.
- *Unique deliverable* - its desired out come is to improve the plants operations.

Other distinctive features of a project identified by Burke (2003) which are also inherent in a TAM implementation are:

- *A start and finish* (although they may be difficult to define - the start may have crystallised over a period of time and the end may be slow phase out)
- *A life-cycle* (a beginning and an end, with a number of distinct phases in between).
- *A budget* with an associated cash flow
- *Activities that are essentially unique and non-repetitive*
- Use of *resources,* which may be from different departments and need co-ordinating
- *A single point of responsibility* (i.e. the project manager)
- *Team roles* and relationships that are subject to change and need to be developed, defined and established (team building).

Project management strategy is therefore very suitable for managing TAM. Project Management is defined in several ways;

PMBOK stated that; "*Project management is the application of knowledge, skills, tools, and techniques to project activities in order to meet or exceed stakeholder needs and expectations from a project"*

For APMBOK, "*Project management is the process by which projects are defined, planned, monitored, controlled and delivered such that the agreed benefits are realised. ....* and further stated that "*Projects brings about change and project management is recognised as the most efficient way of managing such change"*.

Fellow, *et al.* (2002) however gave a more elaborate definition; "*Project Management is the art of directing and coordinating resources throughout the life of a project, by using modern techniques to achieve predetermined objectives of scope, cost, time, and quality and participants expectation"*.

In other words Project management is the discipline of organizing and managing resources in such a way that these resources deliver all the work required to complete the project within defined scope, quality, time and cost; a project is a temporary and one-time endeavour undertaken to create a unique product or service, that brings about beneficial change or added value.

From the above definitions, it means that apart from the scope, time, cost, safety and quality, the project must also satisfy some performance expectations: beneficial change/added value (participants expectations) and this varies from one project to another. This clearly identifies that the purpose of the project is to meet the stakeholders' needs and expectations. It is therefore a fundamental requirement for the Project manager to establish who the stakeholders are (besides the client) and analyse their needs and expectations to define, at the onset, the purpose of the project, its scope of work and objectives.

In TAM projects, the stakeholders'/participants' expectation includes:

- Bringing the plant to their original health
- Making plant safe to operate till the next outage.
- Improving efficiency and throughput of plant by suitable modification.
- Reducing routine maintenance costs.
- Increasing reliability/availability of equipment during operation.

The above expectations have to be achieved on time, within cost and meet all the quality requirements in a safe manner and with no environmental impact for a Turnaround project to be considered successful.

3.3.2 TAM Project Implementation Process

TAM project process consists basically of four phases (Mclay, 2003; Lenahan, 1999; Duffuaa & Daya, 2004; Bijvant, 2004). Though the nomenclature may differ, but for the purposes of this research project the phases are: Initiation, Planning, Execution and Closure. These four phases forms a never ending cycle, implying that the closure phase of one TAM marks the initiation phase of the next TAM (Lenahan, 1999; Oliver, 2002; Bijvant, 2004; Levitt, 2004) as shown in Figure 3.1.

3.3.2.1 Initiation Phase

This phase starts from the moment the senior manager flags up the necessity to start considering the requirements for the forthcoming TAM project (Lenahan, 1999). During this phase all the strategic issues to be addressed and the activities required to move the process to the point where it can actually be planned and prepared are defined in detail (Lenahan, 2006). It is the period during this phase that the key personnels are appointed and the management team formed. During this stage, the TAM team should meet with the policy team to define clearly the ground work for the upcoming TAM (Oliver, 2001 & Lenahan, 1999). The meeting should consider the type and nature of TAM such as significant capital items, time until the next TAM; and other factors affecting the work content. The initiation phase is used to identify the initial work items to be carried out. Among the deliverables of this phase are:

- Preliminary worklists
- Basic cost estimates
- Estimated duration
- Turnaround preparation milestone; and
- manpower forecast for turnaround planning resource

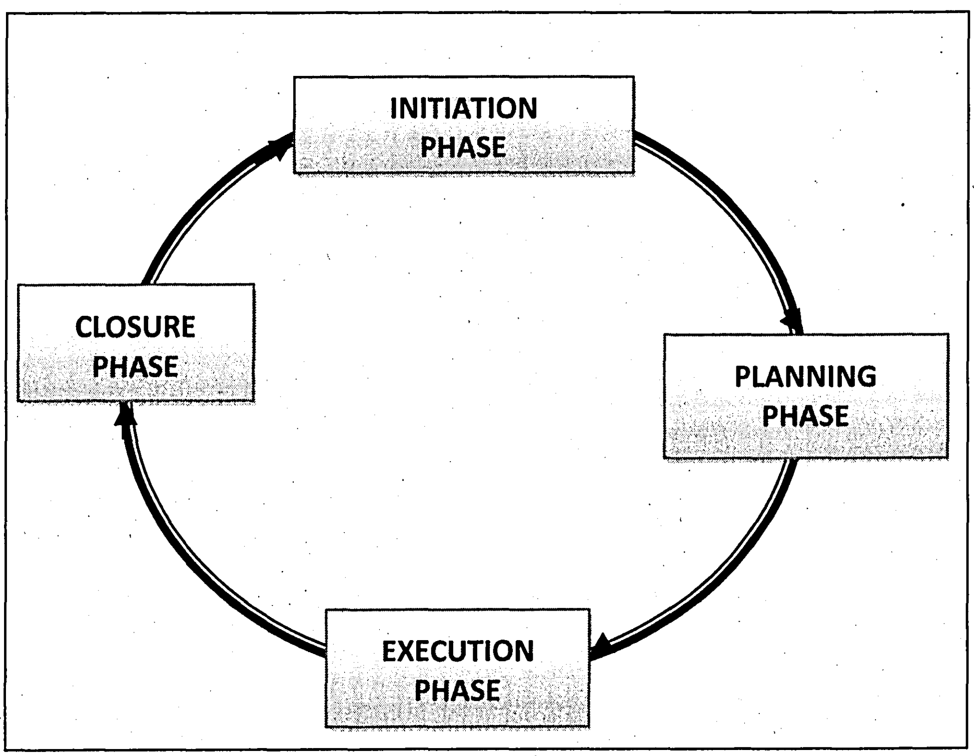


Figure 3.1 TAM Project life cycle.

3.3.2.2 Planning Phase

Having identified the work to be accomplished and the scope of work that can be completed with time and money allotted, the next is Planning phase (Brown, 2004). This is the major phase of the TAM process. The normal TAM features a high volume of work carried out by a large number of people working under time and access constraints. The basic objective of planning is to ensure that the right job is done safely at the right time and assigned to the right people (Duffuaa & Daya, 2004; Lenahan, 1999). According to Raiche (1997), the planning stage is both a time of getting organized and one of educating all the people who will be involved in the Turnaround. In this phase the issues includes:

1. Planning
2. Scheduling
3. Generating control documents
4. Contingency.

The planning phase usually contains elements of uncertainty because it involves some prediction of unknown conditions (of plant items) which, in turn, can involve everything from informed technical assessment to 'finger crossed' guesswork (Lenahan, 2006).

3.3.2.3 Execution Phase

This phase follows the planning phase and ideally starts once the project plan has been approved and base lined. This is the period when the planned work is carried out and monitored against the event schedule, duration, cost, quality and safety requirements (Lenahan, 2006). This phase starts as feed is reduced, then stopped, and includes plant/unit shutdown, preparation of site for entry by workers (staff and contract), worklists execution and verification and finally start-up as covered in the detailed plan (Oliver, 2003).

3.3.2.4 Closure Phase

Lenahan (2006) identified two key elements in these phase:

1. Ensuring that the plant is handed back in a fit condition

2. The de-briefing of every member of the Turnaround organisation.

This phase covers de-mobilisation, documentation, and cost reports and perhaps most importantly, lessons learned that can be carried forward to the next TAM (Oliver, 2001). This is the period of formal hand-over of the plant by TAM manager to the Plant Manager. According to Lenahan (1999); the TAM manager arranges a final site inspection with the Plant Team. This is to ensure that:

- all agreed work has been completed
- all traces of TAM have been removed
- the plant is clean and tidy; and
- any damage done during the turnaround has been repaired.

Finally is the TAM report, which is the TAM manager last activity and of course the final activity of the TAM process. The final report should be a cogent document that is an accurate description of what was done, what needs to be done and what did this all cost (Brown, 2004).The next action is to decide the date for the first meeting of the policy team for the next TAM, and the first document which should be considered at that meeting is the report from the previous TAM (Lenahan, 1999).

3.3.3 Problems of successful implementation of TAM Projects

As explained above, project management methodology can be adapted to manage TAM projects. However, Ertl, (2005) stated that the maturity of the project management discipline in process industries for turnarounds is still very poor and stagnant at best. The main problem of TAM project implementation is that organisations are still implementing TAM as EPC (Engineering, Procurement & Construction) projects (Ertl, 2005). One of the greatest challenges to TAM managers is realizing that turnarounds are different from EPC projects and hence have their own unique characteristics and demands (Ertl, 2005; Oliver, 2002, 2003; Levitt, 2004; Lenahan, 1999). These unique characteristics mean that the factors affecting TAM projects success as well as how they impact on TAM projects are different from that of EPC projects. These features also imply that TAM projects are wrongly evaluated as the success measurement criteria should be different from what is currently used. These elements as shown in Figure 3.2 are wrongly applied to TAM projects and hence are the major problems of TAM projects successful implementation.

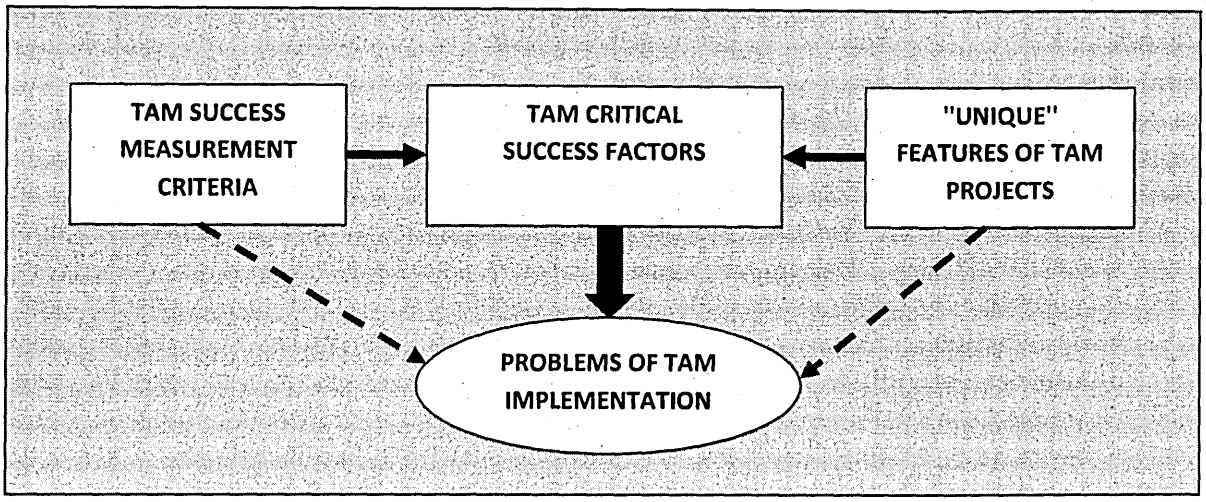


Figure 3.2: Major Problems of TAM project implementation.

3.4 FEATURES OF A TURNAROUND MAINTENANCE PROJECT

As identified above Project management is applicable to TAM management. There are however operational differences that set them apart from other Engineering projects. It has been identified from the literatures that the major cause of TAM project failures is that organisations still manage TAM like other EPC projects. Below are the special features of TAM project which organisations should be aware of to assist in the implementation of TAM projects and the basic differences between TAM and EPC projects are shown in Table 3.1

According to Lenahan (1999), whilst most other projects centre around creating something new, or the addition of something new to existing entity, TAM is concerned mainly with the replacement, repair or refurbishment of items which have malfunctioned in some way, or are worn, corroded or damaged.

TAM projects occur in a very short time (Motylenski, 2003) and require the mobilization of hundreds or thousands of workers and a large quantity of materials and equipment on site, the completion of a substantial work scope (including work the need for which emerges during the event) and the demobilization of the men and equipment, all in a short time (Lenahan, 1999). This short duration makes the measurement of time in hours and shifts (Ertl, 2005; Levitt, 2004).

Table 3.1 Comparison of EPC and TAM projects.

ENGINEERING, PROCUREMENT & CONSTRUCTION (EPC) PROJECTS	TURNAROUND MAINTENANCE (TAM) PROJECTS
Creation of something new or the addition of something new to an existing entity	Concerned mainly with the replacement, repair or refurbishment of items which has malfunctioned or are worn, corroded or damaged
Usually well defined scope, from: a. drawings b. specifications c. contracts d. permits, memos, etc	Usually loosely defined scope, from: a. past turnaround experience b. inspection reports c. operations, maintenance requests d. historical estimates
Scope is static. Few changes occur during execution	Scope is dynamic. Many changes occur as inspections are made.
Can be planned and scheduled well in advance	Planning and scheduling cannot be finalized until scope is approved, generally near the shutdown.
Projects are organised around costs codes/commodities.	Turnarounds are work order based
Generally do not require safety permits to perform work	Turnaround work requires extensive permitting every shift.
Man-power staffing requirements usually do not change.	Man-power staffing requirements change during execution due to scope fluctuations.
Project schedules can be updated either weekly or monthly	Turnaround schedules must be updated every shift, daily.
Projects measure time in days, weeks and months	Turnaround measure time in hours or shifts
Project usually has end point	No clear defined end point.
Project scope are usually all mandatory	Turnaround scope is flexible. Usually a large % of work can be postponed to a later window of opportunity if necessary.
Project schedules are uncompressed. Schedule acceleration can be used to correct slippages in the critical path.	Turnaround schedules are compressed. There may be little or no opportunity to correct the critical path by accelerating the schedule.

(Source: Adapted from Ertl, 2005; Levitt, 2004 & Lenahan, 1999)

Another feature of TAM project is the work scope. A large portion of the scope of work is not usually known until right up to the beginning of TAM (Ertl, 2005; Levitt, 2004; Lenahan, 1999; Oliver, 2001, 2002). This is because the scope of work changes as the equipment is disassembled. This scope fluctuation causes work force staffing changes during the TAM execution (Ertl, 2005 and Levitt, 2004). As a result of these scope changes, planning and scheduling cannot be finalized until the scope is pinned down and approved. This usually occurs late in the process (Ertl, 2005 and Levitt, 2004).

TAM work scope is usually loosely defined and are usually from past turnaround experience, inspection reports operations requests and historical estimates.

TAM projects are characterised by many unrelated jobs as a result of multiple sources of work items (Levitt, 2004). Input of these work items is obtained from projects, process/production, quality assurance, operations, maintenance, engineering and safety departments. (Oliver, 2003; Williams, 2004; Motylenski, 2003; Lenahan, 1999; Duffuaa & Daya, 2004). This results in some cases of one job per work order and leads to many one-step activities (Levitt, 2004). Extensive safety permitting is needed for every shift because of this un-related jobs nature of TAM tasks.

TAM schedules are usually compressed. There may be little or no opportunity to correct the critical path by accelerating the schedule. The compressed work basis for executing TAM means that all team members have less time to analyze and react to changing priorities. Problems that go unchecked can significantly impact the chances for reaching the time and budget goals. As a consequence, there is a much greater need for using the schedule to drive the project execution in a TAM project (whereas it is sometimes used mostly as a contractual tool in EPC projects). It is critical for all schedule and progress information to be highly visible, timely, comprehensive and accurate.

Another point according to Levitt (2004) is that TAM has no clear defined end point. This is because there is always more work to be done. This work scope flexibility results in a large percentage of work being postponed to a later window of opportunity if necessary (Ertl, 2005).

3.5 TAM PROJECTS IMPLEMENTATION SUCCESS EVALUATION

Project evaluation is essential to understand and assess the key aspects of a project that make it either a success or a failure. The success or failure of a project is influenced by a large number of factors and many times it is hard to measure them objectively (Wohlin & Andrews, 2001). These factors can only be adequately identified when the success criteria is properly defined. Inadequacy in measuring the project outcome can contribute to it not being managed effectively. According to Naughton (2004); "*If we are to predict and effect the direction of our projects, we must know where to correct, what to correct, and how much to correct*".

Despite efforts by organisations to ensure successful implementation of TAM projects, there are still several reports of failures. One argument could be that Organisations seems keen to adopt factors to achieve success, such as methodologies, tools, knowledge and skills, but continue to measure the TAM outcome using the wrong criteria. If the measurement criteria were the cause of the reported failures, continuing to use those will simply repeat failures of the past.

Project success is a topic which is frequently discussed and yet rarely agreed upon. The concept of project success according to Liu & Walker (1998) and Chan & Chan (2004) can mean so much to so many different people because of varying perceptions, and leads to disagreements about whether a project is successful or not. Chan & Chan (2004) further stressed that definitions of project success are not universal but are dependent on the nature of the project type, size and sophistication, project participants and experience of owners. Applying the measurement criteria of EPC projects (as currently done) to TAM projects can therefore be misleading considering their differences as identified in Section 3.4. TAM project success measurement criteria are therefore necessary not only to assist in identifying the factors that affect TAM project success but also to ensure a correct evaluation of the TAM project outcome.

Traditionally, the success of a project is assessed using internal measures such as technical and operational goals, and meeting schedule and budget. Chan & Chan (2004) defined criteria for project success as the set of principles or standards by which favourable outcomes can be completed within a specification. Pinto & Slevin (1987) pointed out that project implementation incorporated four basic facets. They pointed out that a project is generally considered successful if it:

- comes in on-schedule (time criterion)
- is executed within budget (monetary criterion)
- achieves basically all the goals originally set for it (effectiveness criterion)
- is accepted and used by the client for whom the project is intended (client satisfaction criterion.

According to recent studies project success is much more than the success of project implementation success. According to Shenhar, *et al.* (1997), it has been recognized that several other measures should be used to define project success. These measures reflect external effectiveness: the project's impact on its customers and on the developing organization itself.

Table 3.2: Literatures on Project success measurement criteria

Source	Project success measurement criteria
Lim, *et al.*, (1999)	**Micro and Macro view points of Project success ;** 1.*Completion criteria*: time, cost, quality, quality, performance & Safety 2. *Satisfaction criteria*: Owners, users, stakeholders & general public
Haughey, (2007)	**Four Levels of Projects success:** 1. *Project Management success*: Cost, time & quality 2. *Repeated project management success*: Predictable outcomes 3. *Project success*: Benefits Realised 4. *Corporate success*: Strategies implemented, value added.
Westhuizen, *et al.*, (2005)	**Two dimensions of success:** 1. *Project management success*: within time, budget, specification, stakeholder satisfaction & quality project management process. 2. *Project product success*: Product or added value success, user satisfaction, individual impact & organisational impact.
Shenhar, *et al.*, (1997)	**Four Dimensions of Project success:** 1. *Project efficiency* (Short term measure): Completed on time, within the specified budget 2. *Impact on customer* (Related to the customer and/or user of the result): Meeting performance measures, functional requirements, technical requirements. 3. *Business & Direct success* (Measures performance) : time, cycle time, yield & quality and total improvement of organisation performance. 4. *Preparing for the future* (long term dimension): Preparing organisation & technological infrastructure for the future.
Atkinson, (1999)	**Three staged Project success:** 1. *The process* (doing it right): cost, time, quality, efficiency 2. *The system* (getting it right): Benefits to stakeholders involved in the project; Criteria from project manager, top management, customer-client and team member; Resultant system. 3. *The benefits* (getting them right): Impact on customer; Business success.
Ashley, et al., (1997)	**Six Criteria of Construction project success measurement.** 1. Budget performance 2. Schedule Performance. 3. Client satisfaction. 4. Functionality. 5. Contractors' satisfaction. 6. Project manager/team satisfaction.
Chan & Chan, (2004)	**Consolidated framework for measuring Project success.** 1. Cost. 2. Time 3. Health & safety 4. Participants' satisfaction 5. User expectation/satisfaction. 6. Environmental performance 7. Commercial profitable/value. 8. Quality

From the literatures reviewed on various engineering projects (see Table 3.2), TAM project success can be evaluated using three main broad components (as shown in Figure 3.3):

- *Management success* - a measure of project management efficiency.
- *Perception of stakeholders* - an assessment of the perception of the Client/Top management, Project team members, and the users of the 'product' of the project.
- *Resultant benefits to the business* - a measure of the benefits to the organisation accruable from the 'product' of the project.

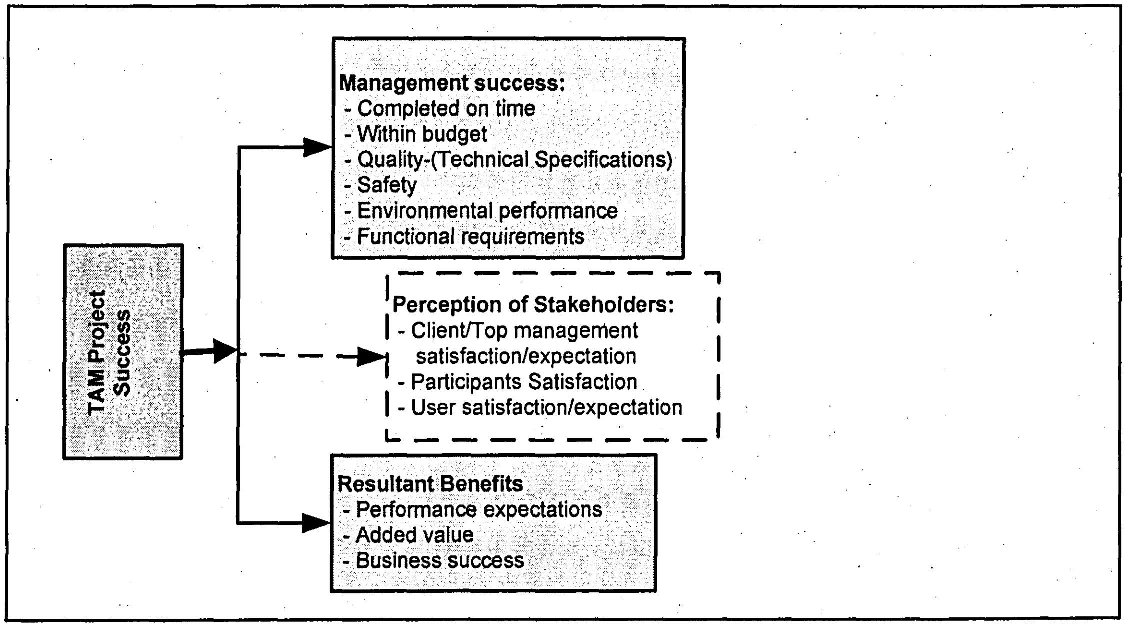


Figure 3.3: Proposed TAM Project Success measurement model (Source: developed for this research).

3.5.1 Management Success evaluation

3.5.1.1 Time (Duration)

Time is the duration for completing the TAM project. Durations of TAM projects are very dynamic and are very difficult to estimate. Unlike in EPC projects where scope variations are minimal, scope changes is a common feature in every TAM project. Despite all strategies that are put in place to estimate and forecast the scope of work, there are always elements of surprises. If the new scope as a result of emergent work imparts on the critical path, the duration might be pushed forward, thereby causing time overruns implying TAM project failure. Is this a good measure? Motylenski (2003), Levitt (2004) and Oliver (2001, 2002) stated duration as a measure of TAM success, but did not define the duration. Motylenski, (2003), considered finishing the TAM project within the duration expected. This definition does not give a good measure of duration as 'expectation' varies from one person to another depending on who is assessing the project.

3.5.1.2 Cost

Cost is another important TAM project success measurement criterion (Motylenski, 2003, Levitt, 2004 and Oliver, 2001, 2002). Cost is defined as the degree to which the general conditions promote the completion of the project within the budget. Again this measurement if considered as in EPC projects will be misleading considering that scope of work changes (additions) resulting in the increase in cost. Situations may arise that despite all the estimates made, the cost may overrun the budget. This cost overrun may be as result of extra resources e.g. equipment hires, spares or contract cost adjustments to cope with the emergent scope which was not considered earlier. If this scenario is not considered properly, the cost used in evaluating the TAM project success may be misleading.

3.5.1.3 Quality

Quality is another basic criterion that is heavily referred to by previous researchers in EPC projects. Project quality means meeting customers need fully for the end product, reducing the reworking of non-conforming tasks, keeping customers informed of the progress of the project (Tukel & Rom, 2001).

However, the assessment of quality is rather subjective. In the construction industry, quality is defined as the totality of features required by a product or service to satisfy a given need; fitness for purpose (Chan & Chan, 2004). In a TAM project, quality is a measure of the adherence to standard operating procedure (SOP) and technical specifications for carrying out a job. These procedures ensure strict compliance of all tasks to Engineering standards. Commissioning incidents (Motylenski, 2003, Levitt, 2004 and Oliver, 2001, 2002) is a measure of the quality of the TAM project.

3.5.1.4 Functionality of the Equipment

There would be no point in undertaking a project if it does not fulfil its intended function at the end of the day (Kometa, *et al.*, 1995). The importance of functionality cannot be over-emphasised. The indicator correlates with the expectations of the TAM project participants and can best be measured by the degree of conformance to all technical specifications. Quality, technical performance, and functionality are closely related and are considered important to the Client/Top management and the TAM project participants. Plant Start-up incidents (Motylenski, 2003; Levitt, 2004 and Oliver, 2001, 2002) is also measure of how the functional requirement is met in a TAM project.

3.5.1.5 Safety

Health and safety are considered as the degree to which the general conditions promote the completion of a project without accidents or injuries. Absence of personal injuries and no facility incidents is one of the characteristics of a successful TAM project (Motylenski, 2003).One measure of all industrial work is safety, and this is acutely true during shutdowns. The goal is no one is hurt or killed (Levitt, 2004). In the nuclear power plants, radiation dose exposure is measured and compared with budgeted levels (IAEA, 2006).

3.5.1.6 Environmental Performance

Environmental impact is a measure of TAM project management success (Motylenski, 2003; Levitt, 2004 and Oliver, 2001, 2002). TAM projects generate large volumes of waste that must be properly identified, labelled, stored and eventually disposed of (CAM, 2003). The Technical committee which was formed by International Organisation for Standardisation developed a series of standards, which are known as ISO14000 series. It contained 21 standards and guidance documents on environmental management and provides a benchmark of proper environmental management practice. In the UK, the Environmental Protection Act. 1990 sets out the framework for integrated pollution Control and process authorisations. The emission limits applicable to the chemical industry are stated in the Environmental Agency process guidelines. These guidelines are used to assess the Environmental Impact Assessment (EIA) of a given TAM project.

3.5.2 Perception of Stakeholders

The impact of the TAM project on the stakeholders is a measure on how the stakeholders evaluate the TAM project outcome. Here the stakeholders include:

- Client/Top management
- Project participants : the TAM project team, the contractors, vendors, etc

- The users; the plant operators, maintenance team etc.

The Client/Top management is considered as the owner of the business and usually evaluates TAM project outcome on the management success criteria and the impact to the business. On completion of TAM project, the owner of the business is usually satisfied if the management process is a success and expects that the technical and business objectives of carrying out the TAM project should also be met at the long run.

The Project participants (TAM management team, contractors, TAM workers); TAM project participants' perception of success varies with the individual participant. They commonly share project management outcome as a criterion for success.

For the users (plant operators), their main mode of TAM success measure is in the operational performances of the equipment and the plant being safe to operate till the next outage.

The maintenance team considers a TAM project on the level of breakdown frequencies (failure levels) in the plant.

3.5.3 Resultant Benefits

The resultant benefits of TAM project on the organisational business is a measure of how the TAM project affects the operations of the plant. This is actually the measure of the 'product' of the project. In other words this is a measure of how the objectives of TAM project are met. The objectives TAM project as stated earlier includes:

- Bringing the plant to their original health
- Making the plant machines safe to operate
- Improvement on efficiency and throughput of plant by suitable modification
- Reduction of routine maintenance costs
- Increasing the reliability/availability of equipment during operation
- Upgrading technology by introducing modern equipment and techniques.

Unfortunately, most of the objectives can only be assessed long after the conclusion of the project. Duncan (2004) gave some suggestions on some projects that have similar problems of evaluation. The Project Management team should determine what it can influence towards the end results (Duncan, 2004), and suggested some project type and success measures as shown in Table 3.3.

Table 3.3: Project type and success measurement criteria (Source: Adapted from Duncan, 2004).

Serial. No	Project Type	Success Measurement
1	Consumer Product	Unit Manufacturing cost
2	Web-based Software Application	100% compliance with public standards
3	Information Technology	Training

From the above it is very evident that there is no clear-cut mode of measurement of TAM project outcome:

- Organisations mostly are using comparative performance metrics to compare the TAM project activity performance instead of assessing each project individually.
- The Duration (time) measurement does not take into consideration the additional duration due to emergent jobs which impacts on the critical path, which must be done to ensure the overall objective of the project being realised.
- The Cost (budget) measure is silent about the cost associated to emergent jobs which must be done to ensure realising the objective of the project.
- Again there is no comment in the literatures of how to measure the benefits to the organisation of the entire project itself. It is true that most of the objectives of a TAM project can only be realised long after hand-over to the operations, but there is need for organisations to agree on some form of measure at the end of the project towards the TAM objectives.

This research work will, considering the above develop a framework to assist organisations to measure the outcome of their TAM projects effectively.

3.6 CRITICAL SUCCESS FACTORS (CSF) OF TAM PROJECTS IMPLEMENTATION

Critical Success Factor (CSF) is a business term for an element which is necessary for an organization or project to achieve its mission. Project success factors define those factors if not done right will result in a failed project. They are required and necessary for successful execution and improved team communication, focus and energy (Witt, 2002).

Despite the extensive research in recent years on the critical success factors of project implementation, there is little agreement on the causal factors of project success. A major reason is the widespread assumption that a universal theory of project management can be applied to all types of projects. According to Dvir, *et al.* (1998), project success factors are not universal to all projects. This implies that different projects exhibit different set of success factors. It is therefore necessary to consider projects success factors according to the project under review noting its peculiar features. The knowledge of TAM project critical success factors is therefore imperative to ensure its successful implementation.

Important to the understanding of the process of Project management is an examination of the underlining factors critical to the implementation process. Researchers in Project Management field have generated several lists of critical factors in an attempt to understand project implementation success. Some researchers have presented theoretical and empirical frameworks that identify project implementation success factors. Table 3.4 shows a list of some attempts by different researchers to determine critical success factors of project implementation.

Table 3.4 List of literatures on critical success factors of Project implementation

SOURCE	CRITICAL SUCCESS FACTORS (CSF)
Ruben and Seeling (1967)	Technical performance as a measure of success. Project manager's experience has minimal impact but the size of previously managed project does affect the manager's performance
Avots (1969)	Adequate basis for Project; Right Project manager; Top Management support; Adequately defined tasks; Adequate Project management techniques; Adequate use of management techniques; Planned project close down Commitment to project.
Sayles & Chandler (1971)	Project manager's competence; Scheduling; Control systems and responsibilities; Communication; Monitoring and feedback; and Continuing involvement in the project.
Martin (1976)	Define goals; Selection of organizational philosophy; General management support; Organize and delegate authority; Selection of project team; Allocate sufficient resources; Provide for control and information mechanisms; and require planning and review.
Baker, et al. (1983).	Clear goals; Goal commitment of the project team; On-site project manager; Adequate funding to completion; Adequate project team capability; Accurate initial cost estimates; Minimum start-up difficulties; Planning and control techniques; Task -social orientation; and Absence of bureaucracy.

Cleland and King (1983)	Project summary; Operational concept; Top management support; Financial support; Logistic requirements; Facility support; Market intelligence; Project schedule; Executive development and training; Manpower and organisation; Acquisition; Information and communication channels; Project review.
Locke (1984)	Make project commitment known; Project authority from top; Appoint competent Project Manager; Set up communications and procedures; Set up control mechanisms (schedules, etc); and Progress meetings.
Morris and Hughes (1986)	Realistic goal; Competition; Client satisfaction; definite goal; Profitability; Third parties; Market availability; The implementation process; Perceived value of the project.
Ashley, et al. (1987)	Management, Organization; Communication; Scope and Planning; Controls; Environmental, Economic, Political and social; Technical.
Morris and Hughes, (1987)	Project requirement/objectives; Community/Customer involvement; Technical tasks; Politics; Financial contract legal problems; Adequate spending; Implementation problems; and Trouble-shooting.
Schultz, et al. (1987)	Clearly defined goals; Sufficient resource allocation; Top Management support; Project Plans and schedules; Competent Project Manager; Competent project team members; Adequate communication; Feedback capabilities and Responsiveness to clients.
Pinto and Slevin (1987)	Project objectives, Top management support, Project planning, Client consultation; communication; Personnel recruitment; Technical tasks; Client acceptance; Monitoring and feedback; and Trouble-shooting.
Cooper & Kleinschmidt (1995)	Top management support; Personnel recruitment; Adequate spending; Project strategy; and High quality processes
Tukel & Rom (1995)	Top management support; Client consultation; Preliminary estimates; Availability of resources; and Project manager's performance.
Pinto & Kharbanda (1995)	Mission at the forefront; Early & Continual Client consultation; Technology; Scheduling system; Project Team; Top management Support and continual what if? Approach
Belassi & Tukel (1996)	Project Manager's Management skills; Project Team; Size & Value; Uniqueness of project activities; Density of project; Life cycle; Urgency; Top Management support; Project organizational structure; Functional manager's support; Project Champion; Political, Economical, social and technological environment; Nature; Client Competitors; Sub-contractors.
Clarke (1999)	Communications; Clear Objectives; Breakdown activities; Using project plans as working documents.
Turner (1999)	Project Plan; Top management support; Personnel Recruitment; Monitoring and feedback; Adequate spending; Technical tasks; Communication; High quality processes; Ownership; and Goal commitment project team
Johnson, *et al.* (2001)	Project Plan; Top management support; Personnel Recruitment; Customer involvement; Project requirement and objectives; Project strategy; Ownership; Realistic expectations; Smaller Project milestones
Poon, *et al.* (2001)	Project objective; Scope; Project manager; Project Team; Planning; Control; Work package; Communication; Information Management; Top Management; HSE.
Frese & Sauter (2003)	Clearly defined goals; Competent project manager; Top management support; Competent project team members; Sufficient resource allocation; Adequate communication channels; Control Mechanisms; Feedback capabilities; Responsiveness to client; Client consultation; Technical tasks; Client acceptance; Trouble-shooting.
Sommer (2003)	Strategic Plan; Executive sponsorship; Technology evaluation; Customer involvement; Scope; Pilots; Testing; Planning; Roll out time; Training; Change to business; Risk analysis.
Torp, et al. (2004)	Project Organisation; Contract strategy; Project planning & Controlling; Stable framework Conditions; Stakeholder management; Technical factors; Nature and market conditions; Objective management; Top management support; Interface towards surrounding projects; and Management of Design

OGC (2005)	Clear links between the project and organisation key strategic priorities; Clear Senior management ownership and leadership; Effective engagement of with stakeholders; Skills and proven approach to project management risk management; Breaking implementation into manageable steps; Evaluation of proposals; Understanding of and contact with the supply industry at senior levels in the organisation; Effective project team integration.
Witt (2006)	Strong project executive leadership and alignment; Clear measurable goals; Actionable business case and performance measures; Clearly defined roles and responsibilities; Well designed execution and continuous improvement plan.

The following factors as identified in the literatures of generic projects (Table 3.4) are known to have direct impact on the success or failure of TAM projects.

3.6.1 TAM project manager (TAM manager)

As Project manager's experience and competence is critical to the outcome of generic projects, (Ruben & Seeling, 1967; Avots, 1969; Locke, 1984; Tukel & Rom, 1995; Belassi & Tukel, 1996; Clarke, 1999; Johnson, *et al.*, 2001; Poon, *et al.*, 2001), the TAM manager has a lot to contribute to the success or failure of a TAM project.

The TAM project manager's role is very critical to the success of TAM project. The requirement of his skill is multi-dimensional, which includes interpersonal, technical and administrative skills. He is responsible for organising, co-ordinating, controlling and motivating the entire TAM project team to perform their duties.

The TAM manager builds the TAM organisation and appoints specialists who make up the TAM management team (Duffuaa & Daya, 2004; Lenahan, 1999; Levitt, 2004; Edwards, 1998). According to Duffuaa & Daya (2004) and Lenahan (1999); for TAM to be successful the TAM manager should possess the following character traits:

- Leadership, team building and negotiation skills
- A good working knowledge of TAM type projects
- Planning and co-ordinating ability
- A flexible approach to complex problems
- The ability to work effectively under pressure
- A strongly sense of humour.

In addition to the above, Levitt (2004), noted that the TAM manager must have major expertise in Turnarounds, Project Management techniques, maintenance job planning, basic maintenance engineering and logistics. A minor in safety, process management and accounting is useful.

3.6.2 Top (Corporate) Management support

The Top management support has been shown to be a necessity towards the success of all projects (Avots, 1969; Locke, 1984; Frese & Sauter 2003; Sommer, 2003; Torp, *et al.,* 2004; OGC, 2005).

In TAM projects the necessity of Top management support is even more obvious. At some point in time the top management will initiate the process which will eventually lead to a plant TAM. The Top management provides the underlying guidance and support needed by the organisation to ensure a successful and effective TAM (Motylenski, 2003).

Due to the complexity of jobs and strategic decisions involved in TAM, the top management usually appoint a policy team to oversee the TAM project (Levitt, 2004; Lenahan, 1999; Motylenski, 2003; Oliver, 2001, 2002, 2003). The team provides funds, establishes constraints, sets objectives, establishes polices, and monitors progress of the planning, execution and completion of the TAM project.

Haber, *et al.* (1992) identified critical Top management functions to include decision-making for prioritization of goals, oversight through presence, clearly defining roles and responsibilities, allocating resources, including financial and personnel, provisions for proactive outage scheduling and planning and developing a mechanism for organisational learning. The empowerment of the TAM manager is also an important function of the Top management to ensure the TAM manager has the necessary authority to ensure adequate management of the project (Haber, *et al.,* 1992 and Edwards, 1998).

3.6.3 TAM Project Goals & Objectives

Clear definition of project goals and objectives have been emphasised in many literatures as a critical success/failure factors of generic projects (Locke, 1984; Tukel &

Rom, 1995; Clarke, 1999; Morris & Hughes, 1987; Schultz, *et al.*, 1987; Pinto & Slevin, 1987).

For a TAM to be successful the organisation must draft clear turnaround goals and objectives consistent with guiding principles and overall plant objectives. The objectives should address: budget, anticipated upcoming run length, downtime duration, starting date, estimated man-hours and any other appropriate item (Motylenski, 2003).The objectives according to Raiche (1997) should include key milestone items that everyone can relate to. The objectives and goals must be established early for the entire operation. Objectives should be concise and measurable as well as applicable to each phase of the shutdown. Examples of objectives according to Lowell (2002) include:

- Limit new or growth work to less than 25% of total shutdown work
- 85% of shutdown work will be determined by inspection and condition monitoring versus historical data
- Zero safety incidents by contractors or plant work force.

3.6.4 TAM Project Team

The composition of the project team has direct impact on the success or failure of generic projects. (Martin, 1976; Baker, *et al.*,1983; Schultz, *et al.*, 1987; Pinto & Kharbanda,1995; Clarke, 1999; Poon, *et al.*, 2001; Torp, *et al.*, 2004; OGC 2005; Johnson, *et al.*, 2001).

For a TAM to be successful, a well motivated and competent team should be selected. Duffuaa & Daya (2004), Gupta, *et al.* (1997) and Oliver, (2001), insist that the most suitable people should be selected with great care to forge the strongest possible organisation (management or core team) for controlling the event. According to Mclay (2003), the TAM team should represent all areas of responsibility: administration, operations, engineering, and maintenance; health, safety, and environment (HSE); quality assurance (QA); procurement, planning, and scheduling; and turnaround supervision. In addition the contractor representatives should also be included in this TAM team (Lenahan, 1999).

Oliver, (2001, 2002) stated that when naming members of the TAM project team, an assessment of their ability to work as a team should be made and where needed appropriate training should be given. Further he maintained that it is very necessary to define the roles and responsibilities of each member to avoid conflict.

3.6.5 TAM Project Plans/Schedules

Project planning and schedules has been identified and established as critical to the success or failure of generic projects (Baker, *et al.,* 1983; Ashley, *et al.,* 1987; Schultz, *et al.*, 1987; Pinto & Slevin, 1987; Belassi & Tukel, 1996;).

Planning has been identified as being absolutely critical to successful shutdown maintenance (Zhao, *et al.,* 2006; IAEA, 2006; Duffuaa & Daya, 2004; Lenahan, 1999; Levitt, 2004; Brown, 2004).

TAM planning involves many different issues, such as coordination of available resources, scheduling, safety concerns, and regulatory and technical requirements for all activities and work undertaken before and during the outage (IAEA, 2006, Randles, *et al.,* 1983). In addition to the above, Lenahan (1999) included cost estimate (budget plan), quality plan and communication and briefing packages as part of the planning process. Planning, according to Duffuaa & Daya (2004) and Oliver (2001, 2002), covers also the following important activities:

- the shutdown start-up logic
- the shutdown network
- the start-up network
- the critical path program; and
- work scheduling which is usually generated using project management software.

The need to integrate the entire work into the plan cannot be over-emphasised because failure to do so is one of the most common causes for TAM to overrun both budget and duration (Oliver, 2001, 2002).

TAM planning is categorized into three; long range planning strategy, medium and short term strategy (IAEA, 2002, 2006).

Long-term plans or long-range business strategic plans are necessary for a successful TAM project (Levitt, 2004; Oliver, 2003; IAEA, 2006; Krings, 2001; McLay, 2003). In the long range planning (IAEA, 2002, 2006) the plant establishes the occurrence and duration of outages according to equipment ageing, need for back fittings and refurbishment. The long term plan optimises plant availability, total outage duration and cost estimates. Long range plan is the tool for controlling the scope of each outage.

Without long range plans, major repairs and inspections often do not get adequate attention until it is too late to properly prepare for their execution (Krings, 2001). It also, according to Oliver (2001, 2002, and 2003), provides the mechanism for integrating TAM schedules and budget into overall corporate plan. Long ranges are for 5 - 10 years and include preliminary cost and budget estimates within the constraints of the expected scope of supplies and services (IAEA, 2006).

A *middle term plan* according to IAEA (2002, 2006) is used to co-ordinate the outages of all plants and take into account market needs. It is more detailed than long term planning and may cover a time of 2 - 5 years. A middle term plan estimates the material and human resources needed and incorporates medium-sized backfitting/refurbishment activities in compliance with industry standards and changes in regulatory requirements (IAEA, 2006).

The *short term plan* is developed using the long term plan as starting point. In addition to the major repairs, the short-term plan, according to Krings (2001), must include detailed lists and estimates for the smaller less costly repair works and as budget and shutdown plan enter the approval process, it should be very clear on what the up-coming TAM will accomplish.

A unique milestone plan is usually prepared for each TAM project. The milestone plan indicates all major activities that need to be developed prior to execution for process operations, maintenance, inspection, project and management (Motylenski, 2003)

To cover for emergent work which is a feature of TAM, contingency planning has to be included in the planning. This is an activity that builds extra time, money and resources into a plan to cover for emergent work (Duffuaa & Daya, 2004).

3.6.6 Communications

Communication has been shown to be a necessity for managing projects successfully (Sayles, *et al.*,1971; Cleland & King, 1983; Locke, 1984; Ashley, *et al.*, 1987; Schultz, *et al.*, 1987; Pinto & Slevin, 1987)

Effective communication is even more critical to the successful implementation of TAM (Lenahan, 1999; Duffuaa & Daya, 2004; Haber, *et al.*, 1992; Edwards, 1998; IAEA, 2002, 2006; Raiche, 1997; Ertl, 2005; Levitt, 2004; Motylenski, 2003; Orendi, *et* *al.*, 1992). According to (Ertl, 2005), because of the compressed time frame associated with TAM, there is less time available to everyone in the TAM team to overcome the problems caused by poor communication. Considering the amount of work which is carried out with large number of people from different contractors, adequate communication plays a central role in reducing delays, conflicts and accidents (Duffuaa & Daya, 2004). IAEA (2002, 2006) emphasised that effective mechanisms to communicate the status and progress of TAM should be in place and reporting the results of TAM activities should be an integral part of TAM execution and not regarded as optional. Haber, *et al.* (1992) identified three major communication dimensions which are to be managed properly to ensure TAM success. These are:

- intradepartmental communication
- interdepartmental communication; and
- external communication.

Orendi, *et al.* (1992) emphasised that multi disciplinary team to plan and review the outage is a way of confronting and solving interdepartmental conflicts that may occur during an outage if only one group plans the outage. For a successful TAM, it is necessary to keep contractors, top management, project team members and all others involved in TAM informed on the progress. It is also important to coordinate their work areas and obtain feed back from them on the work schedule (IAEA, 2002, 2006; Lenahan, 1999; Duffuaa & Daya, 2004; Orendi, *et al.*, 1992). This according to Orendi, *et al.* (1992) ensures that problems encountered are paramount for timely resolution and minimising unexpected risks.

3.6.7 Organisation/ Organisational structure.

The organisational structure for carrying out a project is a major factor to its success (Cleland & King, 1983; Ashley, *et al.*, 1987; Belassi & Tukel, 1996; Clarke, 1999)..
As in all projects, organisation is critical to the success of TAM projects. According to Duffuaa & Daya, (2004) the most suitable people with adequate skills should be selected with great care to forge the strongest possible organisation for controlling the project. The shape and size of TAM organisation will be determined by addressing the following questions:

1. Who will manage the turnaround?

2. Who will carry out the work?

Lenahan, (1999) identified the following options available for TAM management:

1. Select one of the company's own management or engineering staff
2. Bring a consultant management team
3. Bring in a main contractor to manage and execute the bulk of the work.

And these six options on who will do the work:

1. Employ one main contractor, who will execute all work packages
2. Employ on main contractor, executing general tasks, plus specialists contractors
3. Employ one main contractor who employs, and manages subcontractors for a number of packages
4. Employ several contractors executing specific packages of work
5. Rely on contract agencies only to provide manpower, the company supervising it and all other resources itself
6. Use one's own resources and supervision.

The optimum organisation according to Duffuaa & Daya (2004) would blend the following:

- Plant personnel who possess local knowledge
- TAM personnel, skilled in planning, coordination and work management
- Technical personnel who possess engineering design and project skills
- Contractors and others who possess the skills and knowledge to execute the work.

Due to complexity of TAM projects, the organisational model that has, so far worked best is the hierarchic pyramid (Lenahan, 1999, Brown, 2004).

Any existing organisational structure devised for the day to day activity in a company is wholly inadequate for the coordinated activity required during a shutdown, as departmental hierarchy does not respond quickly enough to problems encountered during shutdown execution (Brown, 2004). Levitt (2004) stated that shutdown organisation should ensure that:

- All function are covered by someone
- There is enough depth to be sure that more than 1 or 2 people understand the technical issues of the shutdown
- There is minimal duplication of functions
- The organisation is flexible and can respond to new conditions particularly during the execution phase

- The size of the shutdown is matched by the size of the staff to manage it
- The organisational structure supports coordination, communication and quick decision making
- Roles and responsibilities are defined and communicated clearly
- Communications systems are sound and complete.

3.6.8 Technical Tasks

Technical tasks as a factor for the successful implementation of generic projects has been established (Ashley, *et al.,* 1987; Morris & Hughes, 1987; Pinto & Slevin, 1987; Belassi & Tukel 1996; Poon, *et al.,* 2001; Sommer, 2003).

Most of the jobs done during shutdowns are very technical in nature. Some of these jobs require highly skilled man-power resources and special tools and equipment. According to Lenahan (1999), these skilled man-power resources include coded welders, versatile instrumentation technicians, machine fitters; specialists' vendors such as installers and services of digital control systems and inert entry crews.

For a successful TAM it is very imperative to ensure the availability of these highly skilled man-power resources with their tools and equipment during the event.

To ensure this, the following facts according to Lenahan (1999) must be established:

- The various providers of such resources
- Numbers likely to be available from each source during the event
- Any factors that will affect resource availabilities
- The lead time required to hire each resource
- Alternative providers if the primary source dries up
- The lead times for increasing or replacing resources
- Differentials in pay scales for man-power resources from different suppliers.

3.6.9 Personnel Recruitment

Key Personnel must be recruited, selected and trained to form the project team for technical as well as logistical support in implementing projects. (Schultz, *et al.,* 1987; Pinto & Slevin, 1987; Belassi & Tukel, 1996; Turner, 1999).

A successful TAM depends on the personnel assembled to manage it and those to carry out the actual tasks. First and foremost the organisation should recruit/appoint a competent and experienced manager as the TAM manager. The TAM manager will in turn assemble the TAM project team. The TAM manager with his management team should have adequate TAM management skills and experience in order to manage and guide the others involved in TAM to a successful event. Lack of adequate skilled personnel is one of the constraints in TAM projects (Thorstensen, 2006). Even if the personnel are available, Lenahan (1999) identified the following measures will minimize uncertainty:

- arrange for the personnel at the earliest possible date
- check qualifications
- if possible, test competence in the specific task required
- monitor and record performance and retain for reference

The lack of one scarce skilled personnel on the critical path task can extend the duration of the TAM event.

3.6.10 Contract Strategy

The contract strategy adopted for a particular TAM project can affect its outcome; success or failure (Lenahan, 1999; Duffuaa & Daya, 2004; Levitt, 2004; Brown, 2004; McQuillan, *et al.*, 2003; Motylenski, 2003; Edwards, 1998; Lowell, 2002; IAEA, 2002, 2006). Lenahan (1999) stated that the reasons for using contractors during TAM project include:

- Experience and professionalism
- Some contractors are specialized in certain areas
- Productivity, cost and efficiency.

One of the difficulties historically faced by company managers has been the type of contract strategy to adopt. The use of one managing contractor to plan, prepare and execute TAM is usually preferred over the strategy of using a combination of individual organisations, but this can expose the client organisation to a lot of risks as the main contractor will always not accept responsibility when things go wrong (Edwards, 1998). However, Edwards (1998) advocated for a rather different approach to contract arrangement - using a TAM specialist. In this arrangement the management of TAM becomes the responsibility of the client organisation supported by the specialist.

Lenahan (1999) identified the following as the main factors influencing the selection of contractors:

- the work scope and how it is packaged
- the design of the TAM organisation
- the type of contract to be awarded
- the availability of contractors.

Levitt (2004) include the following as reasons for hiring a contractor for an outage:

- To reduce elapsed time of an outage
- availability of enough personnel in-house
- lack of appropriate licence for some jobs
- lack of specialised equipment, and specific chemicals or materials
- work that can be moved off-site should be done by contractors so that it will not strain resources or infrastructure.

Lenahan (1999), Duffuaa & Daya (2004), Levitt (2004) and Brown (2004) identified 5 contract strategies:

- Single contractor managed contract
- Management fee and reimbursed labour contract
- Fixed-price packages
- Call off contract (on scheduled rates)
- Day work rates.

In addition to the above, construction management contract can be adopted (Levtt, 2004; Brown, 2004). This type of contract requires the contractor to divide the work into trade segments and hires trade subcontractors. Incentive-type contract provide for bonuses to be paid to a contractor for completing the job ahead of time and penalties for late completion (Brown, 2004). In making a choice of a contractor, Lowell (2002) stated that for successful TAM projects, organisation should identify contractors which have the best record for successful execution of shutdowns, those which have proven work processes and integrated planning and scheduling procedures. Analyses of the contractor with best safety records, the lowest rework statistics and the most responsive supervisors should be chosen.

IAEA (2002, 2006) and Lowell (2002) suggested that it is usually a good practice to set up long-term contracts with partnership agreements including the contractor taking full ownership for specified outage tasks with contracting service companies - contracting specialists. These specialists provide breakthrough results by incorporating best practices, work processes and experienced supervision garnered from variety of process industries. Their experience shortens planning time, increases technical specification compliance, increases asset reliability and provides their clients with full range of services not necessarily found in one specific industry.

3.6.11 Logistics

The business of logistics in the context of TAM is the organisation of the reception on site, the storage or accommodation, the maintenance and the mobilization of every item required for the TAM project (Lenahan1999, Duffuaa & Daya, 2004). Logistics concern the disposition of the many thousands of items, large and small, that are required by technical teams to perform their activities in a timely manner. Logistics therefore affects everyone employed on the Turnaround and hence TAM project outcome.

According to Levitt (2004), in addition to the above, logistics must have an information system to know the status at present and at some target time in future. Receiving and managing all objects and substances come under logistics. Site logistics must therefore be planned and prepared with rigour equal to that imposed on technical planning; this is crucial to the success of the turnaround (Lenahan, 1999). Poor logistics can ruin the best devised technical plan and thereby prevent the achievement of the TAM objectives.

Another critical element of logistics is the plot plan (Lenahan, 1999; Levitt, 2004). The plot plan shows the location of every item important to the success of TAM (Levitt, 2004).

Lenahan (1999) noted that a good logistics plan will afford the logistics officer the opportunity to control supply. A bad or non-existent logistics plan may lead to confusion at best and chaos at worst.

3.6.12 Scope

In other projects scope issues are not very critical in project implementation, though organisations should still be aware of any scope creep (Poon, *et al.,* 2001; Sommer, 2003).

One of the special features of TAM project is the fluctuation of the scope of work. A large proportion of the work scope is not usually known until right up to the beginning of the project (Ertl, 2005; Levitt, 2004; Lenahan, 1999; Oliver, 2001, 2002). This situation arises because of the scope changes as equipment is dismantled. As scope changes, all scope dependent issues like cost, duration, spares, equipment and personnel also change. Other scope-related problems arise because of multiple sources of work items such as capital projects, process needs, inspection requirements, operational needs and maintenance. For a Turnaround to be successful, these work items should be integrated to form an integrated plan and scope (Oliver, 2003; Williams, 2004; Motylenski, 2003). Clark & Hayes (2003) maintained that if this is not done, significant sum of money will be wasted on TAM through redundant scope, labour inefficiencies, multiple mobilisations and demobilisations and schedule issues.

TAM projects consist of a mix of maintenance tasks and project work. The list of these activities according to Duffuaa & Daya (2004) can be divided into the following categories:

- Projects
- Major maintenance tasks such as the overhaul of a large machine
- Small maintenance tasks
- Bulk work such as the overhaul of a large number of small items such as valves.

3.6.13 Environment, Health & Safety

Environment, Health & Safety has been identified as a critical success factor in the implementation of a project (Ashley, *et al.,* 1987; Poon, *et al.,* 2001). According to Poon, *et al.* (2001), the natural environment (e.g. the weather) and the political environment (legal requirements requested by the regulatory bodies) are factors that need to be considered in carrying out a project. Further they stated that legislative health and safety measures should also impact on the success/failure of a project.

In TAM projects, adequate systems should be put in place to ensure the safety of the personnel in the plant during its execution. TAM projects introduce a large number of personnel into the plant with a large number especially the contract workers not having any safety training. Even some that must have safety training might never have been exposed to such environment. Safety trainings and awareness programme should therefore be organized to all turnaround teams. Safety policy statement, safety communication networks and safety working routine must be established to ensure safety of the personnel. Safety working routine consists of the following elements (Duffuaa & Daya, 2004):

- work permit
- work environment
- the worker
- the task specification
- material and substances; and
- tools and equipment.

Not including support services such as safety training and management, industrial hygiene monitoring, lead and asbestos testing, and environmental monitoring as part of a turnaround can have a serious impact on scheduled activities as unanticipated delays push the completion date out further and further (CAM, 2003). In the domain of nuclear power plants; risk and safety management are sine qua non conditions and therefore the planning and scheduling system has to enforce safety constraints guaranteeing that the state of the plant is safe at any time during the outage (Gomes, *et al.,* 1997).

A turnaround is a hazardous event. It introduces a large number of people into a confined area, to work under pressures of time with hazardous equipment. In recognition of the greater risk of loss, according to Lenahan (1999), the targets set for safety on TAM must be uncompromising - *zero accidents, incidents and fires.*

3.6.14 Technology

Another factor affecting the outcome of TAM project is the technology available to the organisation in managing and executing the project. Technology plays a major role in the planning/scheduling, communication and job execution itself. Information technology software for Project management and Asset management (CMMS) are major contributions to the effectiveness of planning and scheduling of TAM project activities. Upstream CIO (2005) reported that organisations need to integrate asset and resource management system; *"Through integration, actual resource usage across multiple projects tracks better to the original plan, resource requirements are understood well in advance of TAM or Work order completion dates, and projects work orders are delivered on schedule'.*

This integration results in reduction in TAM implementation cost, reduction in man-power requirement and reduction in shutdown duration. In the case study carried out on Kuwait National Petroleum Company, KNPC, an integrated system of Maximo extended Enterprise; Oracle e-Business Suite and Primavera, according to Upstream CIO (2005) resulted in a savings of about $21.46million per year. Generally the benefits of system integration include:

- On time completion of work orders and TAM
- Increased productivity
- Correct alignment of tasks with craft
- Professional reports and graphics.

Having adequate technology to carryout the tasks also has a direct benefit towards the success of TAM projects. Many larger tasks in process plants involve cleaning of tanks and pressure vessels. Utilizing and preparing for the use of Cleaning-in-Place (CIP) technology offers potential time savings (Thorstersen, 2006). In pipe repair work for instance, Huntsman Olefins6 at Wilton International, during their 2002 shutdown introduced 'Axial Swage' Pipe Connection Technology. The technology according to McQuillan, *et al.* (2003), provided a significant reduction in workload and a savings estimated at 6,500 man-hours. According to Levitt (2004), technology is playing an increasing central role in shutdown management and team coordination. Various technology enhancement gadgets in recent times have improved the success rate of TAM projects.

These according to Levitt (2004) include:

- E-mail and e-mail sent to cell phones
- Intranet web portals with most shutdown information including updated schedules, Gantt charts and work lists
- Wireless networking to lap tops and personal digital assistants (PDA's)
- CMMS sending data on jobs and job status to PDA's.

3.6.15 Monitoring and Feedback

Monitoring and feedback has been identified as a factor for project success (Sayles & Chandler, 1971; Schultz, *et al.*, 1987; Pinto and Slevin, 1987; Belassi & Tukel, 1996; Poon, *et al.*, 2001).

For a successful TAM project, there is need for adequate monitoring and feedback. As noted in the features of TAM projects, the schedules are usually compressed. Problems that go unchecked can have significant impact on the time and budget goals. It is therefore absolutely necessary that the progress of TAM be monitored precisely and continually throughout the entire execution of the project (IAEA, 2006). Progress needs to be checked against milestones that were identified during planning phase. Information on work progress must be prepared and made available to relevant personnel on a regular basis. Deviations from procedures or from critical paths or milestones that are not being achieved need to be reported immediately during the outage to enable appropriate decisions and necessary actions to be taken.

3.6.16 Adequate Resource Allocation

Adequate resource allocation has been identified in the literatures as a critical success factor for project implementation (Martin, 1976; Baker, *et al.,* 1983; Schultz, *et al.*, 1987; Tukel & Rom, 1995; Poon, *et al.,* 2001). These resources includes; personnel, equipment, materials, money etc. Inadequacies in the provision and their allocations in TAM projects leads to time overrun (Levitt, 2004).

It is therefore very necessary to ensure that not only that the resource is available but should be in the right quantities.

3.6.17 Troubleshooting:

Troubleshooting is another critical success factor for project implementation (Pinto & Kharbanda, 1995; Frese & Sauter, 2003) because problems arise in almost every project. Problems arise in every TAM projects. Apart from problems related to the scope changes, there are bound to be problems that are not planned for to arise. The TAM manager and his team should therefore make adequate arrangements on how to handle such issues.

3.6.18 Regulatory Bodies:

One of the reasons of carrying out a TAM project is to satisfy safety statutory issues (Mclay, 2003). Information should be provided to, and fully agreed with, the regulatory body before the work scope freeze, not only with regard to those activities that are work and inspection specific, but also for general activities (IAEA, 2006). This is because last moment and/or misinterpretation of regulatory requirement may lead to outage extension. Information discussed might include any statutory regulatory requirements, concerns of regulatory body, lessons learned and other feedback. IAEA (2006) stated below an example of how tasks were classified by one nuclear power plant operating organisation, when considering regulatory body requirements:

a) **Class 1**: Mandatory for execution of a restart as a result of licence requirements, or technical or availability needs.
b) **Class 2**: Desirable that the task be performed but, if executed, it should be done under regulatory supervision. Task may be shifted to another outage because of time constraints or other reasons, after a safety demonstration.
c) **Class 3**: Task has no safety relevance. If the task is shifted to another outage, that decision need be made only by the operating organisation.

Such categorization has advantages, especially for the restart permission process, because both parties involved have clear agreement, prior to the outage, about required work scope.

SUMMARY - Critical success factors

The factors identified above that affect the outcome of TAM project as seen above can be grouped into two: *Organisational and Managerial factors* and their interaction is shown in Figure 3.4. The Organisational factors involve those factors associated with what the organisation need to put in place to enable the managerial factors to be managed effectively for TAM success. The Managerial factors on the other hand include those factors that can be handled effectively by the TAM project manager and his team to ensure TAM success.

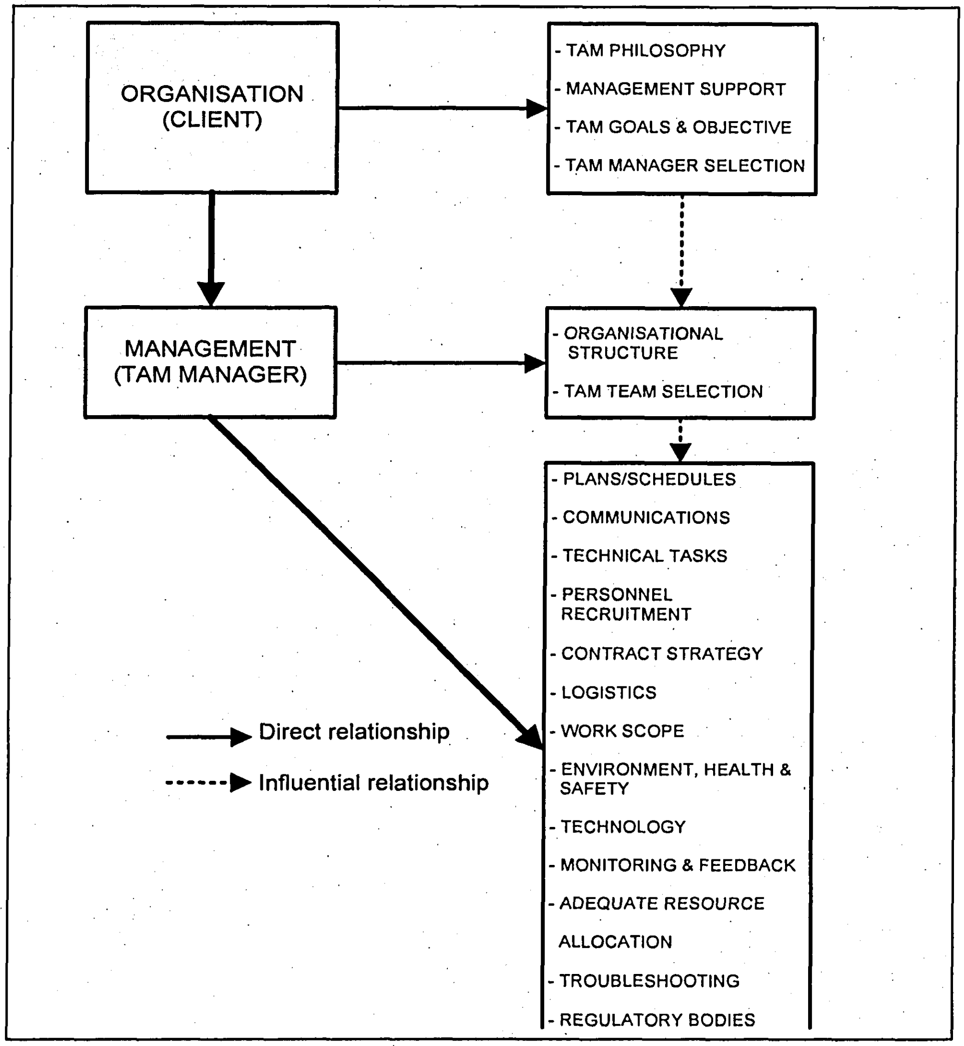


Figure 3.4. The Interaction between TAM Critical success factors.

Organisational Factors

The organisational factors as identified above include:

- TAM Philosophy: This will set up the TA process and establish long-term strategic TA plans.
- Clear TAM project Goals and Objectives
- Selection of a Competent TAM manager
- Top Management Support.

Managerial Factors

The success of all the other factors: managerial factors will depend mostly on the competence, knowledge and skills of the TAM manager selected. There is therefore the need for organisations to ensure that the right candidate is selected to manage the TAM if success is to be achieved.

3.7 SUMMARY OF THE CHAPTER

The chapter explained TAM as a critical maintenance strategy in process plants. Though project management techniques can be used to manage TAM projects, the chapter has identified some peculiar features of TAM that sets it apart from other projects (especially EPC). The major problems facing organisations in implementation of TAM projects were identified from literatures as they implement TAM projects using EPC methodologies. Two major factors affecting TAM project implementation were indentified as; wrong success evaluation and lack of discerning TAM critical success factors (CSF). Detailed literature review explained the various success measurement criteria that can be applied to TAM projects. Three modes of success measures were identified; management success, Perception of stakeholders and the Resultant benefits of TAM to the organisation.

The various CSF for TAM projects and how they impact on TAM projects were extensively explained. These CSF are categorized into two: organisational (organisational-dependent) and managerial (management-dependent) factors.

4.0: TURNAROUND MAINTENANCE PROJECT MANAGEMENT

4.1 AIMS OF THE CHAPTER

As explained in Chapter 3, the tools and techniques of project management is uniquely adaptable to activities associated to TAM. Also from Chapter 3, it has been shown that the critical success factors (CSF) of TAM project implementation are of two main categories; Organisational and Managerial factors. Top among the organisational factors is the selection of the TAM manager, who in-turn influences the management success of the TAM project. This chapter will identify the elements which will assist the organisation to select the most effective individual who will be able to manage the project successfully. The chapter will also identify TAM management methodologies that will enhance the successful implementation of TAM projects. The chapter will be concluded with a chapter summary.

4.2 SELECTION OF A TAM MANAGER (TM)

The factors as identified that are critical for the successful implementation of TAM projects are mainly managerial factors. The success of a TAM project therefore depends to a large extent on the TAM management process and hence the TAM manager. Though much has been written on how to improve the process of TAM project management less is known about the sorts of skills and challenges that specifically characterize TAM managers and the management team.

TAM manager selection is one of the most critical decisions facing Top management of all organisations in engineering facilities in the implementation of TAM projects. Some managers work best on long-duration projects where decision making can be very slow; others may thrive on short-duration projects (such as TAM) that can result in a constant-pressure environment (Kerzner, 1992). In their work on critical success/failure factors in projects; Bellassi & Tukel (1996) confirmed that the Project Manager's managerial skills are the most critical success factor in the implementation of projects. Most of TAM project failure is contributable to the choice of the project manager. Yet organisations appoint the TAM manager without proper assessment.

In this section, we will review the duties of a TAM manager and hence assess the personal qualities, skills, knowledge and competencies that is required of him to be able to manage a TAM project successfully.

4.2.1 Duties of a TAM Manager in the different TAM project phases

The TAM manager (or Turnaround Manager; TM.) is the Project Manager of a TAM project. The TM is the person who has the overall responsibility for the successful planning and execution of a TAM project (Barry, 2008). As in all projects, the roles and responsibilities of TM cut across all the phases of the project from TAM initiation, Planning, Execution and Closure phases.

Initiation Phase

During the Initiation phase, the TM duties according to Lenahan (1999) are as follows:

- Convening the initial meeting of the working Policy team (Top Management) and chairing all subsequent meetings
- Advising Policy team on specific TAM requirements
- Ensuring the collection and collation of basic data
- Selecting and managing the TAM project team.

The TM is also responsible for the development of organisation chart for the Project (Kerzner, 1992). To ensure a successful event, the TM while selecting the TAM management team should select the most suitable personnel, considering their skills, knowledge and competencies (Duffuaa & Daya, 2004; Gupta, *et al.,* 1997; Oliver, 2001). The TM also defines responsibilities to each member of the team (Oliver, 2002). Contractor(s) and vendors selection is also the TM responsibility during this phase. Another critical responsibility of TM which impact on TAM success is the validation of the scope (Lenahan, 1999). This validation is to ensure that only maintenance jobs that can only be done when a plant is shutdown are added in the work list.

Planning Phase

During this phase, the TM is responsible for developing a plan to accomplish the objectives of a TAM project with his management team (Bushman, 2007). Including the team in the plan ensures a more comprehensive plan than when it is done alone. This also ensures commitment of the team to achieve the plan especially as team represents all areas of responsibility: administration, operations, engineering, maintenance; health and safety & environment (HSE), Quality assurance (QA), procurement, planning and scheduling and contractor representative (Mclay, 2003; Lenahan, 1999; Duffuaa & Daya, 2004). The TM during this phase is in charge of organising, optimising, finalising and presenting the following plans to the Policy team for discussion, approval and action (Lenahan, 1999):

- TAM schedules
- Safety plan
- Quality plan
- Cost estimates
- Communication and briefing package.

In addition to the above, the TAM according to Oliver (2001) is responsible for creating:

- Logistics plan
- Additional work approval process as a result of emergent work
- Human resources plan
- Risk plan.

Finally the TM generates the control documents which will be used in the management of the TAM project.

Execution Phase

According to Kerzner (1992), the roles of TM during this phase include:

- Directing all work on the project that is required to ensure that targets and TAM objectives are met.
- Assist in the resolution of differences or problems between departments or groups on assigned jobs.
- Foster and develop a spirit of project team effort.
- Monitor project activities for compliance with company purpose and philosophy and general corporate policies.

In addition to the above, the TM should ensure:

- Organising assistance for the plant team during the plant shutdown.
- Managing the daily conduct of the TAM
- Delegating specific responsibilities, tasks and activities
- Chairing the daily control meetings

- Reporting significant issues to the policy group
- Setting priorities and trouble shooting
- Negotiating changes in resources and work scope
- Organising assistance for the plant team during start up.

Closure Phase

During this phase, the TM responsibilities include:

- Demobilizing of resources and equipment, and organising the cleaning of the site
- Co-chairing debrief sessions with the plant manager
- Collating all information and writing the TA final report.

From the above, it can be seen that the changing phases of the lengthy event, the one constant key figure is the TM (Lenahan, 1999).

4.2.2 Possible errors in choosing a TAM manager

Organisations operating engineering facilities most of the time appoint the TM mistakenly. This mistake in no small measure causes the failure of most TAM projects. Below are some of the issues they mistakenly consider to appoint a TM.

Maturity

One of the fundamental mistakes of the Top management in selection of a TAM manager is the wrong definition of maturity. Maturity in Project management generally comes from exposure to several types of projects in a variety of project office positions. Most Top management mistake this to mean age. It should be noted that managing construction projects or other form of EPC projects for several years does not mean the individual is matured to take up a TAM project (Kerzner, 1992). Each project specific area requires different kinds of skills, knowledge and competencies for its accomplishment successfully.

'Rigid' Tactician

Applying 'inflexible' tactics to subordinates can lead a TAM project to fail as they will be demoralised. The TAM manager must give his subordinate sufficient freedom to get the job done. Selection of hard-hearted tactician to lead a TAM project, who believes in continuous supervision and giving direction, will result in the individuals being unhappy. A line employee who is given 'freedom' by his line manager but suddenly finds himself closely supervised by TM will get frustrated and will reduce his input. Employees must however be trained to understand that supervised pressure will occur in time of crisis.

Technical Expertise

Most often than not, top management of most engineering facilities appoint their technical line managers to run TA. Technical specialists may not be able to divorce themselves from the technical side of the house and become TAM project managers rather than project doers. A TAM project management leadership requires more than just technical competence but encompasses the ability to manage a team (Kloppenburg & Petrick, 1999). Relationship skills complement the effectiveness of hard (technical) skills, because project outcomes are achieved through people, using their knowledge and creativity not through the mere use of techniques (Bourne & Walker, 2004).The greater the TM's technical expertise, the higher the propensity that he will overly involve himself in the technical details of the project. This makes it more difficult for the TM in delegating technical tasks responsibilities as he will over involve himself in the technical details of the project (Wilemon & Cicero, 1970).

New Exposure

Organisations run the risk of TAM failure if an individual is appointed a TM simply to gain exposure. Some organisations tend to rotate their technical line personnel to manage TA in order for them to gain the TAM management experience and exposure (Kerzner, 1992).

Company Exposure

The mere fact that an individual have worked in the various technical divisions of the company does not guarantee that they will make good TM. Their working in the various divisions: engineering, maintenance and project do not still qualify him as a good TM.

4.2.3 Desirable Personal qualities of a TAM manager

The roles and responsibilities of a TAM manager as outlined above confirm the critical role of TM to the success/failure of TAM project. Apart from the skills, knowledge and competencies needed to manage TA successfully, there are other personal qualities which a TM should possess to enable him manage a TAM successfully. However many books he reads, however many courses he attends, the evolving TAM manager is still essentially, a human being. It is his human qualities that will in the end determine his stature in the profession (Walton, 1984). These attitudes (CIC, 2002) or personality traits (Lenahan 1999) are the personal 'state of mind or emotional condition' of the person. These 'human skills' of project managers have the greatest influence on project management practices (El-Sabaa, 1999).

Shared Vision

An effective TM is often described as having a vision of where to go and the ability to articulate it. According to Kerzner (1992), the TM should have clear project leadership and direction. This means a good leader to succeed in managing TAM projects should possess vision, thrive on change and be able to extend boundaries. Visionary leaders enable the project team members to feel they have a real stake in the project. They empower people to experience the vision on their own. They are also supportive but practical and offer opportunities to create their own vision to explore what the vision will mean to their jobs and lives, and envision their future as part of the vision for the organisation (Barry, 2008; CIC, 2002).

A Good Communicator

The ability to communicate with people at all levels is one of the critical attributes of a TM (Griffith & Watson, 2004) and required to ensure TAM project success. The TAM project is characterized by a compressed time frame with large number of activities going on at the same time. It is therefore very imperative that the TM should be a good communicator to ensure all stakeholders are kept informed of the progress of the event (Ertl, 2005).TAM project leadership calls for clear communication about goals, responsibilities, performance, expectations and feedback (PMI, 1996; APM, 2005). There is a great deal of value placed on openness and directness. The TM must have the ability to effectively negotiate and use persuasion when necessary to ensure the success of the team and the project.

Integrity, Loyalty and Honesty

Personal integrity is one of the important personal attributes a TM should possess. This is because the TAM project manager's actions not just his words, sets the modus operandi for the team. Good leadership demands commitment to and demonstration of ethical practices. Creating standards for ethical behaviour for oneself and living by these standards, as well as rewarding those who exemplify these practices are responsibilities of project leaders. Leadership based on integrity represents nothing less than a set of values and dedication to honesty with self and team members. The TAM manager should also be honest, respect superiors and engagements. He should also endorse the organisation's politics and values and also place the organisation's interest before his own (Pettersen, 1991).

Enthusiasm

TAM project team members will appreciate the TM with enthusiasm, with a bounce in their step, with a can-do attitude. TAM team members tend to follow leaders with passionate interest in or eagerness to do something, not those who give reasons why something cannot be done. Enthusiastic TAM leaders are committed to their goals and express this commitment through optimism. Leadership emerges as someone expresses such confident commitment to a project that others want to share his optimistic expectations.

Empathy

A good TAM project manager must possess empathy. Although empathy and sympathy are similar, they are in fact mutually exclusive. While sympathy is an emotional affinity in which whatever affects one correspondingly affects the other and its synonym is pity; empathy is the ability to identify, recognize, perceive and understand somebody else's feelings or difficulties. There is usually appreciation by the workers (subordinates) when the leader acknowledges them with an apparent and distinct vision that they have life outside of work. For successful TAM projects, the TM should have empathy with stakeholders and with project team's aspirations, aims and objective (CIC, 2002). This should also be extended to the contractors and end users requirements.

Competence

Leadership competence does not however necessarily refer to the TAM leaders' technical abilities in the core technology of managing TAM. As project management continues to be recognised as a field in and of itself, TAM leaders will be chosen based on their ability to successfully lead others rather than technical expertise as in the past. It should be noted that expertise in leadership skills is only a dimension in competency. APM (2005) confirmed that having a precedence of winning track record is the surest way of being considered competent.

Ability to delegate Tasks.

Trust is an essential element in the relationship of a TAM project leader and his team. The TM must demonstrate his trust in others through actions and delegation of duties; how much he checks and controls their work and how the TM allows his subordinates to participate. Individuals who are unable to trust other people often fail as leaders and forever remain little more of micro-managers, or end up doing all the work themselves. For a TAM to be successful, the TM must have the ability to delegate tasks to his subordinates.

Cool under Pressure

In a perfect situation, TAM project would be delivered on time, under budget and with no major problems or obstacles to overcome. In reality however, all TAM projects have problems, a TM with a hardy attitude will take these problems in stride. TAM projects are characterised of compressed time frame with a lot of workers to carryout hundreds of tasks at the same time. While under this stressed situations, the TM should be able to consider it as interesting. Successful TM's should feel they can influence the outcome and see it as an opportunity.

Team Building ability

A team builder can best be defined as a strong person who provides the substance that holds the team together in common purpose toward the right objective. In order for a team to progress from a group of strangers to a single cohesive unit, the leader must understand the process and dynamics required for this transformation. The TM should understand the drivers and the objectives of all key individuals on the project and be able to use theories of team building and motivation for the benefit of the successful implementation of the project (CIC, 2002). The TM must also have an understanding of the different team players styles and how to capitalise on each at the proper time for the problem at hand (Barry, 2008).

Problem Solving Abilities

Although an effective TM is said to share problem-solving responsibilities with the team, but the team members tend to have more respect for the TM each time he resolves a problems. In TAM projects as in all projects problems do arise in various forms and the TM should have the necessary ability on how to resolve problems ranging from job-related to human related problems.

Open-mindedness and Tolerance to Ambiguity.

Another personal attribute required by a TM is that he should be open-minded (CIC 2002). Team members feel at ease working with a TM who is ready to listen and consider their own ideas in resolving an issue. Open-mindedness allows the TM to feel free from any prejudice and receptive to new ideas from his subordinates and the Top management and allows him to share and consider others input before taking decisions. According to Pettersen (1991), an effective project manager should have the propensity to change plans, approaches, strategies, policies, or practices according to the demands of the situation.

Personal Qualities

To be able to lead his team, the TAM manager needs to evolve into a 'total' man (Walton, 1984). To do this he should consciously resolve, everyday to cultivate self-disciplines relating to all levels of being, namely:

1. *At the physical level:*
    - bodily care, cleanliness and health
2. *At the emotional level:*
    - Cheerfulness, compassion
    - Imperturbability, serenity and poise.
    - Able to control emotions
3. *At the concrete mental level*:
    - Impartiality, integrity in thought and action
    - Will-propelled thinking, concentration, precision and penetration.
4. *At the creative and intuitional level*:
    - creative thought and imagination expressed in action
5. *'Total' level*:
    - A balanced life lived as an opportunity to serve mankind

Other character traits required for a TM includes:

- Being **supportive** to his subordinates to motivate them in carrying out their jobs and hence ensuring the success of the TAM event.
- The TM should also be **patient** and not hasty in taking decisions to ensure the right things are done.
- The TM should be one who has **determination** and persistence to ensure that the jobs and hence the TA project is carried out successfully.

- **Personality** - the TM must have an impressive personality so that team members, associates and peers look up to him and pay attention to his requests (Poon, *et al.*, 2001).

Interest in the job

Having an interest in the job is also a major personal quality required of a TAM manager. Pettersen, (1991) stated that intrinsic motivation for the work itself and its different activities along with the interest in the working conditions are also a desired attribute needed for a successful management of a TAM project.

Need to achieve and be proactive

For a successful TAM manager, he must have the need to excel and constant desire to do better. To achieve something unique and having the belief in the ability to influence events around him should be one of the qualities of a TAM manager.

4.2.4 Skills, Knowledge & Competencies for managing TAM projects

Project Management is both flexible and changing and appears to provide a promising answer to the challenge of modern organisational complexity. However, this form of management, more organic than functional, has its less advantageous point too. It seems to be accepted in the field that project managers who evolve within a context made more difficult by the variety and complexity of its activities- a context characterised by disorder, ambiguity, and disjunction between formal authority and responsibility - need to develop skills different from those of their colleagues in the functional management. Consequently, it becomes extremely important for the organisation to take these particular requirements into account when selecting a manager that will be able to bring the project to a successful conclusion (Pettersen, 1991).

The job of a TAM manager is demanding, complex and varied requiring the juggling of several issues concurrently. Though traditional project management competencies are critical for TAM success, communication between team members and the entire network is vital to support a shared understanding of project and its goals. Managing TAM projects successfully therefore requires a mixture of skills along with the capability to understand the situation and people and then dynamically integrate appropriate leadership behaviours (Pant *et al*, 2007).

Table 4.1: Management Skills and Knowledge for Refurbishment Projects

1. Leadership	20. Programme maintenance	39. Organization of communication systems	58. Sources of finance
2. Communication (oral/written)	21. Tenant welfare	40. Managing job stress	59. Employment legislation
3. Motivation of others	22. Public relations	41. Recruit/select: manual labour	60. Client/consumer protection law
4. Health and safety	23. Recruit/select: subcontractors	42. Employee training: manual labour	61. Promotion and transfer
5. Decision making	24. Employee training: supervisor/foreman	43. Plant planning and control	62. Employee welfare/counselling
6. Forecasting and planning	25. Competitive tendering	44. Negotiate: supplier	63. Negotiate: govt bodies
7. Site organization	26. Analysis of project risks/uncertainty	45. Creativity	64. Advertising and promotion
8. Budgetary control	27. Programme design	46. Career development and appraisal	65. Market research
9. Supervision of others	28. Identifying personal strengths/weaknesses	47. Decanting buildings	66. Termination/dismissal: management
10. Team building	29. Employee training: management	48. Company accounting	67. Negotiate: trade unions
11. Quality control and assurance	30. Site security	49. Company (strategic) planning	68. Termination/dismissal: manual labour
12. Managing time	31. Productivity maintenance and control	50. Construction law	69. Company law
13. Materials planning and control	32. Negotiate: client	51. Property insurance	70. Use of computer technology
14. Manpower planning and control	33. Costing and estimating	52. Organization structure	71. Organization culture
15. Setting objectives and goals	34. Competitor awareness	53. Termination/dismiss: subcontractor	72. Planning law
16. Conducting meetings	35. Managing change	54. Job analysis/specification	73. Managing other national culture
17. Managing conflicts/crisis	36. Recruit/select: management	55. Code of practice/working rule agreement	74. Demotion and retirement
18. Recruit/select: supervisor/foreman	37. Negotiate: main contractor	56. Termination/dismiss: supervisor/foreman	75. Foreign language
19. Delegating responsibilities	38. Negotiate: subcontractor	57. Contract drafting	

(Source: Adapted from Egbu, 1999)

Egbu (1999) developed an appropriate body of management skills and knowledge for Construction refurbishment projects. According to his findings of the 75 types of management skills and knowledge (as shown in Table.4.1), the six most important for construction refurbishment projects are leadership, communication (oral/written) motivation of others, health and safety, decision making, forecasting and planning.

Table 4.2. Project Management skills for generic projects

Source	Project management Skills.
Bushman (2007)	Analytical thinking, organisation, leadership, communication, interpersonal, problem-solving, time management, human resources
El-Sabaa (1999)	Mobilizing, communication, coping with situations, delegating authority, planning, organising, strong goal orientation, technical knowledge, project knowledge, computer skills, understanding methods, processes and procedures; technology required.
Petterson (1991)	Problem solving; judgment and practical sense; decisiveness; planning and organisation; control; strategy and organisation know-how; specialised knowledge; delegation of responsibilities; team structuring; consideration towards team members; Development of team members; Teamwork, flexibility and cooperation; resolving conflicts; oral communication; interpersonal influence; persuasion and negotiation
Walton (1984)	Technological understanding, project economics and evaluation; personnel management; system design and maintenance; planning and control; financial; procurement; public speaking and teaching.
Kerzner (1992)	Team building; leadership; conflict resolution; technical expertise; planning; organisation; entrepreneurship; administration; management support; resource allocation

El-Sabaa (1999) identified three groups of skills for successful implementation of projects: Human skill, conceptual and organisational skills and Technical skills. Construction Industry Council, CIC (2002) developed a comprehensive list of the attributes of a project manager for construction projects. These includes; the attitude (state of mind or emotional condition), Skills (an observable behaviour or input) and Knowledge (an understanding or underpinning grasp). Other researchers have also developed some management skill set for generic projects as shown in Table 4.2.

The management skills as shown in Tables 4.1 and 4.2 clearly show that specific management skills/knowledge is needed for the successful management of specific projects. As shown in chapter 3, TAM projects have peculiar characteristics that set them apart from other engineering projects. To manage a TAM project successful, TAM-project-management-specific skills/knowledge are required by the TAM manager and the team. From the literatures reviewed, the following skills, knowledge and competencies have been identified as requirement for TAM management success.

Team Building Skills

One of the management skills/knowledge needed for a successful TAM project is the ability of the TAM manager to build and maintain a cohesive TAM team. Team building, whether formal or informal is a process of 'finding a common ground' between parties who may or may not have prior working relationship (Buckner, 2005). The TAM team represents all areas of responsibility: administration, operations, engineering, and maintenance; health, safety, and environment (HSE); quality assurance (QA); procurement, planning, and scheduling; and turnaround supervision (Mclay, 2003) including the contractor representatives (Lenahan, 1999). To be effective the TAM manager must provide an atmosphere conducive to teamwork (Kerzner, 1992). The healthier the atmosphere within the team, the greater the likelihood the team will perform effectively (Pinto & Kharbanda, 1995) to ensure TAM success.

Leadership skills

An absolutely essential prerequisite for TAM project success is the TM's ability to lead the team within a relatively unstructured environment (CIC, 2002; Bushman 2007; Petterson, 1991; Egbu, 1999). It involves dealing effectively with managers and supporting personnel across functional lines with little or no formal authority (Kerzner, 1992). The essence of leadership lies in the ability to use it flexibly. This means that not all subordinates or situations merit the same response. Under some circumstances an autocratic approach is appropriate; other situations will be far better severed by adopting a consensual style (Pinto & Kharbanda, 1995). In TAM projects, with increase in contract labour, together with a corresponding increase in fragmented specialised work and the difficulties associated with labour on site, the leadership skill is even more necessary.

Conflict Resolution Skills

The ability to cope with unexpected, changes, conflicts and crisis is needed in TAM project management. As mentioned earlier the TAM team involves individuals from the different departments in the organisation including the contractors. In reality therefore there is usually interpersonal tensions naturally resulting as a result of putting individuals from diverse backgrounds together and requiring them to coordinate the TAM activities. The result of differentiation among functional departments demonstrates that conflict under these circumstances is not only possible but unavoidable (Pinto & Kharbanda, 1995). The ability of a TM to recognize a conflicting situation and resolving it efficiently is therefore very critical to a TAM success.

Planning Skills

Planning has been identified as being absolutely critical to a successful shutdown maintenance (Duffuaa & Daya, 2004; Lenahan, 1999; McLay, 2003; Williams, 2004; Krings, 2001; Gupta, *et al.*, 1997;; Levitt, 2004; Brown, 2004; Buckner, 2005). The TAM manager should not only have the ability to identify objectives and priorities, establish work timetables and organize resources to achieve the objectives but the ability to define tasks and work methods (Petterson, 1991). Considering the changes in work scope that is a common feature of TAM (Ertl, 2005; Levitt, 2004; Lenahan, 1999; Oliver, 2001, 2002), the TM should have adequate planning skills to cope with their planning.

Organisational Skills

Organisational skills are particularly important during the TAM initiation stage when the TAM manager establishes the organisation by integrating personnel from different disciplines into an effective work team (Duffuaa & Daya, 2004). It requires more than mere constructing a TAM organisational structure. At a minimum, it requires defining the reporting relationships, responsibilities, lines of control and information needs (Kerzner, 1992). In addition, the TM should have the ability to build formal and informal collaboration networks and to implicate others to reach objectives (Pinto & Kharbanda, 1995).

Time management Skills

Time management skill is critical to TAM project outcome. The nature of a TAM project with a high level of uncertainty in the work scope, lends itself to project time overrun. The TM should therefore have the ability to prioritize, delegate and manage time effectively (Bushman, 2007) to ensure the project is delivered within the time constraint.

Negotiation skills

Negotiations involved in TAM project are of different dimensions. Egbu (1999) identified six different negotiation skills/knowledge as very critical for the successful implementation in refurbishment projects. In TAM projects the TM should have the ability to negotiate with:

- The Contractors - main contractor or sub-contractors
- Suppliers or Vendors
- Equipment Manufacturers representatives
- Government Agencies - Regulatory bodies
- Inspection Agencies
- Trade unions

Each of the group above requires different negotiation skills/knowledge.

Forecasting skills

TAM projects is characterised of a lot of unforeseen jobs due mainly on the scope variations when the equipment are opened for repairs (Ertl, 2005; Levitt, 2004; Lenahan, 1999; Oliver, 2001, 2002). These scope changes imparts directly on the resources which ultimately affects cost and duration. In this kind of environment of uncertainty, increased variation to work scope and costs likely to escalate at short notice, the skills/knowledge associated with forecasting is very necessary for TAM success.

Motivation Skills

TAM projects occur in a very short time (Motylenski, 2003) and require the mobilization of hundreds or thousands of workers and a large quantity of materials and equipment on site. For successful project delivery, long working week and overtime work is a common feature of TAM projects. These lead to low morale and productivity of TAM project work. To this end, the skill/knowledge of motivating others is needed.

Management Support Building skills

The TM is surrounded by a myriad of organisations that either support or control his activities. An understanding of these interfaces is important to project managers as it enhances their ability to build favourable relationships with senior management (Kerzner, 1992). The TM should have the ability to manage the political and power dimensions within and around the project team, as failure to understand and control the political process has been the downfall of many good projects (Lovell, 1999). Kerzner (1992) identified four key variables that influence the TM's ability to create favourable relationships with senior management:

- his ongoing credibility
- the visibility of the project
- the priority of the project to other organisational undertakings
- His own accessibility.

Resource Allocation skills

The ability of the TM to allocate resources is a necessity towards achieving a successful TAM project. The resources which include man, money and materials if not adequately allocated as at when due can lead to TAM project overruns (Levitt, 2004). This skill/knowledge is very obvious in TAM projects especially due to changing scope.

Communication/Presentation skills

Public speaking and teaching together with chairmanship of meetings are common jobs of TMs. TM are involved in a lot of meetings; with the TAM team and the Top management (Policy team). In each group the TM makes presentations on the status of the project; the need for resource approval from the Top management and more input in the case of TAM team. In either case the skill of clear presentation of issues is a necessity. The TAM manager should therefore have the ability to communicate clearly, effectively and regularly (Bushman, 2007).

Decision Making Skills

TAM project work is characterised by high risk, uncertainty and high numbers of variation orders to the works. Working under such situations and at the same time attempting to achieve the stipulated time for project completion, TMs would have to make impromptu and sound decisions. The skill/knowledge of decision making is therefore very necessary.

Health, Safety & Environment

Safety and environmental incidents have been identified as measures of TAM project success (Motylenski, 2003; Levitt, 2004; IAEA, 2006). For a successful TA, it is therefore imperative that the TM should be knowledgeable of the safety and environmental impact laws of the jobs to be done as well the environmental laws in their area of operation and their applicability. In the UK, TM would need to be knowledgeable and conversant with the 1988 regulation on Control of substances Hazardous to Health (COSHH).

Use of Computer Technology

In the modern day, the knowledge and skill in computer is important to manage TAM projects. Apart from its use in dissemination of information, softwares have been developed to enhance managing of projects. Microsoft Projects and Primavera have been known world wide as very useful in project management planning, scheduling and control. In addition, Computer maintenance management systems (CMMS) can now be integrated with project management softwares (such as primavera) to manage TAM projects (Upstream CIO, 2005).

Technical Skill/ Knowledge

The TAM manager should have adequate Technical skill/knowledge. The TM should have a good working knowledge of TAM type projects (Duffuaa & Daya, 2004; and Lenahan, 1999). In addition to the above, Levitt (2004), noted that the TAM manager must have major expertise in Project Management techniques, maintenance job planning, basic maintenance engineering and logistics. The acquisition of sufficient knowledge of the technology of the project is necessary to enable the project manager to understand all aspects intelligently (Walton, 1984).

Control skills

Control requires the continuous reporting of work done (monitoring), the assessment of its time and cost (Walton, 1984). It also comprises the ability to maintain that everyday activities are in line with objective and project deadlines and to ensure follow-up and make corrections if necessary (Petterson, 1991). For TAM success it is critical that the TM should posses this control skill.

Contractual Skill/Knowledge

As stated earlier contracting out job in a TAM project is unavoidable (Lenahan1999; Levitt, 2004, Brown, 2004; McQuillan, *et al.,* 2003, Motylenski, 2003; Edwards, 1998; Lowell, 2002; IAEA 2002, 2006). TAM projects involve various forms of contract. Irrespective of the type used, it is required that the TM should have specific knowledge of the various procurement methods and related forms of contract needed in the execution of a TAM project. He should have the necessary skill/knowledge to know the best form of contract for a particular situation. TM should also have the capability of the legal implications of every form of contract to avoid conflicts and unnecessary claims.

Regulatory Processes Skill/Knowledge

One of the reasons of carrying out a TAM project is to comply with safety regulations (Mclay, 2003). The TM should therefore have a good knowledge of all statutory regulatory requirements required during the Project and their timings to avoid time overruns. These includes according to IAEA (2006);

d) licence requirements, or technical or availability needs
e) Desirable that the task be performed but, if executed, it should be done under regulatory supervision.

Quality Management Skill/knowledge

Quality management involves quality planning, quality control and quality assurance. For a successful TAM project the TM should have the skill to handle these quality constraints.

Risk management skills

Shutdowns are big events in the life of a plant. The size itself without any other factors constitutes a risk for the organisation (Levitt, 2004). TAM projects constitute a lot risks. The TAM manager should have the skill to identify, quantify the risks and the adequate response to handle the risks.

Administrative skills

Administrative skills are essential for TAM managers. The Project manager must be experienced in administrative duties such as planning, staffing, budgeting, scheduling and other control techniques (Kerzner, 1992). In dealing with technical personnel, the problem is seldom to make people understand administrative techniques such as budgeting and scheduling, but to impress upon them that costs and schedules are just as important as elegant technical solutions. Some helpful tools for the manager in administration includes: the meeting, the report, the review and budget and schedule controls.

Human Resources Management skills

TAM involves the coming together of lot of people from diverse backgrounds towards achieving a successful project. The TM must understand the drivers of all their team members and how these may be achieved within the context of the project and endeavour to build productive relationships with all key members of the project team (CIC, 2002). The TAM manager must be familiar with the basic principles of all relevant rules and regulations.

Table 4.3 List of Personal Attributes, Management Skills and Knowledge/Awareness for successful TAM projects.

Personal Attributes, Attitude & Traits	Management Skills	Knowledge and Awareness
Shared Vision	Team building	Health and safety regulations (Site safety rules)
Good communicator	Leadership	Project Management techniques
Integrity, Loyalty and Honesty	Conflict resolution	Organisation of communication systems
Enthusiasm	Planning	Setting objectives and goals
Empathy	Organisational	Technical Knowledge
Competence	Time management	Regulatory processes
Ability to delegate tasks	Negotiation	Contractual Knowledge
Cool under pressure	Forecasting	Tendering Strategies
Team building ability	Motivation	Site security
Problem solving abilities	Management support	
Open-mindedness and Tolerance to ambiguity	Resource allocation	
Supportive	Communication/presentation	
Patient	Decision making	
Determination	Health, safety & Environment	
Interest in the job	Use of computer	
Need to achieve and be proactive	Technical	
	Control	
	Quality Management	
	Risk management	
	Administrative	
	Human Resources management	
	Budgeting and budgetary control	

Budgeting and budgetary control

Budgeting for the cost of a TAM project is one of the functions of the TAM manager. He should therefore have the necessary skill/knowledge for budgeting and budgetary control. In TAM projects because of the fluctuations associated with the scope, it is therefore apparent that the TAM manager should understand this and develop a budget that ensures a successful TAM.

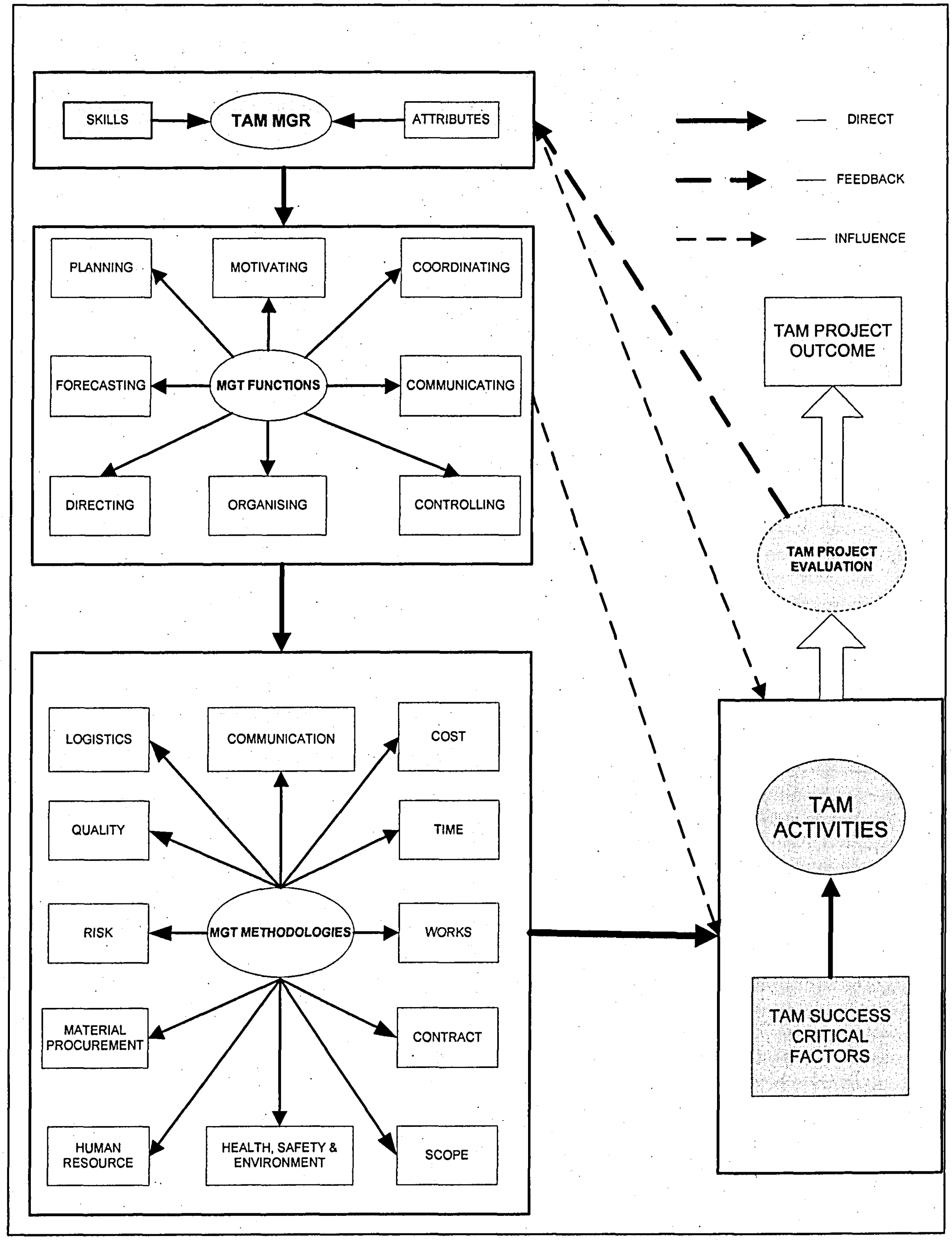


Fig: 4.1 Interaction between TAM Manager's Skills, Attributes and Functions with Management Methodologies and TAM project outcome.

Summary of the Qualities of a TAM Manager

The skills, knowledge and personal attributes required to manage TAM projects as identified from the literatures are shown in Table 4.3. These skills, knowledge and personal attributes enable the TAM manager to carry out TAM management functions using TAM specific management methodologies more effectively. This has direct impact on the success or failure of TAM as shown in Figure 4.1. Engineering facilities operators need to assess the skills and attributes of individuals before their appointment as TAM manager. This assessment will also enable them to appoint a contractor/consultant or specialist to manage the TAM project in the absence of an in-house manager with the relevant skills and attributes.

4.3 MANAGEMENT METHODOLOGIES FOR TAM PROJECT SUCCESS

As identified earlier, most of the factors affecting the successful implementation of a TAM project are managerial factors. Inefficient management methodology has been identified as a major cause of TAM projects failures (Ertl, 2005). How best can the TAM manager and his team members manage the project to ensure success?

According to Ertl (2005), the discipline of project management enjoys different states of maturity across different industries and further stated that; "*The maturity of project management discipline in process industries for Turnarounds is still very poor and stagnant at best. There appears to be little, if any, development or dialogue of the discipline within the field*".
One of the greatest challenges of TAM managers is realising that TAM projects are different from EPC (Engineering, Procurement and Engineering) projects. They require a specialised project management methodology. The PMI has published a guide to the Project Management Body of Knowledge (PMBOK);
'The primary purpose of this guide is to identify and describe that subset of the PMBOK which is generally accepted. Generally accepted means that the knowledge and practices described are applicable to most projects most of the time, and that there is a widespread consensus about their value and usefulness. Generally accepted does not mean that the knowledge and practices described are or should be applied uniformly on

all projects; The project team is always responsible for determining what is appropriate for any given project'.

It is therefore imperative that the TAM managers should note the obvious differences between TAM projects and EPC projects and hence the need to determine the appropriate management methodology using the PMBOK guidelines. The following management methodologies as identified from the literatures are applicable to TAM projects.

4.3.1 Scope Management

Scope management is the process by which the deliverables and work to produce them are identified and defined (APM, 2005). PMI (1996) explained that project scope management includes the processes required to ensure that the project includes all the work required, and only the work required to complete the project successfully. This is the greatest challenge facing organisations in TAM project management. Scope management in TAM virtually passes through all the phases as outlined by PMBOK: Scope initiation, Scope planning, Scope Definition, Scope Verification and Scope change control.

Scope initiation is the process of formally recognizing the need to carryout a TAM project. Input about these work items is obtained from projects, process/production, quality assurance, operations, maintenance, engineering and safety departments (Oliver, 2003; Williams, 2004; Motylenski, 2003, Lenahan, 1999; Duffuaa & Daya, 2004). Operations may continue to identify potential scope for the TAM until the last minute (Ertl, 2005).

Planning for the work scope is a problem in TAM projects because the entire scope is not usually known till all the equipments are opened and inspected. As a result of scope changes, planning and scheduling cannot be finalized until the scope is pinned down and approved. This usually occurs late in the process (Ertl, 2005; Levitt, 2004). One result of this situation is that TAM budgets are rarely based upon a complete, detailed plan. TAM budgets unlike EPC projects are often based upon conceptual estimates, extrapolations of past TAMs, or incomplete planned scopes that are compensated with large contingency (Ertl, 2005).

Scope definition involves subdividing the major project deliverables into smaller more manageable components in order to:

- Improve the accuracy of cost, time and resource estimates
- Define baseline for performance measurement and control
- Facilitate clear responsibility assignments.

Scope verification or validation is very critical in TAM projects. The validation process is employed to ensure, as far as possible, that the approved work scope contains only what is necessary to, maintain or enhance the reliability of the plant and which cannot be done at any other time (Lenahan, 1999). This also eliminates the possibility of duplication of work items because of multiple sources of work item. TMs should therefore devise means of validating the work scope to ensure only shutdown dependent jobs are done and also avoiding duplications.

In TAM the scope will change - sometimes dramatically. It is therefore imperative for the management of TAM projects to be prepared or plan on how to manage scope changes. As equipment is opened, cleaned and inspected, the extent of required repairs can be determined, planned, cost and either approved or tabled for future window of opportunity. Every add-on to the schedule should be processed with a defined procedure for evaluation/approval (Ertl, 2005).

4.3.2 Time Management

Time management in a TAM project includes the processes required to ensure timely completion of the event. One of the signs of low maturity in TAM project management is the state of the planning and scheduling that is intended to form the foundation of the management process. Ertl (2005) emphasised that a successful TAM management methodology must set high standard for the planning and scheduling to be successful. PMI (1996) identified the following processes for Time management:

- Activity Definition
- Activity sequencing

- Activity duration Estimation
- Schedule development
- Schedule control.

Activity definition, sequencing and duration estimates of a TAM project is very dynamic unlike in EPC projects. This therefore calls for a different management methodology in other to achieve success. Planning activities that are overly broad in scope are one of the obstacles of using schedule for any meaningful purpose. This is because according to Ertl (2005):

- They are difficult to estimate with confidence
- They can mask details that the planner neglected to consider
- They preclude a detail critical path analysis where more detail may allow refinements in the logic
- They detract from the accuracy of progress estimates (estimating percentage complete is more difficult).

For successful time management, activities must be clearly defined, and should be measurable. This means that anyone should be able to determine if a particular activity (as defined) is in progress, or completed. Activities must be defined every time there is a break or change in work content.

Baseline line schedules (other than critical and near critical paths) are meaningless for TAMs once they start. For TAM projects, it is expected that as inspections are performed, a changing scope (and therefore priorities for constrained resources/non-time-critical work) often poor schedule compliance (for unavoidable circumstances) will force the schedule for non-time-critical work to change from update to update. TAM managers have a lot of discretion with regards to scope management schedules. While there will be portions of the scope aside from the critical path work that must be executed within the instant project, a significant portion of the scope may usually be postponed to future TAM or maintenance opportunities.

Because of the dynamic nature of TAM, it can be counter productive to employ soft logic and resource levelling schemas that level the schedule. Both techniques are designed to produce a static plan for execution that is not practical for TAM, although it works well with EPC projects. What is the best way to carry out the resource levelling in TAM projects, considering the constant time-consuming of using the soft logic to cope with changes/updates to maintain meaningful schedule once deviations from schedules occur.

4.3.3 Cost Management

Creating budget for a project is relatively straightforward if the exact work scope is known (and will not change over the life of the project) and the unit costs of resources, goods and services are known. Unfortunately, this is almost never in the case of TAM (Lenahan, 1999).

The cost is usually hedged around uncertainties due mainly to changing work scope and contingencies. Many TAM projects have failure predetermined, should budgets be based upon detailed plan. At the end of executing a TAM project, the final scope usually encompasses several categories of work according to Ertl (2005):

- Known scope (planned/estimated)
- Anticipated repairs (may or may not have been planned/estimated)
- Unanticipated repairs (not planned/estimated)
- Unauthorised work (not planned/estimated)
- Cancelled work (planned/estimated but culled during execution).

Prior to execution, the TAM may have a budget set including known scope, anticipated repairs and some contingency for the remaining items. Because most indirect costs (not necessarily material costs though) are keyed off the direct labour costs, the key to successful cost control in a TAM is execution control (keeping resources productive) and scope management (balancing add-ons against non-critical work). Under these situations it is very difficult to have a realistic budget for the TAM project and this can result to project failure.

4.3.4 Quality Management

Project quality management includes the processes required to ensure that the project will satisfy the needs for which it was undertaken. Poor quality work has been identified as one of the causes of outage extensions (IAEA, 2006). According to (PMI, 1996) quality entails several aspects:

- *Quality planning* - identifying which quality standards are relevant to the project and determining how to satisfy them.
- *Quality assurance* - evaluating overall project performance on regular basis to provide confidence that the project will satisfy the relevant standards

- *Quality control* - monitoring specific project results to determine if they comply with relevant quality standards and identifying ways to eliminate causes of unsatisfactory performance.

Quality planning is an issue that is usually poorly addressed by TAM organisations (Ertl, 2005). To assure quality, the requirements of every task must be correctly specified and then performed to that specification (Lenahan, 1999).

For successful TAM projects, the organisation should establish quality procedures to cover the three aspects as identified above to ensure the objective of the TAM project is achieved and on time too.

4.3.5 Human Resource Management

According to PMI (1996), project Human Resource Management includes the processes required to make the most effective use of the people involved with the project.

This involves:

- *Organisational Planning* - identifying, documenting, and assigning project roles and responsibilities and reporting relationships
- *Staff Acquisition* - getting the human resources needed assigned to and working on the project
- *Team Development* - developing individual and group skills to enhance project performance.

The greatest challenge that turnarounds present over EPC projects is the management of the human resource pools. This is true at a macro (overall staffing levels) and micro (delegation of work to labour pools) level (Ertl, 2005). Considering the diverse nature of the different individuals involved in TAM project, the TAM manager must have team building skills to ensure all work together towards ensuring success.

Adequate Human resource management is paramount to the success of TAM projects as humans, coordinate, manage, ordinate, perform, process, decide, approve, and carryout all the activities aimed at ensuring the successful completion of the project

4.3.6 Communications Management

One of the single most important aspects to successful turnaround management is communication. Because of the compressed time frame, there is less time available to everyone in the turnaround team to overcome the problems caused by poor communication (Ertl, 2005). Considering the amount of work which is carried out with large number of people from different contractors, adequate communication plays a central role in reducing delays, conflicts and accidents (Duffuaa & Daya, 2004). IAEA (2002, 2006) emphasised that effective mechanisms to communicate the status and progress of TAM should be in place. Further the reports stated that reporting the results of TAM activities should be an integral part of TAM execution and not regarded as optional.

Project communications Management includes the processes required to ensure timely and appropriate generation, collection, dissemination, storage and ultimate disposition of project information (PMI, 1996). The processes include:

- *Communication planning* - determining the information and communications needs of the stakeholders: who needs what information, when will they need it, and how will it be given.
- *Information distribution* - making needed information available to project stakeholders in a timely manner.
- *Performance reporting* - collecting and disseminating performance information. This includes status reporting, progress measurement and forecasting.
- *Administrative closure* - generating, gathering and disseminating information to formalize phase or project completion.

It is therefore desirable for TAM success adequate communication management technique should be put in place; planned and executed properly.

4.3.7 Risk Management

All projects are inherently risky, because they are unique, constrained, complex, based on assumptions and performed by people. As a result, project risk management must be built into the management of projects, and should be used throughout the project life cycle (APM, 2005).

TAM projects usually entail a high degree of risk. Because the scope of work is only partially known, managers must prepare for the possibility that the effort to clean or repair equipment may exceed estimates and expectations when the equipment is opened and inspected for the first time (Ertl, 2005). Other sources of risks in a TAM project according to Levitt, (2004) include; late changes into shutdown, essential staffing being unavailable, delays in delivery of critical spares (particularly sole source), labour action or information pickets, items to be delivered during the shutdown, weather, accidents, sabotage, design errors and omissions, first time jobs, misunderstandings, poor estimates, lack of skills, poor communications and contractors financial problems.

For adequate risk management, PMI (1996) summarized the Risk Management system as follows:

- *Risk identification* - determining which risks are likely to affect the project and documenting the characteristics of each.
- *Risk Quantification* - evaluating risks and risk interactions to assess the range of possible project outcomes.
- *Risk Response development* - defining enhancement steps for opportunities and responses to threats.
- *Risk response Control* - responding to changes in risk over the course of the project.

It is imperative for TAM success, therefore that the TAM manager should have the skill/knowledge in managing risks in a TAM project situation.

4.3.8 Health, Safety and Environment Management

APM (2005) defined Health, safety and environmental management as the process of determining and applying appropriate standards and methods to minimise the likelihood of accidents, injuries or environmental impact both during the project and during the operation of the deliverables.

A TAM project is a hazardous event. It introduces a large number of people into a confined area, to work under pressures of time with hazardous equipment (Lenahan, 1999).For a successful management of a TAM project, the planning function of any

TAM must develop a safety plan and environmental plan (Lenahan, 1999; Levitt, 2004; Brown, 2004).

Most of the time TAM project works are combinations of maintenance and project (construction) works. This makes TAM inherently more dangerous than routine maintenance work or construction work. Levitt (2004), identified the following as some of the reasons that make TAM projects more dangerous (to people, property and environment):

- There are new people in the plant (contractors)
- The work scheduled is not normally done (tank entry)
- More of the work is at a height than with normal maintenance
- The work is larger work (construction)
- Equipment is open and disassembled (the hazard is normally inside so that operations workers on the outside are protected)
- The work site is not stable, and new hazards are being introduced everyday.
- There are induced hazards (cutting, burning, open lines and tank entry)
- There is pressure to complete the work on time (the company is losing money everyday)
- The heavy overtime causes fatigue
- Many days are worked without time off
- Work continues around the clock
- There is extreme danger right after start-up due to errors in design or execution of modifications and repairs.

Considering the nature of un-related jobs, extensive safety permitting is needed for TAM projects unlike in EPC projects. UK and EU legislation demands that health and safety risk assessment and management are carried out for most commercial activities, including projects (APM, 2005). In the UK, the Environmental Protection Act 1990 sets out the framework for integrated pollution Control and process authorisations. The emission limits applicable to the chemical industry are stated in the Environmental Agency process guidelines. These guidelines are used to assess the Environmental Impact Assessment (EIA) of a given TAM project.

TAM managers should put appropriate management methodology in place to ensure that the safety of the personnel involved in the TAM project.

4.3.9 Materials Procurement Management

Materials Procurement Management refer to the complete process of bidding, purchasing, delivering and storing supplies needed for the TAM project. Materials can account for 25 - 35% of a total TAM cost (Motylenski, 2003). Material management is not just a concern during the execution of the TAM, decisions about material procurement and utilization is required during the planning and scheduling stages of the project. This implies that the availability of materials greatly influence the implementation of the TAM project. The benefits of an effective material management include:

- Reduction in materials delay
- Timely availability of materials consequently leads to improved productivity
- Improvement in spares inventory management which leads to decline in interest charge thereby saves cost.

Not just getting the materials, there must be a quality assurance system to ensure that the quality of the materials received conforms to specification as poor quality material results in poor quality of work which causes TAM duration extension (IAEA, 2006).

4.3.10 Contract Management

TAM projects are usually dependent on the use of contractors.

Levitt (2004) identified the following as reasons for hiring a contractor for an outage:

- To reduce elapsed time of an outage
- availability of enough personnel in-house
- lack of appropriate licence for some jobs
- work that can be moved off-site should be done by contractors so that it will not strain resources or infrastructure.

In addition, Lenahan (1999) stated that the reasons for using contractors during TAM project include:

- Experience and professionalism
- Some contractors are specialized in certain areas
- Productivity, cost and efficiency.

The contract management includes application of appropriate project management processes to the contractual relationship(s) and integration of the outputs from these processes into the overall management of the project (PMI, 1996). PMI (1996) further explained; "*The legal nature of the contractual relationship makes it imperative that the project team be accurately aware of the legal implications of actions taken when administering the contract*".

Lenahan (1999); Duffuaa et al (2004); Levitt, (2004), Brown, (2004) identified 5 contract strategies:

- Single contractor managed contract
- Management fee and reimbursed labour contract
- Fixed-price packages
- Call off contract (on scheduled rates)
- Day work rates.

Proper analyses need to be done to ensure that the appropriate contract strategy is adopted to ensure the successful delivery of the project.

4.3.11 Logistics Management

The business of logistics in the context of TAM is the organisation of the reception on site, the storage or accommodation, the maintenance and the mobilization of every item required for the TAM project (Lenahan, 1999, Duffuaa & Daya, 2004). It also includes the procurement of equipment (e.g. hiring of material handling equipment).The logistic activity ensures that the right thing is in the right place at the right time and in a fit condition to perform its function. Site logistic must be planned and prepared with rigour equal to that imposed on technical planning: this is crucial to the success of TAM project (Lenahan, 1999).

4.4 INNOVATIONS TOWARDS OPTIMIZING TAM PROJECTS MANAGEMENT

Considering the failures associated with TAM projects, several attempts (innovations and models) have been made to optimize the implementation of these projects in the diverse engineering facilities.

Despite these innovations, there are reported failures of TAM projects. A critical review and evaluation of these innovations is therefore necessary if a significant contribution towards ensuring the successful implementation of these projects is to be achieved. This evaluation need to be carried out to identify and ascertain; the strengths/contributions as well as the weaknesses/limitations of these current innovations. This information will assist in the development of a best practice framework which will incorporate the strengths of these innovations and also advance ways of resolving their limitations.

Below are some of the models that have been developed towards solving this problem. These attempts are very recent and this goes a long way to showing that the problem of TAM project optimization is still real in the engineering facilities.

4.4.1 RAPID Project - (MARINTEK Review No. April 2006)

Statoil (a Norwegian integrated oil and gas company) in 2003 engaged MARINTEK to challenge TA strategies and execution of maintenance that requires shutdown. The project is called RAPID, which stands for Remove Activities, Prolong Interval and Decrease duration. This project was carried out as part of an improvement campaign that focused on increased production and reduced maintenance and operational costs.

Remove activities

Removing activities reduces the scope of the TA and opens the possibility of shorter turnarounds. Some of the solutions/results provided are:

1. *Work scope challenge* - a systematic approach to challenging the scope of work. The methodology was programmed and implemented in the maintenance management administration using CMMS - SAP.
2. *Utilization of unplanned production shutdowns* - when an unforeseen shutdown occurs, some maintenance work can be done, instead of scheduling every thing for TAM.
3. *Improved or new inspection methods* - mapping of methodologies that are capable of verifying the technical condition of equipment without having to open it.

4. *Improved or new methods to perform 'hot work' during operation* - surveying 'hot work' technology, e.g. welding habitats, hot tapping, various methods of cold cutting/grinding etc.

Prolong Intervals

Under this heading condition monitoring of equipment is made very important. This aspect also included mapping methods for temporary repair of minor faults in pipe work with a view to making it last until the next repair opportunity.

Decrease duration

The duration of a turnaround is usually determined by critical jobs (critical path). Some of the solutions/results provided are:

1. *Methodology to challenge critical jobs* - This is done by restructuring the tasks and improve maintainability, this reduced the TAM duration considerably.
2. *Mapping of Cleaning in Place (CIP) technology* - considerable time can be saved by introducing cleaning of most of the pressure vessels without bringing them down.

4.4.2 RAM Approach - (Gupta S.K & Paise J.E Sun Oil Co. Ohio, 1997).

The use of reliability, availability and maintainability analysis techniques to develop a comprehensive turnaround scope was developed by Gupta S.K and Paise J E both of Sun oil Co. Ohio USA. This was developed in other to optimize TAM scope and its execution so that turnaround costs, duration and frequency are reduced while the plant's production availability is improved. This approach defines the minimum scope required for a turnaround that will provide the desired Reliability, Availability and Maintainability (RAM) of the units until the next scheduled TAM project. This was achieved by carrying out a thorough assessment of the units and by economically justifying every scope item. Some key advantages of this RAM approach are:

- Systematic approach with very little or no chance of missing items of concern.
- Analysis, results, recommendations and decision were documented for future reference.
- Involvement throughout organisation (operations, technical and maintenance) in the process - a team approach.

- Thorough assessment of the unit based on RAM principles by the stakeholders
- Economic justification
- Total buy-in from the organisation
- Identifies and defines future data collection requirements
- Establishes a baseline assessment and a process to continually improve RAM of the units.

4.4.3 MACRO Project - (John Woodhouse 2002)

The MACRO (Maintenance Cost Risk Optimization) is a project sponsored by UK government, Halliburton Brown & Root, Yorkshire Electricity, The National Grid Company and the Woodhouse Partnership. Other members included petrochemical, transport, utilities, manufacturing, process companies and relevant professional bodies. According to Woodhouse (2002);

MACRO has yielded a suite of methods for cost/risk/performance trade-off decisions - such as optimal maintenance or inspection intervals, equipment renewal or upgrade justification, shutdown strategy, spares requirements etc.

In each of these areas a blend of innovative, risk-based evaluation techniques was developed alongside structured guidance 'rules'. In summary, the innovations developed by this project are to prolong intervals of Shutdown by:

- Improving the design of the equipment components that are subject to failure.
- Improving risk-based evaluation techniques on equipment.

The result of this study in many instances increased the Shutdown intervals by 100% and hence a significant savings.

4.4.4 ROMAN - A Planning Tool - Gomes, et al. (1997)

ROMAN (Rome Lab Outage Manager) is a planning and scheduling tool developed by Rome Laboratory, the Electrical Power Research Institute, Kaman Science and Kestrel Institute for outage management. This is developed based on the problem experienced by planners in the outage projects because it incorporates safety and risk constraints. ROMAN's main innovation compared to the current state of art of outage management tools is its integrated approach to outage management automatically enforcing safety constraints during the planning and scheduling phase. Another innovative aspect of

ROMAN is its integration of more robust schedules that are feasible overtime windows. In other words ROMAN generates a family of schedules by assigning time intervals as start times to activities rather than single point start times, without affecting the overall duration of the project. ROMAN has been proven successful since it clearly extends the current functionality offered by existing software tools for outage management.

- It incorporates all the technological constraints currently used for automatic generation of schedules.
- It offers the additional capability of generating schedules enforcing safety constraints.
- It generates more robust schedules guaranteeing feasibility over time windows.
- It generates schedules very fast - the current version of ROMAN handles up to 2000 activities and it takes approximately 1 minute.
- The schedules generated are potentially better than current solutions since new possibilities are explored.

4.4.5 Integration applications speeds Turnaround projects

Kuwait National Petroleum Company (KNPC) worked with MRO software and Primavera to develop an integrated system that encompassed project management, enterprise asset management and financial systems at different sites. Explaining further Jason Kasper of Asset performance Networks (2005) stated; "*Through integration, actual resource usage across multiple projects tracks better to the original plan, resource requirements are understood well in advance of turnaround or work completion dates, and projects and work orders are delivered on schedule*".

4.5 FINDINGS FROM THE INNOVATIONS

Most of the works currently done on the optimization of TAM projects are based on:

- Reduction in the TAM Work scope.
- Reduction in the duration of TAM Project.
- Prolonging shutdown intervals.

Despite the above innovations, management of Turnarounds itself is still poor. Ertl (2005) stated about TAM management methodology; '*The maturity of the project* *management discipline in process industries for turnarounds is still very poor and stagnant at best'.*

Considering the negative impact of TAM projects to the organisation and the economy, Ertl (2005) stated; *'Considering the stakes, it is high time for the industry, to raise the bar in the maturity of their turnaround management methodology'.*

Identifying plant shutdown maintenance projects as still an enigma in many organisations; Woodhouse (2002) commented of TAM projects; *"Much efforts has gone into the efficient planning and delivery of the work involved, but relatively little guidance exists for determining what work is worth doing in the first place, and how this should be clustered into appropriate packages to share shut down opportunities. A surprising number of organisations (particularly in the utilities and service areas of operation) still do not even know how much a shutdown costs them".*

From the above, it is evident that the current innovations have not addressed the problem of TAM implementation failures adequately. These innovations have not addressed the issue of:

- Managing TAM projects to ensure success
- Human resource needs especially the TAM manager who is required to have the necessary management skills to ensure TAM management success
- TAM specific Management methodologies

It is envisaged that the above problems will be reduced if not eliminated through:

- Defining and establishing success measurement criteria
- Establishing the critical success factors of TAM projects.
- Establishing TAM manager selection criteria
- Establishing efficient and effective management methodology for TAM projects.

And finally developing a framework for the successful implementation of TAM projects in engineering facilities.

4.6 SUMMARY OF THE CHAPTER

The chapter presented how problems associated with managing TAM successfully can be addressed. The chapter started with the selection of the TAM project manager. It identified the functions of a TAM manager over the four TAM phases and some of the errors in the selection of a TAM manager. The personal attributes needed for a TAM manager to ensure TAM success were highlighted. Management skills/knowledge areas needed by TAM manager (and TAM team) for TAM management were also identified and explained. The chapter went further to explain that engineering facilities operators need to assess the skills and attributes of individuals before their appointment as TAM manager. This assessment will also enable them to appoint a contractor/consultant or specialist to manage the TAM project in the absence of an in-house manager with the relevant skills and attributes. The TAM specific methodologies were identified. The chapter explained that project techniques put up by Project Management Institute is only a guide; specific management methodologies for TAM should be adopted noting its peculiar features. The chapter identified these methodologies. The chapter finally covered some innovations carried out across the globe to improve on the management of TAM projects. The chapter concluded by noting that the problem of managing TAM project successfully is not yet addressed by the current innovations.

5.0: RESEARCH METHODOLOGY

5.1 AIMS OF THE CHAPTER

The chapter describes and explains the methodological approaches adopted for this research. The chapter starts with the explanation of research, the research process and the methodological framework of the research. It also provides logic and the rationale for the selected approaches. The chapter identifies the conceptual theoretical framework for the research including a critical analysis of the research design adopted for this research study.

5.2 INTRODUCTION

The word research is used in everyday speech to cover a broad spectrum of meaning, which makes it a decidedly confusing term. This term has been defined by different scholars.

Leedy (1996) defined research as *"a systematic process of collecting and analyzing information (data) in order to increase our understanding of the phenomenon with which we are concerned or interested".*

Further Kerlinger (1970) stated that research is a systematic, controlled, empirical and critical investigation of hypothetical propositions, about presumed relations among natural phenomena.

Amaratunga, *et al.* (2002) explained that:

- Research is a process of enquiry and investigation
- Research is systematic and methodical; and
- Research increases knowledge.

Generally research is a step-by-step process that involves collecting and examining information (data) in order to improve our knowledge and understanding of the social world.

Blaxter, *et al.* (2003) explained that even a brief review of writings on research will uncover a lengthy and potentially baffling list of kinds of research. These include:

- pure, applied and strategic research
- descriptive, explanatory and evaluation research
- market and academic research
- exploratory, testing-out and problem-solving research

- covert, adversarial and collaborative research; basic, applied, instrumental, participatory and action research.

The basic characteristics shared by the different kinds or views of research are that they are, or aim to be, planned, cautious, systematic and reliable ways of finding or deepening understanding (Blaxter, *et al.*, 2003).

5.2.1. The Research Process

The research process is the overall scheme of activities with which scientists engage in order to ascertain knowledge; it is the paradigm of scientific inquiry (Nachmias and Nachmias, 2000).

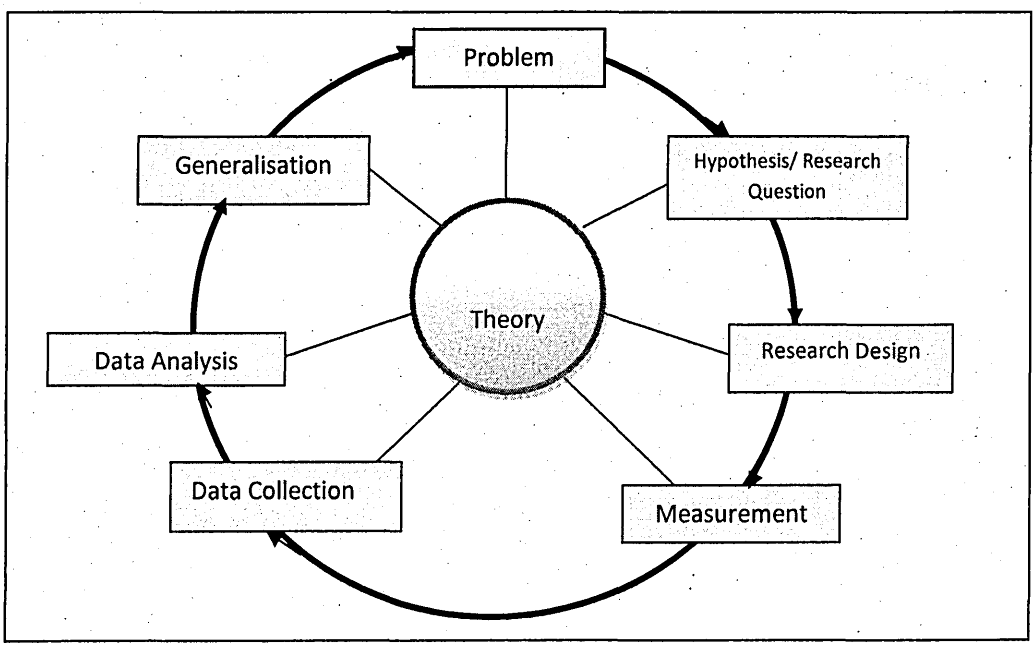


Figure 5.1: The main stages of the research process (Source, Nachmias & Nachmias, 2000 pg. 20).

As illustrated in Figure 5.1, the research process consists of seven main stages; problem, hypothesis/Research question, research design, measurement, data collection, data analysis and generalisation. Each stage according to Nachmias and Nachmias (2000) affects theory and is affected by it as well. Leedy (1996) identified eight distinct characteristics of a research process as follows;

1. Research originates with a question.
2. Research requires a clear articulation of a goal
3. Research follows a specific plan of procedure

4. Research usually divides the principal problem into more manageable sub problems.
5. Research is guided by the specific research problem, question, or hypothesis.
6. Research accepts certain critical assumptions.
7. Research requires the collection and interpretation of data in attempting to resolve the problem that initiated the research.
8. Research is by its nature, cyclic; or more exactly, helical.

The most characteristic nature of a research process is its cyclic nature (Nachmias & Nachmias, 2000; Blaxter, *et al.*, 2003). It usually starts with a problem and ends with a tentative empirical generalisation. This cyclic process continues indefinitely, reflecting the progress of a scientific discipline. The nature of the cycle however varies between research designs.

5.2.2 Deductive and Inductive Thinking

In logic, we often refer to the two broad methods of reasoning as the deductive and inductive approaches. Figure 5.2 shows the difference between these two research concepts schematically.

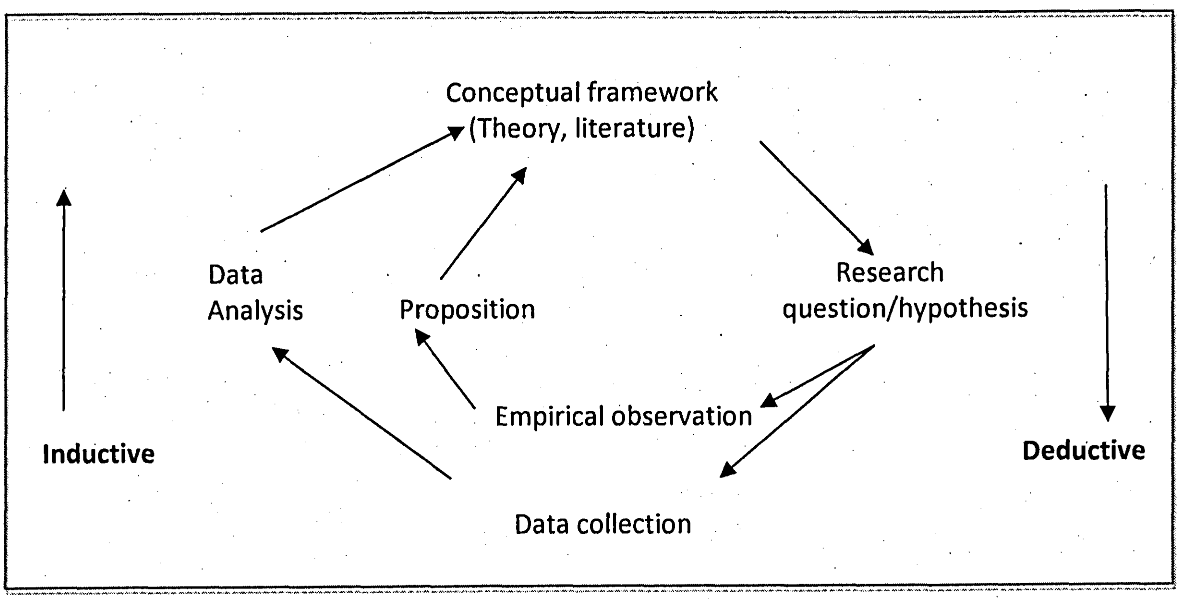


Figure 5.2: Representation of Research Process; Inductive versus Deductive (Source: Adapted from Blaxter, *et al.*, 2003 pg. 7)

5.2.2.1 Deductive Logic

Deductive logic begins with one or more premises. According to Leedy & Ormrod (2005), these premises are statements or assumptions that the researcher initially takes to be true. A deductive approach involves the testing of already established ideas, theories and hypotheses using data collected for this purpose. It works from the more general to the more specific. Deductive (aka "top-down) approach begins with a conceptual framework based on a theory or ideas from the literatures about a topic of interest. This framework is then narrowed down into more specific hypothesis or research questions that can be tested or answered. This then narrowed down even further so that observations or data to address the hypotheses or the research question can be collected. This will ultimately lead to the testing the hypotheses or answering the research questions with specific data - a confirmation (or not) of the conceptual framework.

5.2.2.2 Inductive Reasoning

Inductive reasoning begins not with a pre-established truth or assumption but instead with an observation (Leedy & Ormrod, 2005). An inductive approach involves deriving ideas and opinions directly from research data to enhance understanding of an issue or situation. This works the other way (when compared with the deductive approach), moving from specific observations or data to a broader generalisations and theories. Inductive (aka "bottom-up") approach begins with specific observations and measures, begin to detect patterns and regularities, formulate some tentative hypothesis or research questions that can be explored and finally ending up in the development of some general conclusions or theories.

Typically, the inductive approach is more open-ended and exploratory, especially at the beginning and hence involves a qualitative methodology. Deductive approach is narrower in nature and is concerned with testing or confirming hypotheses and utilises quantitative methodology. Even though a particular study may look like it is purely deductive (or inductive), most social research involves both inductive and deductive reasoning at some time in the project. The starting point of research separates deductive and inductive research, after the initial stages, all type of research becomes an interaction between the deductive and inductive research (Gummesson, 2000).

5.2.3 Research Philosophy

Philosophers of science and methodologists have been engaged in a long-standing epistemological debate about how best to conduct a research. According to Amaratunga, *et al.* (2002), this debate has centred on the relative value of two fundamentally different and competing schools of thought or inquiry paradigms:

1. Logical positivism uses quantitative and experimental methods to test hypothetical-deductive generalisations.
2. Phenomenological (interpretive science) inquiry uses qualitative and naturalistic approaches to inductively and holistically understand human experience in the context-specific settings.

Baer (1979) stated that a philosophical system undergirds the choice of a methodology. Qualitative and quantitative methods are derived from entirely different perspectives of philosophical paradigm (positivism and phenomenology); the researcher should have a clear understanding of the inherent differences between them. These are outlined in Table 5.1.

Table: 5.1 Characteristics of Philosophical paradigms.

Positivism	Phenomenology
Outside Observer; separate from phenomena	Intertwines observer and phenomena
Seeks causal relationship	Many different but equal truths dependent upon the purpose of the researcher
Seeks one truth to explain a phenomenon of interest	Seeks understanding of the meaning of the phenomena of interest
Quantitative; context stripping assumptions and methodologies	Qualitative; holistic analysis
Increased reliability.	Increased validity

(Source: Adapted from Shih, 1998).

5.3 RESEARCH APPROACHES

Research may be categorised into two distinct types: qualitative and quantitative as shown in Table 5.2. The former according to Amaratunga, *et al.* (2002) concentrates on words and observations to express reality and attempts to describe people in natural situations. In contrast, the quantitative approach grows out of a strong academic tradition that places considerable trust in numbers that represent opinions or concepts.

Table 5.2: Comparison of Research Paradigms - strength and weaknesses.

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

Source: (Amaratunga, *et al.*, 2002. pg. 20)

5.3.1 Quantitative Research

Quantitative research designs are characterised by the assumption that human behaviour can be explained by what may be termed "social facts" which can be investigated by methodologies that utilise "the deductive logic of the natural sciences (Amaratunga, *et al.*, 2002). Quantitative research sometimes gets more respect, reflecting the tendency to regard science as related to numbers and implying precision. Quantitative research is regarded as "objective" in nature. Naoum (1998 pg.39) defines quantitative research as:

'An enquiry into a social or human problem, based on testing a hypothesis or theory composed of variables, measured with numbers, and analysed with statistical procedures, in order to determine whether the hypothesis or the theory holds true'.

Generally, it employs strategies like surveys, structured interviews and other modes of research resulting in statistically significant contributions. Quantitative approach is selected under the following circumstances when (Naoum, 1998):

- Facts about a concept, a question or an attribute are required, and
- Collection of factual evidence and study of the relationship between these facts is desired in order to test a particular theory or hypothesis.

In quantitative research the data collected takes the form of measurements or counts which is statistically analysed. The process of quantitative research follows standard procedures, methods, forms of analysis and reporting results of the research undertaken. This standardisation maximises objectivity.

A quantitative research design has always been concerned with defining an epistemological methodology for determining the truth-value of propositions and allows flexibility in the treatment of data, in terms of comparative analysis, statistical analyses and repeatability of data collection in order to verify reliability (Amaratunga, *et al.*, 2002).

5.3.2 Qualitative Research

Qualitative is considered "subjective" in nature. Nachmias and Nachmias (1996) hold that qualitative research attempts to understand behaviour and institutions by analysing values, rituals, symbols, beliefs and emotions. The approach emphasises meanings, experiences (often verbally described), description and so on (Naoum, 1998). Blaxter, *et al.* (2003) explained that qualitative research is concerned with collecting and analysing information in as many forms, chiefly non-numeric, as possible. It tends to focus on exploring, in as much detail as possible, smaller numbers of instances or examples which are seen as being interesting or illuminating, and aims to achieve 'depth' rather than 'breath'.

Qualitative research offers insights and understandings of participants, which is unobtainable by quantitative research, but more than just non-numerical research, it aims to study the subject in their naturally occurring environment and hence generate non-biased data. It describes in words, rather than numbers, and the qualities of the subject through observation. Methods of qualitative research include structured and unstructured interviews, group interviews and focus groups. Qualitative methods can highlight key themes or patterns emerging in the project which are used to comprehend and manage data and used to develop and test hypothesis.

5.3.3 Comparing quantitative and qualitative research.

From the above, a number of contrasting features of quantitative and qualitative research are obvious. The difference between each one, according to Naoum, (1998) may be somehow quantifiable but such measurements will not convey the importance and special impact of some over others.

Although Table 5.3 shows distinctive features of the two approaches, the relationship between theory/concepts and research strategy in terms of verifying the theory/concept against proffering theory to emerge from the data is not as clear-cut as is sometimes implied (Naoum, 1998).

Table 5.3: The attributes of qualitative and quantitative research paradigms.

Qualitative paradigms	Quantitative Paradigms
Advocates the use of qualitative methods	Advocates the use of quantitative methods
Concerned with understanding behaviour from actor's own frames of reference	Seek the facts/causes of social phenomena
Naturalistic and uncontrolled observation	Obtrusive and controlled measurement
Subjective	Objective
Close to the data: the 'insider' perspective	Removed from the data: the 'outsider' perspective
Grounded, discovery-oriented, exploratory, expansionist, descriptive, inductive	Ungrounded, verification oriented, reductionist, inferential and hypothetico-deductive
Process-oriented	Out-come oriented
Valid: "real", "rich" and "deep" data	Reliable: "hard" and replicable data
Ungeneralizable: single case studies	Generalizable: multiple case studies
Holistic	Particularistic
Assume a dynamic reality	Assume a stable reality

Source: (Cook & Reichardt, 1979 pg.10)

Blaxter, *et al.*, (2003) identified the following similarities between qualitative and quantitative research:

1. While quantitative research may be mostly used for theory testing, it can also be used for exploring an area and generating hypotheses and theory.
2. Similarly, qualitative research can be used for testing hypotheses and theories, even though it is mostly used for theory generation.
3. Qualitative data often include quantification (e.g. statements such as more than, less than, most as well as specific numbers).
4. Quantitative approaches (e.g. large scale surveys) can collect qualitative (non-numeric) data through open-ended questions.
5. The underlying philosophical positions are not necessarily as distinct as the stereotypes suggest.

5.3.4 The Mixed-Methods Research

According to Hesse-Biber & Leavy (2006), mixed-method research usually refers to the use of both the qualitative and quantitative methods in one study. Amaratunga, *et al.* (2002) stated that there is a strong suggestion within the research community that research, both quantitative and qualitative, is best thought of as complimentary and should therefore be mixed in research of many kinds. Das (1983) (as sited in Amaratunga, *et al.*, 2002) states that:

"...qualitative and quantitative methodologies are not antithetic or divergent; rather they focus on different dimensions of the same phenomenon. Sometimes, these dimensions may appear to be confluent: but even in these instances, where they apparently diverge, the underlying unity may become visible on deeper penetration... The situational contingencies and objectives of the researcher would seem to play a decisive role in the design and execution of the study".

Bryman (1988) feels that common technical problems facing researchers in relation to quantitative and qualitative approaches need greater recognition. The emphasis on their epistemological separateness runs the risk of failing to give due attention to these common problems. The recognition of mutual technical problems may also invite a questioning of whether the quantitative and qualitative research traditions really are as far apart from each other as the epistemological argument may be taken to imply. Amaratunga *et al,* (2002) further explained that mixed-methods research is a reference to a combination of research methods - thus the use of qualitative and quantitative techniques together to study the topic - which is powerful for gaining insights and results, and for assisting in making inferences and in drawing conclusions. Figure 5.3 shows a typical mixed-method research approach.

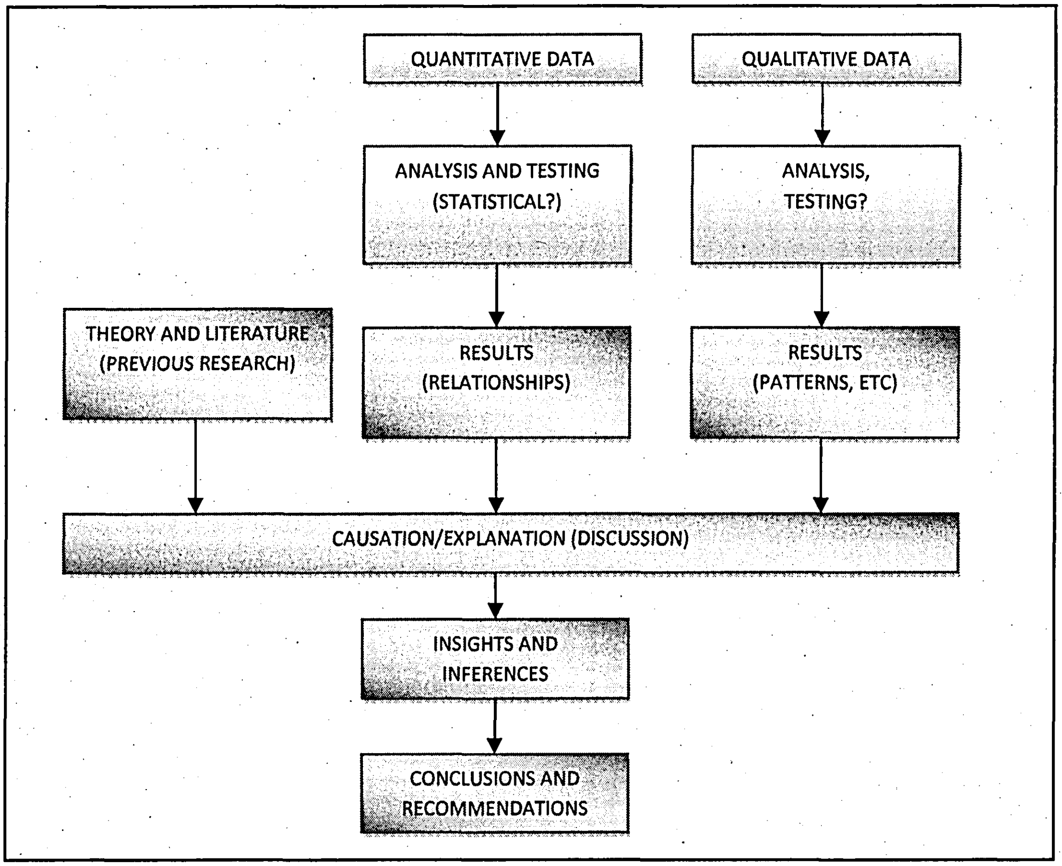


Figure 5.3: Mixed-method research process (Adapted from Amaratunga, *et al.*, 2002)

Myers & Haase (1989) suggest four guidelines for integrating the qualitative and quantitative research approaches. The guidelines:

1. Specify that the world should be viewed as a whole, an interactive system with patterns of information exchanged between subsystems or levels of reality.
2. Assert that both subjective and objective data should be recognised as legitimate avenues for gaining understanding.
3. Call for both atomistic and holistic thinking to be used in design and analysis.
4. Specify that research participants should include not only those who are subjects of methodology, but also those who administer or operate the methodology.

From the above it is evident that many studies do not adhere to the 'purist' letter of their paradigm, so that qualitative studies use words such as frequency, proportion, smaller and larger, implying some form of measurement, and quantitative studies often insert subjects' impressions and opinions in their own words. Thus few studies are strictly quantitative or qualitative in nature. Bryman (1988) suggests where the approaches may be usefully employed together:

1. The approach can aid decisions regarding the number of cases to employ
2. Qualitative research can be used to facilitate quantitative research by acting as a precursor, highlighting important aspects for a later survey
3. Quantitative research can be used to facilitate qualitative research to generalize findings to a large sample, or to identify groups who warrant in-depth qualitative study
4. The approaches can be combined so that methods from one paradigm fill the gaps left by the others
5. Qualitative research may facilitate interpretation of relationships between variables
6. The two approaches may be combined so that 'macro' and 'micro' levels of the objects under study are examined
7. The approaches may also be combined to allow the examination of both structure and process, the researcher's and the subject's perspective, allow cross-sectional and longitudinal data to be collected, and both to generate and test theory.

Hesse-Biber and Leavy, (2006) identified five specific reasons why researchers might adopt a mixed-method approach. These include:

1. ***Triangulation:*** This strategy involves using more than one method to study the same research question. Here the researcher is looking for a 'convergence' of the research findings to enhance credibility of the research findings.

2. ***Complementarity;*** In this strategy the researcher seeks to gain a fuller understanding of the research problem and/or to clarify a given research result. Mixed-method is employed in the service of assisting the researcher's total understanding of the research problem.

3. ***Development;*** This is a case whereby 'results from one method help develop or inform the other method.
4. ***Initiation;*** Another reason cited for using mixed-methods is that of 'initiation', whereby a given research studies' findings raise questions or contain contractions that require clarification. A new study is than initiated to add new insights to the understanding of the phenomenon under investigation.
5. ***Expansion;*** Expansion is initiated to 'extend the breadth and range of the study'.

Figure 5.4 illustrates four basic models of mixed-method research. The most significant of the four possible ways of a mixed-method research is the model 4, when the two methodologies are used equally; often the results from each approach are used to cross-validate the study findings (Steckler, *et al.*, 1992**).** In this case researchers analyse the results of each method separately and decide if the results from each method suggest the same conclusions. If they do, then the researcher's confidence in the results and conclusion is strengthened. If they do not, the researcher tries to understand why, and tries to determine which results are more valid. This procedure is termed triangulation of methods (see Section 5.3.5)

Jick (1979) identified four advantages of using a mixed-method research approach. These are as follows:

1. It allows researchers to be more confident of their results. It can also stimulate the creation of inventive methods, new ways of capturing a problem to balance with conventional data-collection methods.
2. Mixed methods can also help to uncover the deviant or off-quadrant dimension of a phenomenon. Different view points are likely to produce some elements which do not fit a theory or model. Thus old theories are re-fashioned or new theories developed.
3. The use of mixed-method can also lead to a synthesis or integration of theories. This may also serve as the critical test, by virtue of its comprehensiveness, for competing theories.
4. Another benefit is the important part played by qualitative methods in the mixed-method approach. The researcher is likely to sustain a profitable closeness to the situation which allows greater sensitivity to the multiple sources

of data. The convergent approach utilises qualitative methods to illuminate "behaviour in context".

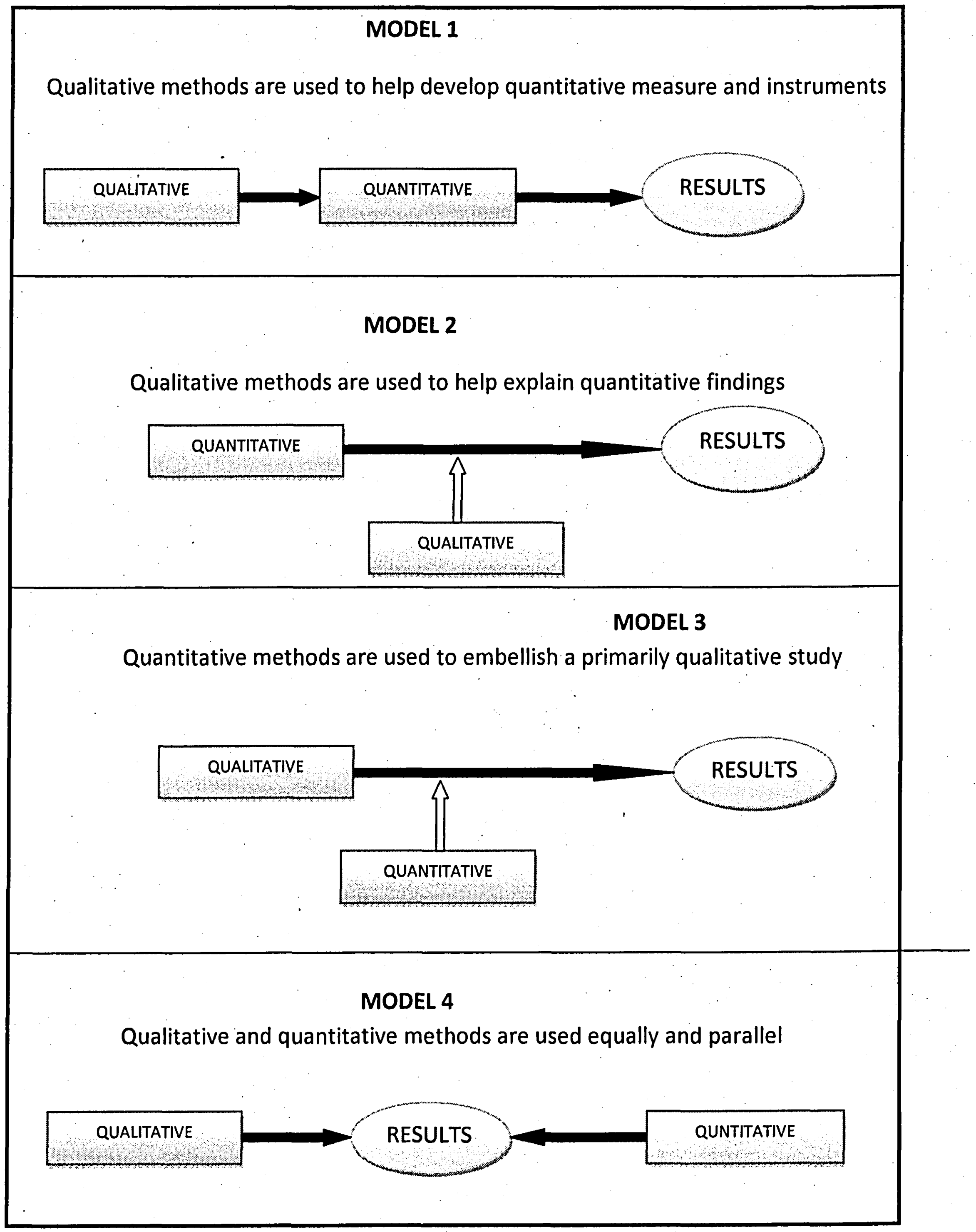


Figure 5.4: Integrating Qualitative and Quantitative Research Methods

(Source: Steckler, *et al.*, 1992)

5.3.5 Triangulation

Triangulation is a commonly used technique to improve the research validity. Burns (2000) defines triangulation as:

"The use of two methods of data collection in the study of some aspects of human behaviour."

Amaratunga, *et al.* (2002) explained that triangulation is the combination of methodologies in the study of the same phenomenon. The assumption in triangulation is that the effectiveness of triangulation rests on the premise that the weakness in each method will be compensated by the counter-balancing strengths of another. Triangulation techniques explain more fully, the richness and complexity of human behaviour by studying it from more than one stand point and/or using variety of methods. Exclusive reliance on one method may bias or distort the investigation. Burns (2000) stated that triangulation is interpretive research and will naturally produce different sets of data. More the methods contrast with each other, the greater the confidence about the finding.

Shih (1998) identified six types of triangulation:

1. *Investigator Triangulation*: a research team or thesis/dissertation committee who have a shared interest in the topic under study, as well as diverse perspectives and areas of expertise with regard to the top, or two or more "research trained" investigators with divergent backgrounds (who) explore the same phenomenon.
2. *Data (source) Triangulation*: the use of multiple data sources with similar foci to obtain diverse views about a topic for the purpose of validation.
3. *Theory Triangulation*: use of multiple perspectives to interpret a single set of data. This can occur in either theory testing or theory generating studies.
4. *Method Triangulation*: involves the use of more than one research method or data collection technique to study a single phenomenon.
5. *Unit of analysis Triangulation:* is related to person dimension of data sources. This is particularly suited when obtaining data on individual behaviours and perceptions, as well as interactions between individuals.
6. *Analysis Triangulation:* refers to the use of more than one strategy to analyse the same set of data for the purpose of validation.

5.4 METHODOLOGICAL FRAMEWORK ADOPTED FOR THIS RESEARCH

Research is a process through which we attempt to achieve systematically (and with the support of data) the answer to a question, the resolution of a problem or a greater understanding of a phenomenon. This process is frequently called research methodology (Leedy, 1996). The core concept underlying all research is its methodology. The methodology controls the study, dictates the acquisition of the data, arranges them in logical relationships, sets up a means of refining the raw data, contrives an approach so that the meanings that lie below the surface of the data become manifest, and finally issues a conclusion or series of conclusions that lead to expansion of knowledge. The entire process is a unified effort as well as an appreciation of its components parts. Research methodology has two primary functions according to Leedy (1996);

- To control and dictate the acquisition of data
- To corral the data after acquisition and extract meaningfulness from them.

For this research study, aims and objectives as presented in Chapter One indicate that the study revolves around understanding the problems that are involved in the management of TAM projects and proffer solutions to them. It is therefore an exploratory research study with principal aim to develop a framework for organisations operating process industries for the implementation of TAM projects effectively, efficiently and successfully.

5.4.1 RESEARCH STATEMENT

The economic importance of engineering facilities especially the process industries to the economy of any nation and the well being of the populace cannot be over-emphasised. In other to remain profitable, organisations transfer their operating costs onto their products. If the operating costs go up the prices most of time rises. One the major contributors to operating cost is maintenance cost, the availability and reliability of the plant assets (plant, machinery, equipment, systems etc.).

From the literatures, it has been identified that one of the maintenance strategies which organisations use to improve on these areas is Turnaround Maintenance (TAM) Project (Ertl, 2005; Duffuaa & Daya, 2004; Lenahan, 1999; Mclay, 2003).

Findings from the literatures show that organisations are still finding it difficult on how to implement TAM project successfully. A major cause is that organisations are still managing TAM projects like other EPC projects (Ertl, 2005; Oliver, 2002, 2003; Levitt, 2004; Lenahan, 1999) and hence assumes that the critical success factors and success measurement criteria of EPC projects are applicable to TAM projects. However, it should be noted that neither project success factors nor project success criteria are universal but are dependent on project type, size and sophistication (Dvir, *et al.*, 1998; Chan & Chan, 2004).

Coupled with these, Ertl (2005) stated about TAM project management, *'The maturity of project management discipline in process industries for Turnarounds is still very poor and stagnant at best'. There appears to be little, if any, development or dialogue of the discipline within the field'.*

Supporting the above assertion, Woodhouse (2002), complained of TAM projects, *'A surprising number of organisations (particularly in the utilities and service areas of operation) still do not even know how much a shutdown costs them'.*

In addition, recently, Vichich (2008) confirmed that an average TAM project exceeds cost and schedule targets by more than 20% and 83% of turnarounds do not satisfy all performance expectations.

Despite these problems, no empirical work has been done on how to *implement TAM project successfully*. Most of the works are on the optimization of TAM projects through:

- Reduction in the TAM Work scope
- Reduction in the duration of TAM Project
- Prolonging shutdown intervals.

This research work is novel as it is aimed at developing a framework that will ensure that TAM projects are implemented efficiently, effectively and successfully. This will be carried out by identifying and establishing:

1. The success criteria for TAM projects
2. The factors responsible for success/failure of TAM projects
3. Management skills needed to ensure TAM success
4. Specific Management methodologies to ensure TAM success.

The novelty of this study is to identify and establish the above issues and hence develop a framework to ensure TAM project implementation success.

5.4.2 RESEARCH QUESTION

The research question is the most critical part of the research - it defines the proposal, and guides the researcher's arguments and inquiry, and provokes the interest of the reviewer (IIS, 2001). Designing and defining the research questions are probably the most important step to be taken in a research study (Yin, 2003; Stake, 1995). When one gets the research question right; it suggests not only the field for study, but also the methods for carrying out the research and the kind of analysis required (Baxter, *et al*, 2001). Research questions need to meet a number of requirements. They according to Ritchie, *et al.,* (2003), need to be:

- clear, intelligible and unambiguous
- focused, but not too narrow
- relevant and useful, whether to policy, practice or the development of social theory
- informed by and connected to existing research or theory, but with the potential to make an original contribution or to fill a gap; and
- feasible, given the resources available.

Thus in designing and development of this research questions, the researcher recognises the functions of research questions as identified by Punch (1996):

- Research question help to organise the project and give a direction and coherence of research method and design to be employed
- Delimitation of research works and shows the boundaries
- Keeping the research focussed during the project
- Help in framework development for writing up the project
- Indicate and give direction on the research data needed to be collected.

After critical literature review and pilot studies carried out the main research question for this research thesis is:

"How best can organisations operating engineering facilities ensure the successful implementation of Turnaround Maintenance Projects?"

Essentially the research is about establishing the causes of TAM project failures and developing a framework to ensure the successful implementation of TAM projects.

In order to achieve the above, the following questions need to be addressed:

- *What are the conditions that make a TAM project successful or a failure?*
- *What are the critical success factors for TAM project Implementation?*
- *What are the management skills needed to manage TAM successfully?*
- *What are the management methodologies applicable to TAM projects to ensure success?*

Marshall and Rossman (1999) explained that research questions need to be flexible, so that data gathering can respond to increasingly refined research questions, especially in qualitative approach, which is uniquely suited to uncovering the unexpected and exploring new avenues.

5.5 SELECTION OF A RESEARCH APPROACH

A major issue that confronts researchers is the decision on what kind of research should be done: should it be qualitative or quantitative should both the elements be present (Walker, 1997)? The methodology selected should be the one that will be the most effective to collect the data needed to answer the research question.

5.5.1 Guide to the selection of Research approach

Shih (1998) suggested four issues which need to be fully and carefully evaluated before choosing an appropriate research approach:

1. *Philosophical paradigm and goal of the research*

Qualitative and quantitative methods are derived from entirely different perspectives of philosophical paradigm (phenomenology and positivism), the researcher should have a clear understanding of the inherent differences between them. The strengths and weaknesses of each position must be continually considered.

2. *The nature of the phenomenon*

The nature of the phenomenon is particularly critical in qualitative studies. In order to use an idea about a phenomenon as a methodological guideline, it is necessary first to have a good understanding of the phenomenon.

3. *The level of research question*

As explained above, the research question drives the research. They are like objectives, rather than aims whereby they should contain within themselves the means for assessing their achievement. The research question governs the decision whether to utilise quantitative, qualitative or mixed-methods.

4. *Practical consideration*

Though the paradigm have some impact on the research, but the selection of the type of research approach should be guided in part by the demands of the research based on a 'common-sense' melding of the wise and efficient use of resources and practical goal of the research.

Leedy & Ormrod (2005) suggested a number of guidelines (see Table 5.4) to assist in the selection of an appropriate research approach.

Table 5.4: Guide for the selection of a Research approach.

Use this approach if:	Quantitative	Qualitative
You believe that:	There is an objective reality that can be measured	There are multiple possible realities constructed by different individuals
Your audience is	Familiar with/supportive of quantitative studies	Familiar with/supportive of qualitative studies
Your research question is	Confirmatory, predictive	Exploratory, interpretive
The available literature is	Relatively large	Limited
Your research focus	Covers a lot of breath	Involves in-depth study
Your time available is	relatively short	Relatively long
Your ability/desire to work with people is	Medium to low	High
Your desire for structure is	High	Low
You skills in the area(s) of	Deductive reasoning and statistics	Inductive reasoning and attention to detail
Your writing skills are strong in the area of:	Technical, scientific writing	Literary, narrative writing

Source: Leedy & Ormrod (2005)

5.5.2 Research approach adopted for this research

After a thorough review of the nature of the phenomenon (TAM project implementation), the aims & objectives of the research and the research questions, it is obvious that neither qualitative nor quantitative approach alone will be suitable for this research. The research questions require both confirmatory and exploratory approaches to be adequately answered.

Based on the above, the mixed-method approach is identified as the most appropriate, and hence is adopted for this research study. This choice decision is further supported below:

1. Qualitative approach

The research work for this project is focused on organisations and their processes, cultures and strategies. Clearly, it requires a deeper understanding of the intentions underlying the action. As explained above, for this type of research enquiry, the qualitative approach makes sense as is most suitable for exploratory research, and also tends to attempt to deduce answers to 'how?' and 'why?' questions (Walker, 1997). It is also evident in view of Cassell & Symon (1994) that qualitative methods are more appropriate to the kind of research questions focusing on organisational processes, as well as outcomes, and trying to understand both individual and group experiences at work. Marshall and Rossman (1999) and Gummesson (2000) agree that qualitative methodology provide powerful tools for research in management subjects, including general management, organisation, corporate strategy, and more. Moreover the main research question for this thesis will be best addressed in a natural setting, using exploratory approaches. Marshall and Rossman (1999) emphasised the strength of qualitative methodology in such studies for the following types of research:

- Research that delves in depth into complexities and processes
- Research that seeks to explore where and why policy and local knowledge and practice are at odds
- Research on informal and unstructured linkages and processes in organisations
- Research on real, as opposed to stated, organisational goals
- Research that cannot be done experimentally for practical or ethical reasons.

Leedy & Ormrod (2005) noted that qualitative research studies typically serve one or more of the following purposes:

1. *Description;* They reveal the nature of certain situations, settings, processes, relationships, systems or people
2. *Interpretation;* They enable the researcher to (a) gain new insights about a particular phenomenon, (b) develop new concepts or theoretical perspectives about the phenomenon, and/or (c) discover the problems that exist within the phenomenon.
3. *Verification;* They allow the researcher to test the validity of certain assumptions, claims, theories, or generalisations within real-world contexts.
4. *Evaluation;* They provide a means through which a researcher can judge the effectiveness of particular policies, practices, or innovation.

Amaratunga, *et al.* (2002) explained that qualitative research data focus on naturally occurring, ordinary events in its natural settings, so that there is a view on what "real life" is like. Another complementary feature of qualitative data which makes it necessary for this study is their richness and holism, with strong potential for revealing complexity. Such data provide descriptions that are vivid, nested in a real life context and have a ring of truth. Qualitative data, with their emphasis on people's "lived experience", are fundamentally well suited for locating the meanings people place on events, processes and structures of their lives; their "perceptions, assumptions, prejudgements, presuppositions" and for connecting these meanings to the social world around them (Amaratunga, *et al.*, 2002).

The Qualitative Research approach was used in this study to determine *how* TAM projects can be managed successfully.

2. <u>*Quantitative approach*</u>

In order to determine how organisations operating engineering facilities can manage TAM projects successfully, there are some questions (research sub-questions) that need to be answered. The answers to these questions will form a good background with which to ascertain how this project can be handled.

Considering these research sub-questions and explanations above, it is evident that a deductive approach (quantitative research method) is required in this study before the inductive approach.

Quantitative data are not abstract but are hard and reliable; they are measurements of tangible, countable, sensate features of the world (Naoum, 1998). It is worthy to note that the quantitative research process is directed towards the development of testable hypothesis and theory which are generalisable across settings and in contrast this methodology is more concerned with how a rich, complex description of the specific situations under study will evolve (Amaratunga, *et al.,* 2002). According to Naoum (1998) quantitative research should be selected under the following circumstances:

1. When the facts about a concept, a question or an attribute is required
2. When factual evidence and study of relationship between these facts in order to test a particular theory or hypothesis.

The quantitative research approach was used in this study to determine and establish:

1. Success measurement criteria of a TAM project
2. Critical success factors of a TAM project implementation
3. Management skills needed to manage TAM successfully
4. The management methodologies applicable to ensure TAM project success.

From all the above, it is very evident that the choice of mix-method research approach is most appropriate for this research project.

5.6 SELECTION OF RESEARCH STRATEGIES

As shown above, a mixed-method approach is best suited for this research. There are however different research strategies applicable to both the qualitative and quantitative approaches. To ensure that the best research strategy is chosen a thorough review of the various strategies are explained as follows:

5.6.1 Qualitative Research Strategies

Qualitative data is a source of well-grounded, rich descriptions and explanations of processes in identifiable local context (Amaratunga, *et al.,* 2002). The strategy of enquiry comprises the skills, assumptions, and practices used when moving from one paradigm and a research design to the collection of empirical materials (Denzin & Lincoln, 2000). Qualitative research can be conducted in different ways.
Leedy & Ormrod (2005) identified five common qualitative research strategies as follows:

Table 5.5: Characteristics of major types Qualitative strategies

Design	Purpose	Focus	Method of Data Collection	Method of Data Analysis
Case Study	To understand one person or situation(or perhaps a very small number) in great depth	One case or a few cases within its/their natural setting	. Observations . Interviews . Appropriate written documents and /or audiovisual material	. Categorization and interpretation of data in terms of common themes . Synthesis into an overall portrait of the case(s)
Ethnography	To understand how behaviours reflect the culture of a group	A specific field site in which a group of people share a common culture	. Participant observation . Structured or unstructured interviews with "informants". . Artifact/document collection	. Identification of significant phenomena and underlying structures and beliefs. . Organisation of data into a logical whole (e.g., chronology, typical day).
Phenomenological Study	To understand an experience from the participants' points of view	A particular phenomenon as it is typically lived and perceived by human beings	. In-depth, unstructured interviews. . Purposeful sampling of 5-25 individuals	. Search for "meaning units" that reflect various aspects of the experience . Integration of the meaning units into a "typical" experience.
Grounded Theory study	To derive a theory from data collected in a natural setting	A process, including human actions and interactions and how they result from and influence one another.	. Interviews . Any other relevant data sources	. Prescribed and systematic method of coding the data into categories and identifying interrelationships . Continual interweaving of data collection and data analysis . Construction of a theory from the categories and interrelationships.
Content analysis	To identify the specific characteristics of a body of material	Any verbal, visual, or behavioural form of communication	. Identification and possible sampling of the specific material to be analysed . Coding of the material in terms of predetermined and precisely defined characteristics	. Tabulation of the frequency of each characteristic. . Descriptive or inferential statistical analyses as needed to answer the research question

Source: Leedy & Ormrod, (2005) pg 146.

- Case Study
- Ethnography
- Phenomenological Study
- Grounded Theory study
- Content Analysis

The purpose, focus, method of data collection and method of data analysis for these qualitative research strategies are shown in Table 5.5.

Marshall & Rossman (1999) grouped the qualitative research strategies into core and secondary methods.

Core methods include:

1. Participation in setting
2. Direct observation
3. In-depth interviewing and
4. Analysing documents and material culture.

The secondary or specialised methods include life histories and narrative enquiry, films, videos, and photographs, kinesics, proxemics, unobtrusive measures, questionnaires and surveys, projective techniques and psychological techniques. The research question as discussed earlier determines the appropriate research strategy to be adopted. Denzin & Lincoln (2000) suggests that research strategies are merely tools; it is the researchers' responsibility to select the strategy that is most suited to answer the research questions from the variety of qualitative strategies and knowing their strengths. As shown in Table 5.5 each qualitative strategy offers a particular and unique perspective that illuminates certain aspects of reality more easily than others and produces a type of results more suited for some applications than others. For the purpose of this research, *case study was* found to be the most appropriate qualitative strategy.

5.6.2 Quantitative Research Strategies

Quantitative research is an approach that has been the dominant strategy for conducting social research. According to Bryman (2008), quantitative research can be construed as a research strategy that emphasises quantification in collection and analysis of data and that:

- entails a deductive approach to the relationship between theory and research, in which the accent is placed on the testing of theories
- has incorporated the practices and norms of the natural scientific model and of positivism in particular; and
- embodies a view of social reality as an external, objective reality.

Table 5.6: Comparison of the different Quantitative research strategies

Kinds of Quantitative Research	Type of Quantitative Research	Brief explanation of characteristics
Cause-and-effect Research	Pure Experiment	Enables manipulation of an independent variable in order to see the effect on the dependent variable
	Quasi Experiment	Same as above except that there is no randomization of subjects between levels of the independent variable.
	Ex-post-facto or causal-comparative.	Causal relation could be established by causal-comparative method although not as strong as the experimental method.
	Time series design	Cause-and-effect relationship established by a series of observations based on a defined duration between observations. These are recorded for a group of subjects before and after.
Descriptive Research	Survey research	Focus on the description of a phenomenon
	Correlational research	Examines the extent to which differences in one characteristic or variable are related to differences in one or more other characteristics
	R & D type of research	The focus is on development of a prototype and a validation process to justify its usefulness.
	Evaluation research	The focus is on evaluating an event by means of the above types of research and to make judgement about its usefulness

Source: Adapted from Ismail (2005)

Ismail (2005) identified two major kinds of quantitative research strategies based on with or without cause-and-effect relationships (see Table 5.6). A cause-and-effect relationship type demands experimental, ex-post-facto method or probably a time series design for longitudinal observations. A non cause-and-effect relationship requires a plain descriptive research describing about the pattern of relationships among the variables. These according to Ismail (2005) are; survey, correlational, R&D type and evaluation research. Considering the above quantitative research strategies, the *survey research* is identified as the most suitable for this study.

According to Yin, (2003) the selection of a research strategy depends on:

1. Type of research question posed
2. Extent of control an investigator has over actual behavioural events, and
3. Degree of focus on contemporary as opposed to historical events.

Table 5.7 shows the relationship between the above conditions and the research strategy.

Table 5.7: Relevant situations for Different research strategies

Strategy	Form of research question	Requires control of Behavioural events?	Focuses on Contemporary Events?
Experiment	How, why?	Yes	Yes
Survey	Who, what, where, how many, how much?	No	Yes
Archival analysis	Who, what, where, how many, how much?	No	Yes/No
History	How, why?	No	No
Case Study	How, why?	No	Yes

(Source: Yin, 2003)

In summary Table 5.7, also confirms that; *Survey* and *case studies* strategies are most suitable to answer the 'what' and 'how' research questions respectively and also for a research that focuses on contemporary events like a TAM project implementation. From all the above it can be seen that *Survey research* (quantitative) and *Case studies* (qualitative) are most appropriate for this research.

5.7 CASE STUDIES

The basic case study entails the detailed and intensive analysis of a single case (Bryman, 2008). Stake (1995) explained case study as the study of the particularity and complexity of a single case, coming to understand its activity within important circumstances. Some known studies in sociology are based on this kind of design. According to Yin (1994) their use in many situations, include:

- Policy, political science and public administration research
- Community psychology and sociology
- Organisational and management studies
- City and regional planning research
- Business administration, management science and social work.

The case study according to Amaratunga & Baldry (2001) is a research strategy which focuses on understanding the dynamics present within single settings.

Yin (2009, pg 18) defines case study in two ways:

1. The first part begins with the scope of the study,

"A case study is an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident."

2. The second part covers other technical characteristics, including data collection and data analysis strategies,

"The case study inquiry copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result relies on multiple sources of evidence, with data needing to converge in a triangulating fashion and as another result benefits from the prior development of theoretical propositions to guide data collection and analysis."

Case studies typically involve the observation of an individual unit and the emphasis tends to be upon an intensive examination of the setting. Bryman (2008) identified these as situations where case studies have been used. These include research on; a single community, a single school, a single family, a single organisation or management in organisations, a person, and a single event. There is a tendency to associate case studies with qualitative research, but such identification is not appropriate. It is however true those exponents of case study design often favour qualitative methods, such as participant observation and unstructured interviewing, because these methods are viewed as particularly helpful in the generation of an intensive, detailed examination of a case (Bryman, 2008). However, Simon (2009) explained that what defines a case study is its singularity - of the phenomenon being studied.

5.7.1 FEATURES OF THE CASE STUDIES METHOD

Case study research includes both single and multiple-case studies (Yin, 2009). Though it has been tried to distinguish between these two approaches (and have used such terms as the comparative case method as a distinctive form of multiple-case studies), single and multiple case studies are in reality but two variants of case study designs (Hamel, *et al.*, 1993). A major key strength of the case study method involves using multiple sources and techniques in the data gathering process (Soy, 1997). Simon (2009) identified the following as the key strengths of a case study research:

- Case study using qualitative methods in particular enables the experience and the complexity of programmes and policies to be studied in-depth and interpreted precisely.
- Case study can document multiple perspectives, explore contested view-points, and demonstrate the influence of key actors and interactions. It can explain how and why things happened.
- Case study is useful for exploring and understanding the process and dynamics of change.
- Case study is flexible, that is, neither time-dependent nor constrained by method. It can include a range of methods, whatever is most appropriate in understanding the case.
- Case studies written in accessible language, including vignettes and cameos of people in the case, direct observation of events, incidents and settings, allows audiences of case study reports to vicariously experience what was observed and utilize their tacit knowledge in understanding its significance.
- Case study has the potential to engage participants in the research process.

In case studies, Stake (1995) identified that the major conceptual responsibilities of the researcher includes:

- Bounding the case, conceptualising the object of study
- Selecting phenomena, themes or issues that is, the research question
- Seeking patterns of data to develop the issues
- Triangulating key observations and bases for interpretation
- Selecting alternative interpretations to pursue
- Developing assertions or generalisations about the case.

In case studies, it is very advantageous to start with a theoretical framework or theory to guide the collection of data and its analysis. This according to Simons (2009) provides security, focus and makes analysis comparatively straightforward. Theoretical framework is also needed to avoid the twin dangers of being overwhelmed by data and being drawn into narrative rather than theory building. Building a theory from data (grounded theory) has an advantage of being grounded, but this can take more time and is not always easy to generate a theory from contrary, ambiguous, complex, qualitative data (Simons, 2009) and Glaser & Strauss (1967) advocated for an initial framework, which is then tested against the data gained in the study. Even for studies where the existing knowledge is poor (especially in purely exploratory study), Yin (2009) emphasised that case study should be preceded by statements about what is to be explored, the purpose of the exploration and the criteria by which the exploration will be judged.

For case studies, Yin (2009) proposed five components which are especially important;

1. *The study's questions,* the research questions framed as 'who', 'where', 'how', and 'why' determine the relevant strategy to be used. It must be clarified and stated succinctly before moving on.
2. *Its propositions,* each proposition directs attention at something that should be examined within the scope of the study
3. *Its unit of analysis* is concerned with defining what the case study really is. The unit of analysis in a case study could be an individual, community, an organisation, a nation-state, an empire or a civilisation (Tellis, 1997)
4. *The logic linking the data to the propositions and*
5. *The criteria for interpreting the findings* are not well developed in case studies however they are represented in the data analysis and report.

5.7.2 CASE SELECTION

The choice of a case for the study is a critical decision in any case study. In choosing a case, Simons (2009) identified a number of factors that must be put into consideration:

- type of case to be conducted
- location of the case
- the case that will yield most understanding, and
- travel time and cost.

It may be useful to select cases which are typical or representative of other cases, but a sample of one or a sample of just a few is unlikely to be strong representation of others. Case study is a non sampling research (Stake, 1995). Since the objective of a case study is to achieve the greatest possible amount of information on a given problem or phenomenon, a representative case or a random sample may not be the most appropriate strategy. This is because according to Flyvbjerg (2006), the typical or average case is often not the richest in information. Flyvbjerg (2006), advocated for information-oriented sampling as the best approach to case selection. Table 5.8 summarises the various forms of sampling. In information-oriented sampling cases are selected on the basis of expectations about their information content. This is a form of non-probability sampling termed purposive, purposeful or criterion-based sampling, that is, a case is selected because it serves the real purpose and objectives of the research for gaining insight and understanding into a particularly chosen phenomenon. This sort of sampling, according to Burns (2000), is based on defining the criteria or standards necessary for a unit to be chosen as the case. A blue print of attributes is constructed and the researcher locates a unit that matches the blueprint recipe.

In this research study, information-oriented sampling was used in the case selection. The details of the selection criteria used for this research is elaborated in Chapter 7.

Table 5.8. Strategies for the selection of samples and cases for a Case study.

Type of Selection	Purpose
A. Random selection	To avoid system biases in the sample's size is decisive for generalization
1. Random sample	To achieve a representative sample that allows for generalisation for the entire population.
2. Stratified sample	To generalize for specially selected sub-groups within the population
B. Information-oriented selection	To maximize the utility of information from small samples and single cases. Cases are selected on the basis of expectations about their information content.
1. Extreme/deviant cases	To obtain information on unusual cases, which can be especially problematic or especially good in a more closely defined sense
2. Maximum variation cases	To obtain information about the significance circumstances for case process and outcome, e.g. three or four cases that are very different on one dimension: size, form of organisation, location, budget.
3. Critical cases	To achieve information that permits logical deductions of the type,' if this is (not) valid for this case, then it applies to all (no) cases'.
4. Paradigmatic cases	To develop a metaphor or establish a school for the domain that the case concerns

Source: Flyvbjerg (2006)

5.7.3 QUALITY OF CASE STUDY RESEARCH DESIGNS.

According to Yin (2009), the quality of any given research can be judged according to the following four tests:

Table 5.9: Tests and techniques for establishing validity and reliability in case study Research

Case study design tests	Corresponding Design Tests	Case study techniques	Phase of research in which techniques occur
Construct Validity	Confirmability (corresponding to objectivity and neutrality of positivism)	. Use Multiple sources of evidence . Establish chain of evidence . Have key informants review draft case study report	Data collection Data collection Research's diary and report writing
Internal Validity	Credibility	. Do within-case analysis, then cross-case pattern matching . Do explanation-building . Assure internal coherence of findings and concepts are systematically related	Data analysis Data analysis Data collection and data analysis
External validity	Transferability	.Use replication logic in multiple-case studies .Define scope and boundaries of reasonable analytical generation for the research .Compare evidence with extant literature	Research design Research design Data analysis
Reliability	Dependability	.Give full account of theories and ideas . Assure congruence between research issues and features of study design . Develop and refine case study protocol . Use multiple researchers . Record observation and actions as concrete as possible . Record data, mechanically develop case study database . Assure meaningful parallelism of findings across multiple data sources. . Use peer review/examination	Research design/ analysis Research design Research design Data collection Data collection Data collection Data collection Data analysis

Source: Adapted from Riege (2003); pg 78-79

a. Construct validity
b. Internal validity (for explanatory or causal studies only and not for descriptive or exploratory studies)
c. External validity
d. Reliability.

Because a research design is supposed to represent a logical set of statements, the researcher also can judge the quality of any given design according to certain logical tests. Concepts that have been offered for these tests include trustworthiness, credibility, confirmability, and data dependability. There are several techniques which can enhance the validity and reliability in case study research Table 5.9 shows the tests and the techniques for establishing validity and reliability in a case study research.

5.7.3.1 Validity

The checks and balances of random sampling, of standardised and reliable instruments are missing in case studies. Mainly available according to Burns (2000), are the techniques of triangulation plus the commitment to seek deliberately to disconfirm one's own interpretations. As with tests, the validity of the case depends on the purpose to which it is put. The following are validity tests inherent to case study:

1. *Construct validity*

This test is especially challenging in case study research. Critics of case studies often point to the fact case study investigators fails to develop a sufficiently operational set of measures and that "subjective" judgements are used to collect the data (Yin, 2009). According to Riege (2003), the corresponding design test for construct validity is confirmability. This assesses whether the interpretation of data is drawn in a logical and unprejudiced manner. Three ways have been identified for improving construct validity.

a. Use of multiple sources of evidence in data collection phase (Burns, 2000; Riege, 2003 and Yin, 2009).
b. Establishment of chain of evidence in the data collection phase (Burns, 2000; Riege, 2003 and Yin, 2009).
c. Reviewing of draft case study reports in the report-writing phase (Riege, 2003)

2. *Internal validity*

Internal validity deals with question of how well the findings match reality. According to Yin (2009), internal validity is mainly a concern for explanatory case studies where the researcher is seeking causal relationship, whereby certain conditions are believed to lead to other conditions, as distinguished from spurious relationships. However, if the major assumption underlying qualitative research is that reality is ever-changing, subjective in interpretation and holistic, and not a single fixed entity, then it is not feasible to try and measure congruence between data collected and some notion of reality (Burns, 2000).

Riege, (2003), identified credibility of the findings as the corresponding design test for internal validity and suggested three ways of increasing internal validity in a case study research:

a. Use of within-case analysis, the cross-case and cross-nation pattern matching in the data analysis phase
b. Display of illustrations and diagrams in the data analysis phase, to assist explanation building in the data analysis phase
c. Assurance of internal coherence of findings in the data analysis phase, which can be achieved by cross-checking the results.

Burns (2000) suggests that internal validity has been assessed by a number of strategies, such as triangulation, re-checking with participants as to observer interpretations made, peer judgment, and long-term observation.

3. *External Validity*

According to Riege (2003), external validity is all about transferability or generalisation in conventional quantitative research. This test is achieved when the research shows similar or different findings of a phenomenon amongst similar or different respondents or organisations that is achieving analytical generalisation. The generalisation is however not automatic, a theory must be tested by replicating the findings. Once such direct replications have been made, the results might be accepted as providing strong support for the theory (Yin, 2009). Here a major insight is to consider multiple cases as one would consider multiple experiments, that is, to follow "replication" logic.

To increase external validity, Riege (2003), recommended the following techniques:

a. Use of (literal and/or theoretical) replication logic in multiple case studies in the research phase

b. Definition of the scope and boundaries in the research design phase, which help to achieve reasonable analytical generalisations rather than statistical generalisations for the research in the research design phase
c. Comparison of evidence with the extant literature in the data analysis phase, to clearly outline contributions and generalise those within the scope and boundaries of the research, not to larger population.

5.7.3.2 Reliability

The objective of a reliability test, according to Yin (2009) is to be sure that, if a later investigator followed the same procedures as described by an earlier investigator and conducted the same case study all over again, the later investigator should arrive at the same findings and conclusions. In other words, the purpose of this test is to show indications of stability and consistency in the process of inquiry. The underlying issue here is whether the procedures or techniques used in the process of study are consistent and dependable (Riege, 2003). The following are identified by Riege (2003) as techniques that can improve the reliability of a case study research:

a. Give full account of theories and ideas for each research phase
b. Assurance of congruence between the research issues and features of the study design in the research phase
c. Record observations and actions as concrete as possible
d. Development and refinement of the case study protocol in the research design phase can be achieved by conducting several pilot studies testing the way of questioning and its structure
e. Use of a structured or unstructured case study protocol
f. Use multiple researchers who continually communicate about methodological decisions.
g. Record data mechanically, for example, by the use of tape recorder
h. Development of a case study data base at the end of data collection phase, to provide a characteristic way of organising and documenting the mass of collected data
i. Assurance of meaningful parallelism of findings across multiple data sources
j. Use peer review/examination.

Finally, Burns (2000) maintains that to improve reliability and enable others to replicate your work, the steps and procedures taken in the study must be clearly explicit and well documented. Further details of case studies and the case studies design used in this research are explained in Chapter 7.

5.7.4 SOURCES OF EVIDENCE

Yin (2009) identified six commonly sources of evidence in case studies. These includes: documentation, archival records, interviews, direct observations, participant-observation and physical artefacts. The strengths and weaknesses of these six major sources are shown in Table 5.10. These six sources of evidence are reduced to three main methods of data collection - interviewing, observing and document analysis (Simon, 2009). For this research study, data were collected from these main sources. As shown above the use of these multiple sources of evidence improves the construct validity of the data collected from the case organisations.

5.7.4.1 Documentation

Documentary information is likely to be relevant to every case study topic. Yin (2009) identified the following documentary evidence as being useful for a cased study:

- letters, memoranda, e-mail correspondence and other personal documents, such as diaries, calendars, and notes
- agendas, announcements and minutes of meeting and other written reports of events
- administrative documents - proposals, progress reports, and other internal records
- formal studies or evaluations of the same "case" that one is studying; and
- news clippings and other articles appearing in the mass media or in community newspapers.

Table 5.10: Sources of Evidence in case study Research: Strengths and Weaknesses

Source of Evidence	Strengths	Weaknesses
Documentation	• Stable - can be reviewed • Unobtrusive - not created as a result of the case study • Exact - contains exact names, references and details of an event • Broad coverage - long span of time, many events, and many settings	• Retrievability - can be difficult to find • Biased selectivity, if collection is incomplete • Reporting bias - reflects (unknown) bias of author. • Access - may be deliberately withheld.
Archival Records	• *[Same as those for documentation]* • Precise and usually quantitative	• *[Same as those for documentation]* • Accessibility due to privacy reasons
Interviews	• Targeted - focuses directly on case study topics • Insightful - provides perceived causal inferences and explanations	• Biased due to poorly articulated questions • Response bias • Inaccuracies due to poor recall • Reflexivity - interviewee gives what interviewer wants to hear.
Direct observations	• Reality - covers events in real time • Contextual - covers context of "case".	• Time - consuming • Selectivity - broad coverage difficult without team of observers. • Reflexivity - event may proceed differently because it is being observed. • Cost - hours needed by human observers.
Participant observation	• *[Same as above for direct observations]* • Insightful into interpersonal behaviour and motives	• *[Same as above for direct observations]* • Bias due to participant-observer's manipulation of events
Physical artefacts	• Insightful into cultural features • Insightful into technical operations	• Selectivity • Availability

Source: Yin (2009) pg 102

Burns (2000) explained that it is essential to remember that these documents may not be accurate or lack bias, and that they have been written with specific audience in mind for specific purpose. In fact documents must be carefully used and should not be accepted as literal recordings of events that have taken place. For case studies, the most important use of documents is to corroborate and augment evidence from other sources (Yin, 2009; Burns, 2000). Yin (2009) outlined the following as some of needs for the study of documents in a case study research:

- Documents are helpful in verifying the correct spellings and titles or names of organisations that might have been mentioned in an interview
- They can provide specific details of issues and events, and
- Inferences can be made from documents. These however should be treated as clues worthy of further investigation rather than as definitive findings because the inferences could later turn out to be false leads.

During the case studies conducted for this research, reports, minutes of TAM meetings and other organisational documents related to TAM projects were collected. More information about the case organisations were gathered through the company internet sites and brochures. Different industry-wide information database were also used.

5.7.4.2 Interviewing

Interviewing - verbal questioning - is one of the most common methods of data collection (Sarantakos, 2005) and qualitative researchers rely quite extensively on it. The qualitative research interview seeks to describe and the meanings of central themes in the life world of the subjects (Kvale, 1996). Khan & Cannell (1957) described interviewing as a conversation with a purpose. Typically, qualitative in-depth interviews are much more like conversations than formal events with predetermined response categories (Marshall & Rossam, 1999). Interviews are particularly useful for getting the story behind a participant's experiences. The interviewer can pursue in-depth information around the topic. The interviews should be a guided conversations rather than structured queries, according to Yin, (2009). Simons, (2009) suggested that interviewing has four major purposes:

1. To document the interviewee's perspective on the topic or to find out what is in and on the mind of someone else
2. Is the active engagement and learning it can promote for the interviewer and the interviewee in identifying and analysing issues

3. The inherent flexibility it offers to change direction to pursue emergent issues, to probe a topic or deepen a response, and to engage in dialogue with participants
4. The potential for uncovering and representing unobserved feeling and events that cannot be observed.

Interviews are essential, as most case studies are about people and their activities. These need to be reported and interpreted through the eyes of interviewees who provide important insights and identify other sources of evidence. Most commonly, case study interviewers use unstructured or open-ended form of interview, so that the respondent is more of an informant than a respondent. The case study investigator needs to be cautious about becoming too dependent on one respondent and must use other sources of evidence for confirmatory and contrary evidence. However, at times a more structured interview may be held as part of a case study. This could involve sampling procedures and survey instruments. But it would form only one source of evidence, rather than the only source of evidence as in a survey (Burns, 2000). In Chapter 7, details of the interviews conducted in this research are provided.

5.7.4.3 Participants and non-participants Observation

Both participant and non-participant observation can be used in case studies (Burns, 2000).

Participant-observation is a special mode of observation in which the investigator is not merely passive observer. Instead may assume a variety of roles within a case study situation and may actually participate in the events being studied (Yin, 2009). The major problems associated with participant-observation are concerned with potential bias. The investigator may become too closely involved and lose detachment, or assume advocacy roles detrimental to unprejudiced reporting.

On the other hand, a non-participant observation (or direct observation) stands aloof from the case being studied. There is usually an opportunity for direct observation in a case study since the study takes place in the natural setting of the "case". According to Yin (2009), if the phenomenon of interest is not purely historical, some relevant behaviours or environmental conditions will be available for observation. Such observations serve as yet another source of evidence in a case study.

During the site visits of the case organisations, some direct observations were made on some of the critical equipments and in one situation the visit coincided with one of the organisational TAM project event. Details are explained in Chapter 7.

5.8 SURVEY RESEARCH

Survey research involves acquiring information about one or more groups of people perhaps about their characteristics, opinions, attitudes, or previous experiences by asking questions and tabulating their answers (Leedy & Ormrod, 2005). Alternatively survey research is the method of collecting information by asking a set of pre-formulated questions in a predetermined sequence in a structured questionnaire to a sample of individuals drawn so as to be representative of a defined population. The ultimate goal is to learn about a large population by surveying a sample of that population.

Blaxter, *et al.* (2003) identified the following characteristics of a survey research;

- Questions are designed so that answers from individual interviews can add together to produce results which apply to the whole sample
- The research is based on interviews with a representative sample of respondents
- The questions are designed to be unbiased
- Surveys lend themselves to future replication
- Large surveys can often be broken down.

The major weakness of a survey research however, is that it relies on breath rather than depth for its validity.

5.8.1 Survey Methods - Self-completion questionnaires

There are basically three methods of gathering data with surveys: self-completion questionnaires, personal interviews, and telephone interviews (Nachmias & Nachmias, 1996; Leedy & Ormrod, 2005). Evaluation of these three survey methods is shown in Table 5.11.

Considering the above evaluation criteria, the self-completion questionnaire is identified as being most appropriate for this research project.

Bryman (2008) identified two major modes of self-completion questionnaires administration: The internet and the Postal mail questionnaires.

Table 5.11: Evaluation of the three Survey Methods

Criterion	Personal Interview	self-completion Questionnaires	Telephone
Cost	High	Low	Moderate
Response Rate	High	Low	High
Control of interview situation	High	Low	Moderate
Applicability to geographically dispersed populations	Moderate	High	Moderate
Applicability to heterogeneous populations	High	Low	High
Collection of detailed information	High	Moderate	Moderate
Speed	Low	Low	High

Source: Adapted from Nachmias & Nachmias, 1996.

5.8.1.1 Internet Questionnaires:

There has been considerable growth in the number of surveys being administered online. According to Bryman (2008), these internet questionnaires are mainly distributed through e-mail or the web (web surveys).

1. E-mail Questionnaires

This can be seen as the electronic way of administering questionnaires. The questionnaires are sent directly to people via e-mail. People are then expected to complete the questionnaire on their computer and return the completed questionnaire back to you, again, via e-mail. Although a less common strategy, you may send a questionnaire via e-mail in which the recipient will print it off to fill out before sending it back to you by post. E-mail (electronic mail) is becoming an increasing popular method of survey information dissemination and is fast becoming an alternative to postal mail survey. The following has been identified as major drawbacks to e-mail questionnaires:

- The questionnaires can only be distributed when the e-mail addresses of respondents are correctly known

- People may treat the questionnaire as SPAM (or junk mail) and consequently you could end up with a number of complaints from annoyed people (damaging your image)
- Misunderstood questions cannot be explained
- Questionnaires may be returned incomplete.

2. Web-based survey Method

In recent years, some researchers have adopted using the internet for data collection. This is called web-based survey methods or world-wide web survey research. This is usually done by putting a questionnaire on a website and invite people who visit the site to respond (Leedy & Ormrod, 2005). Commercial websites for data collection are now available. According to Leedy & Ormrod (2005), two of the most widely used websites for online surveys are Zoomerang (zoomerang.com) and SurveyMonkey (www.surveymonkey.com).

The major advantage of online questionnaire is population access. Large numbers of people now have access to the internet and in particular the www (Schmidt, 1997) and when the desired sample is large, the web-survey offers a better reach. It also saves time and is far more cost-effective than mailed questionnaires.

The following limitations of the web-based survey have been identified by Schmidt (1997):

- *Incomplete Responses*; One of the potential problem with survey research is incomplete form submissions, and this is more obvious in web-survey. Here most of the respondents may not be interested in the research, and may simple visit the website without any intension of contributing a complete data.
- *Un acceptable Responses*; whether due to entry error or intent to supply incorrect information, respondents may supply unacceptable data. For instance, text may be entered where a numeral string was requested, or vice versa.
- *Multiple submissions*; Also whether due to entry error, intent to foil the survey, or just out of curiosity, respondents may submit their set of responses more than once
- *Security and data integrity*; on the web, there is nothing preventing anybody who has access to your site from downloading and examining the source for the HTML pages that you present. In other to foil your survey results, nothing

prevents others from sending data to your CGI (Common Gateway Interface) for processing.

Leedy & Ormrod (2005) suggest that virtually in any study, the people who participate in an online research project will not be representative either of a particular group of people or of the overall population of human beings, insisting that participants will be limited to the people who;

a. are comfortable with computers
b. spend a fair amount of time on the Internet
c. enjoy partaking in research studies
d. Have been sufficiently enticed by the research topic to participate.

Also, in cases where a questionnaire can be completed by anyone who has access to the internet, many respondents are apt to be college students who are earning course credit for their participation. Such sample will surely be biased to some degree.

5.8.1.2 Mail Questionnaire

Mail Questionnaires (or the postal mail questionnaire) are one of the most widely used social research techniques. There are a number of different ways in which questionnaires can be administered. They can be sent by mail to intended respondents, who then complete and return them themselves (Blaxter, *et al.*, 2003). The mail questionnaire is an impersonal survey method. For this study, the mail questionnaire was used as against the internet questionnaires. The following were also considered:

1. *Cost*

Economy is one of the most obvious appeals of mail questionnaires. The mail questionnaire does not require a trained staff of interviewers; all it entails is the cost of planning, sampling, duplicating, mailing and providing stamped, self-addressed envelopes for the returns. The lower cost is particularly evident when the population under study is widely spread over a large geographic area. Under this condition the cost of travelling for interviews or lengthy telephone interview could become prohibitive (Nachmias & Nachmias, 1996).

2. *Greater Anonymity*

The absence of the interviewer also provides greater anonymity of the respondent. According to Leedy & Ormrod (2005), participants can respond to questions with assurance that their responses will be anonymous; thus they may be more truthful than they would be in a personal interview.

3. *Reduction in bias error*

The use of mail questionnaire reduces biasing errors that might result from the personal characteristics of interviewers and variability in their skills. Personal interview situations are fraught with possibilities for bias due to the nature of interaction between the interviewer and the respondent.

4. *Considered answers and consultations*

Mail questionnaires are also preferable when questions demand a considered answer or if answers require respondents to consult personal documents or other people.

5. *Accessibility*

Mail questionnaires permits wide geographic contact at minimal cost. When surveys requires wide coverage and addresses a population that is dispersed geographically, interviewing would involve high level travel cost and large investments of time.

Other strengths of mail questionnaire according to Burns (2000) include:

- Errors resulting from the recording of responses by interviewers are reduced
- The respondent is free to answer in their own time and at their own pace
- Fear and embarrassment, which may result from direct contact, are avoided
- The problem of non-contact with the respondent (i.e. the respondent is unavailable when the interviewer is available) is overcome.
- Each respondent receives the identical set of questions, phrased in exactly the same way. The absence of an interviewer, or third party, contributes to the standardisation of responses, as variations in voice inflections, word emphasis, or the use of probes, are eliminated. Better standardisation, particularly through the use of structured instrument, means higher reliability.

Some of the disadvantages of mail questionnaires identified include:

- Need to make the questions simple
- No control over who fills out the questionnaires
- Low response rate.

In this study these weaknesses were recognised and adequately addressed as follows:

- The questions were made very simple

- Questionnaires were sent to organisations for distribution to the relevant competent personnel
- The personnels were required to identify their position in the organisation on the questionnaire
- Follow-ups were made to ensure a good response.

5.8.1.2 Questionnaire Designs

The foundation of all questionnaires is the question. The survey questionnaire is guided by the research questions and is the data collection tool. Therefore it sits between the research questions and the research strategy and process of data collection (Punch, 2003). The questionnaire must translate the research objectives into specific questions; answers to such questions will provide the data for hypothesis testing. Survey questions may be concerned with facts, opinions, attitudes, respondents' motivation, and their level of familiarity with a certain subject. Most questions however, can be classified in either of two general categories: factual questions and questions about subjective experiences (Nachmias & Nachmias, 2000).

Factual questions

Factual questions are designed to elicit objective information from the respondents regarding their backgrounds, environments, habits, and the like. The most common type of factual question is the background question, which is asked mainly to provide information that can be used to classify respondents.

Questions about Subjective Experiences

Subjective experience involves the respondents' belief, attitudes, feelings and opinions.

a. Attitudes are general orientations that can incline a person to act or react in ascertain manner when confronted with certain stimuli. Nachmias & Nachmias (2000) explained that attitudes can be described by their content (what the attitude is about), their direction (positive, neutral, negative feelings about the object or issue in question), and their intensity (an attitude may be held with greater or lesser vehemence).

b. Respondents are frequently asked about their beliefs. This can take the form of whether the respondent believe that certain matters are true or false (Bryman, 2008).

c. Bryman (2008) also suggested that respondents may be asked questions about normative standards and values. Here respondents may be asked to indicate what principles of behaviour influence them or they hold dear.

d. Questions can also be asked about knowledge. These questions can be employed to 'test' respondents' knowledge in an area.

Types of Survey Questions

The content of the questions is another one important aspect of constructing survey questionnaires. Nachmias & Nachmias (2000) explained that the structure of the questions and the response categories that accompany them should also be considered. Basically there are three types of question structures: closed-ended questions, open-ended questions and contingency questions.

In a **closed-ended question**, respondents are offered a set of answers and asked to choose the one that most closely represents their views. Closed-ended designs enable researchers to produce aggregated data quickly, but the range of possible answers is set by the researcher and not the respondents, and the richness of potential responses is lower (Boynton & Greenhalgh, 2004). Their major drawback according to Nachmias & Nachmias (2000) is that they may introduce bias, either by forcing the respondent to choose from given alternatives or offering the respondents alternatives that might not have otherwise come to mind.

Open-ended questions on the other hand are not followed by any specified choice and the respondents' answers are recorded in full. Here there is not one definite answer to the question as respondents are given the opportunity to answer in their own words.

The choice of questions according to Nachmias & Nachmias (2000) depends on a number of factors. These include:

1. *The objectives of the questionnaire.*

   Closed-ended questions are suitable when the objective is to lead the respondent to express agreement or disagreement with explicit point of view. If the objective is to learn how the respondent arrived at a particular point of view, an open-ended question is more appropriate.

2. *The respondent's level of information about the topic in question:*
   Open-ended questions provide opportunities to ascertain a lack of information on the part of the respondent, whereas closed-ended questions do not.
3. *The extent to which the topic has been thought through by the respondent:*
   The open-ended question is preferable in situations where respondents have not crystallized their opinions. Using a closed-ended question in such situations involves the risk that in accepting one of the alternatives offered, respondents may make a choice that is quite different from the opinion they would otherwise have expressed had they gone through the process of recalling and evaluating their past experiences.
4. *The ease with which respondents can communicate the content of the answer or the extent to which respondents are motivated to communicate on the topic:*
   The closed-ended question requires less motivation to communicate on the part of the respondent, and the response itself is usually less revealing than in the case of the open-ended question.

Generally, the benefit of closed-ended questions is that they are easy to standardize, and data gathered from closed-ended questions lend themselves to statistical analysis. The major down side is that they are more difficult to write than open-ended questions. This is because the researcher must design choices to include all possible answers a respondent could give for each question. There are five basic types of closed-ended questions formats. These are explained in Table 5.12.

Table 5.12 Types of Survey Questions and their best uses.

Type of question...	Best Used for.
1. Open-ended	Breaking the ice in an interview; when respondents' own words are important; when the surveyor doesn't know all the possible answers.
2. Closed-ended	Collecting rank ordered data; when all response choices are known; when quantitative statistical results are desired.
a. Likert-scale	To assess a person's feelings about something.
b. Multiple-choice	When there are a finite number of options (remember to instruct respondents as to the number of answers to select).
c. Ordinal	To rate things in relation to other things.
d. Categorical	When the answers are categories and each respondent must fall into exactly one of them.
e. Numerical	For real numbers, like age, number of months, etc.

Source: Adapted from Waddington (2000).

Closed-ended questions using Likert-scale (scale of 1 - 5) were adopted for this research. These were used to assess the perceptions of the respondents on the various propositions in the questionnaire.

5.8.1.3 Avoiding Bias

One of the major short coming of mail questionnaire is response bias. Bryman (2008) identified the following as possible issues in questionnaire construction that should be avoided to prevent response bias:

1. Avoid ambiguous terms: avoiding terms like 'often' or 'regularly' as measures of frequency
2. Avoid double-barrelled questions: asking of two things in the same question.
3. Avoid a general question
4. Avoid long questions; questions should be clear, precise and relatively short
5. Avoid a leading question; as it suggests to the respondent that the researcher expects a certain answer
6. Avoid questions that include negatives
7. Avoid technical terms

5.8.2 RELIABILITY AND VALIDITY OF SURVEY RESEARCH

The quality of survey research is assessed by the reliability and validity of the measurement.

5.8.2.1 Reliability

Reliability, according to Sarantakos (2001) means the ability of an instrument to produce consistent results whenever it is repeated even by another researcher. It is concerned mainly with the question of whether the results obtained in a study are repeatable. Hence Bryman (2008) stated that reliability refers to the consistency of a measure. There are two prominent factors involved when considering whether a measure is reliable:

- *Stability,* This consideration entails ensuring that a measure is stable overtime. This is to ensure consistency over time, that is, if the same instrument is given to the same respondent under the same circumstances at different time, the same result will be achieved.

- *Internal consistency*: ensuring that each proposition inference and conclusion of each theme is consistent with each other and working in the same direction.

5.8.2.2 Validity

The subject of validity is complex, controversial and peculiarly important in research. Validity is the term used to describe how the research instrument measures what is intended to measure (Punch, 1998). That is, measurement of validity means the extent to which an instrument measures what it is claimed to measure or the degree to which a study accurately reflects or assesses the specific concept that the researcher is attempting to measure.

5.8.2.3 Assurance of Validity and Reliability

To ensure that this study is valid and reliable; the following were put into consideration:

- *Propositions*: to clearly define the research questions and attributed propositions.
- *Sample size*: to obtain large sample size of population
- *Participants*: ensuring that the participants are experienced TAM professionals.
- *Time*: creating adequate time for data collection and collation.
- *Research Instruments*: careful selection of research instruments by carrying out a pilot study, to ascertain the suitability and adequacy of the instrument.
- *Triangulation*: the use of multiple research technique and approach for data and information generation. This is to ensure that the demerit of one approach will be cancelled by the merits of others.
- *Mechanical recording and electronic system*: The use of mechanical recording system, audio tape recorder for interview and computer softwares for data analysis: the use of SPSS 16.0 and NVivo 8.0.
- *Operational framework validation*: conducting a validation of the framework developed with experienced TAM implementation professionals for comments, observations, shortfall and contribution for final amendment of operational framework.

5.9 PILOT STUDIES

Before the start of any major study or research, it is usually advised to carry out a trial of the methods and procedures to be employed. This trial, pre-study or 'mini' study version of a full-study is called pilot study. According to Blaxter, *et al.* (1996), piloting, or "reassessment without tears", is the process whereby the researcher tries out the research techniques and methods which are planned for the main study to see how they work in practice and, if necessary, modify the plans accordingly. Van-Teijlingen and Hundley (2001) stated that the term pilot study can be used in two different ways in social research. It can refer to so-called feasibility studies which are "small scale version(s), or trial run(s), done in preparation for the major study". However, a pilot study can also be the pre-testing or 'trying out' of a particular research instrument. Shuttleworth (2008) explained that a pilot study is a standard scientific tool for 'soft' research, allowing scientists to conduct a preliminary analysis before committing to a full-blown study or experiment. Pilot studies generally help to identify any potential flaws and short comings in the research design methods. Important time is also saved which may be wasted in modifying the methods later. Moreover, it authenticates the relevance and practicality of the research issues and methods early on in the research. The value of pilot research cannot be underrated, the researcher may think of knowing well enough, but things never work quite the way it is envisaged, even if done many times before.

Woken (2009) identified the following as some of the reasons for carrying out a pilot study.

1. It permits preliminary testing of the hypotheses that leads to testing more precise hypotheses in the main study. It may lead to changing some hypotheses, dropping some, or developing new hypotheses.
2. It often provides the researcher with ideas, approaches, and clues you may not have foreseen before conducting the pilot study. Such ideas and clues increase the chances of getting clearer findings in the main study.
3. It permits a thorough check of the planned statistical and analytical procedures, giving you a chance to evaluate their usefulness for the data. You may then be able to make needed alterations in the data collecting methods, and therefore, analyze data in the main study more efficiently.

4. It can greatly reduce the number of unanticipated problems because you have an opportunity to redesign parts of your study to overcome difficulties that the pilot study reveals.
5. It may save a lot of time and money. Unfortunately, many research ideas that seem to show great promise are unproductive when actually carried out. The pilot study almost always provides enough data for the researcher to decide whether to go ahead with the main study.
6. In the pilot study, the researcher may try out a number of alternative measures and then select those that produce the clearest results for the main study.

5.9.1 Pilot studies adopted in this Research

In this research two phases of pilot studies were carried out. The need for carrying out these pilot studies were for the researcher to gain thorough insight on the implementation of TAM projects and to discover possible weaknesses, inadequacies, ambiguities and problems in all aspects of the research, so that these can be corrected before the main research data collections.

5.9.1.1 Pilot Study Phase I

The first phase of pilot studies was carried out to familiarise with the research and the research environment. Two pilot studies were carried out in this phase:

1. Interviews

This involved random interviews with some Maintenance Managers working in engineering facilities. The main objective for this pilot study was to access the real need for the research.

The criteria used for selecting the managers were as follows:

- Hands-on maintenance managers
- Experienced in maintenance strategies in a continuous process plant
- Geographical proximity
- Accessibility to the maintenance manager

The outcomes of the pilot study I include:

- The confirmation that shutdown maintenance projects are unavoidable.

- That most organisations are struggling with their Turnaround maintenance projects.
- There is no clear framework for managing TAM projects.

The study assisted the researcher in the development of substantial research problem and also confirmed that participants are ready to contribute to the study when called upon.

2. Workshop

The research proposal for this study was presented at the *Association of Researchers in Construction Management (ARCOM) Doctoral Workshop on June 1, 2007 at Sheffield Hallam* University. The theme of the workshop was *Facilities, Refurbishment and Maintenance management.* Present in the workshop were academicians, practitioners and other PhD researchers in Facilities Construction, Maintenance management. The objectives of the presentation include:

- To access the real need for the research
- To access to ensure that the level of the contribution of the research to knowledge is reasonable enough for a PhD degree
- To access the adequacy of the research approach and design
- To determine the suitability of the methods of data collection
- To ascertain the adequacy of the data analysis methods.

The responses and the feedback from the attendees assisted in the giving direction to this work. It also assisted the researcher in the conceptualisation of the framework to be developed.

5.9.1.2 Pilot Study Phase II

This study was carried out to ascertain the adequacy of the survey and case study questions and the design that was employed for the actual research data and information collection. This study assists the researcher to:

- Estimate the cost and duration of the main study and the effectiveness of the organisation.
- Check the adequacy of the sampling frame
- Estimate the level of response and forms of drop-outs
- Ascertain the suitability of the questions to be administered

- Ensure that the research design and instruments will provide substantial and valid answers to the research problem
- Consolidate the conceptual framework for the research study.

1. Survey Questionnaire

The participants for the study included PhD researchers, academicians and some senior maintenance managers of engineering facilities. Each group was given a copy of the draft questionnaire and was requested to provide their feedback and comments on the questionnaire itself. As suggested by Naoum (2002), the respondents were solicited to comment on:

- The clarity of the instructions
- The length of time it took to complete the questionnaire
- The clarity and ambiguity of the questions
- Any objection to answering any of the questions and why
- Any omissions of any topic or issues unrealised
- The appropriateness of the layout.

The feedback obtained from the pilot study was examined and considered. The comments of these respondents were used in refining the questionnaires design to derive the final questionnaire.

2. Case Study Interview Questions

The case study interview questions were also piloted. The participants here also included PhD researchers, academicians and some senior maintenance managers of engineering facilities.

In this pilot study, the participants were required to read the interview questions and express their views and comments on:

- The clarity of the questions
- The suitability of the questions in answering the research questions
- Any omissions of any topic or issues unrealised
- The appropriateness of the layout.

The feed back and comments obtained from this study were used to refine the interview questions appropriately.

To ascertain the time it will take for the interview, a pilot interview was carried out with a Shutdown maintenance manager. The resultant comments on time from the interviewee helped in redefining some of the questions. This helped in estimating time that was requested from the case study interview respondents.

5.10 CONCEPTUAL THEORETICAL FRAMEWORK

A theoretical framework is a collection of interrelated concepts, like a theory but not necessarily so well worked-out. A theoretical framework guides the research, determining what things you will measure, and what statistical relationships you will look for. According to Simons (2009), having a theoretical framework at the beginning of a research study provides security, focus and makes analysis comparatively straightforward. In observing the procedure to support the external validity of the research, the theoretical framework for this study was first developed by conceptualising the phenomenon drawn from the literature review. This was achieved by critically analysing the findings from the literature investigations to determine precisely the research problem and formulation of clear research question, which is important in developing the research design (De Vaus, 1994; Robson, 2002).
In view of the critical review of the literatures and considering the research problem, it was possible to develop, formulate and adopt a theoretical framework for this research work on the successful implementation of TAM projects.

The theoretical framework comprises of three major components (see Figure 5.5); the organisation/management input, TAM implementation process and TAM evaluation. The framework considers that successful TAM project can be achieved through:

- The Organisation (Top Management) appointing and supporting a TAM manager with the right personal attributes and skills. The TAM manager assembling the right TAM management team.
- The TAM Manager and his team using the right management methodologies and the current innovations to manage the critical success factors which imparts on TAM activities during the TAM implementation
- The TAM implementation evaluation should use the right success measurement criteria, ensuring that the three elements of TAM project success are used, i.e.,

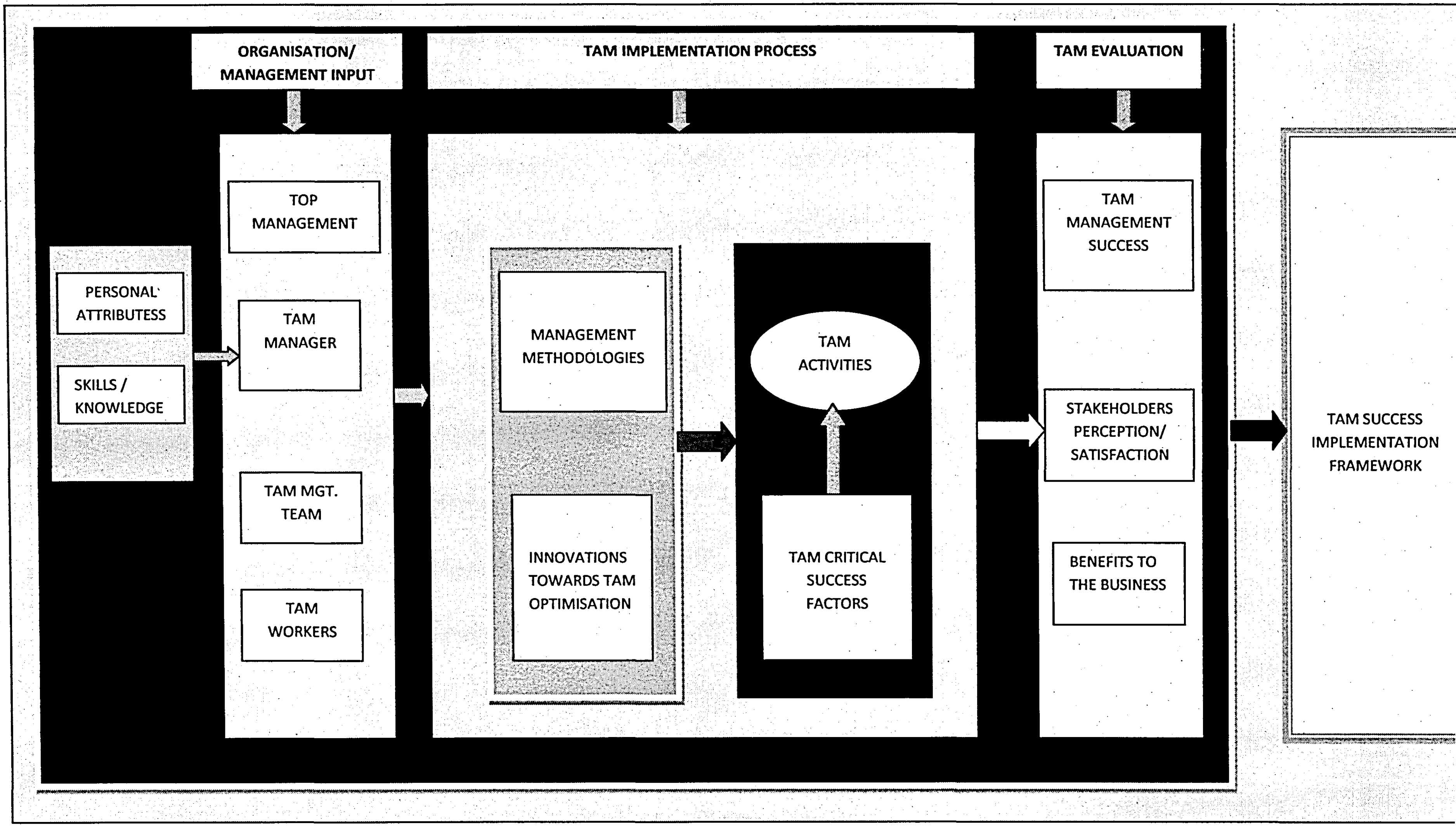


Figure 5.5: Conceptual Framework for the Successful Implementation of TAM projects.

- Management success, Perception of Stakeholders and Benefits to the organisation i.e. the TAM objectives are met.
- Finally the TAM Successful Implementation Framework will be developed from the combination of the above.

5.10.1 Rationale for the frameworks.

After thorough evaluation of the current practice in the industry, and also appraisal of different innovation towards optimization of TAM projects, it was found that the following issues have not been addressed:

a. Success Measurement criteria to evaluate the outcome of TAM projects.
b. Skills and Attributes required by TAM management to ensure the successful implementation of TAM projects.
c. The critical success factors for TAM projects and how they affect the project
d. Specific Management methodology for TAM projects.

Thus, the Turnaround Maintenance Project Implementation framework to be established, intend to be efficient to ensure the success of TAM projects if properly implemented.

5.11 RESEARCH DESIGN ADOPTED FOR THIS RESEARCH

Nachmias & Nachmias (1996) explained that the research design is the "blueprint" that enables the researcher to come up with solutions to research problems and guides in the various stages of the research. A research design provides a framework for the collection and analysis of data (Bryman, 2008). The choice of research design reflects decisions about the priority being given to a range of dimensions of the research process. These decisions according to Bryman (2008) include the importance attached to:

- expressing causal connections between variables
- generalization to larger groups of individuals than those actually forming part of the investigation
- understanding behaviour and the meaning of that behaviour in its specific social context; and
- having a temporal (i.e., over time) appreciation of social phenomena and their interconnections.

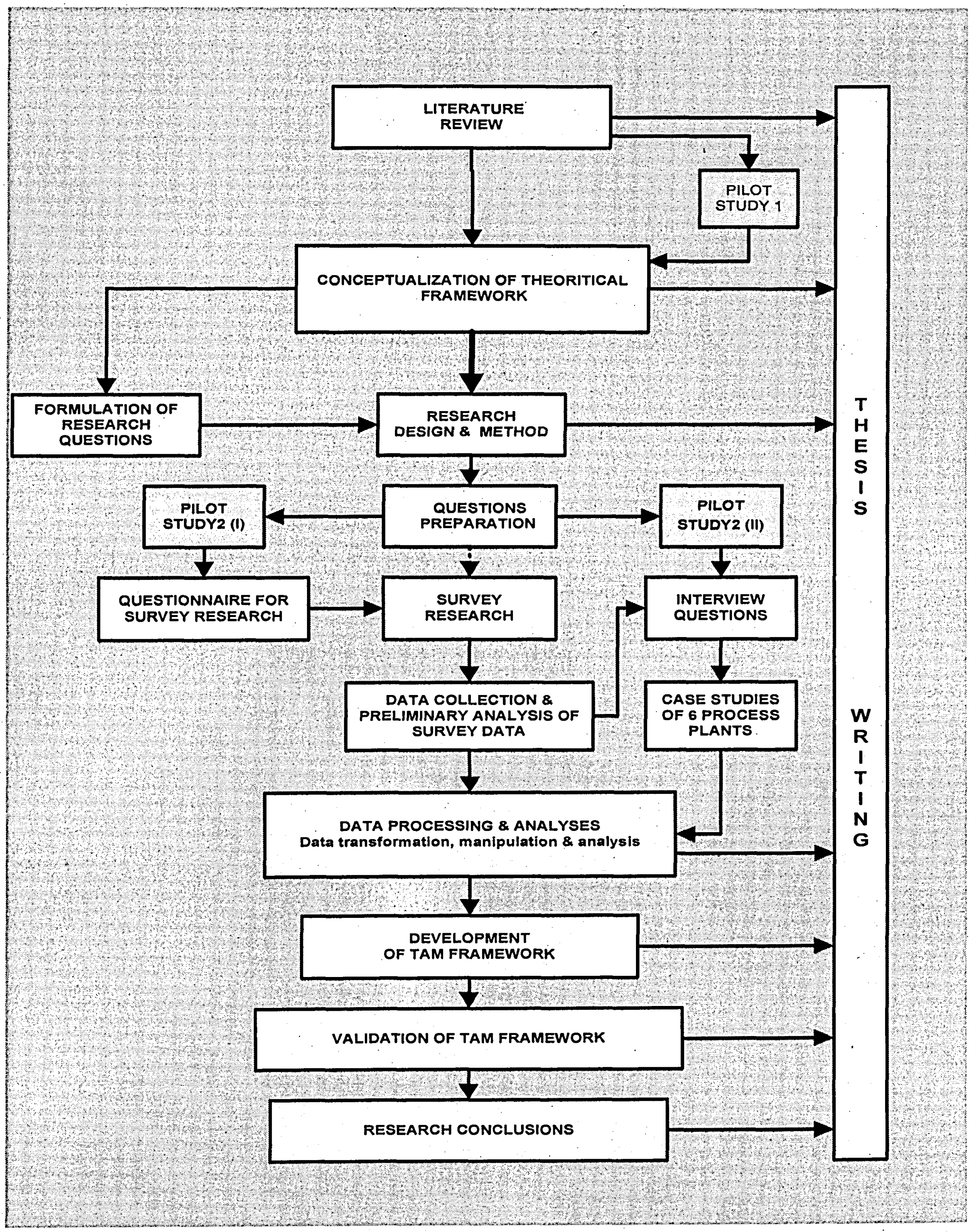


Figure 5.6: Research Process flowchart

The main purpose of the research design is to help avoid the situation in which the evidence does not address the initial research questions. The research design for this research project is illustrated in Figure 5.6 and consists mainly of the following phases:

- Literature Review
- Conceptualization of theoretical framework.
- Research design and Methods
- Development of TAM framework
- Validation of TAM framework.

5.11.1 Literature Review

The literature review and analysis formed the main secondary data. A thorough literature review was carried out bearing the aims and objectives as well as the research question of the research in mind. These are covered in Chapters One, Two, Three and four.

5.11.2 Conceptualisation of theoretical framework

The theoretical framework was determined by firstly specifying exactly what is to be investigated. This was undertaken by critically analysing the findings from the literature investigations and Pilot studies 1 to determine precisely the research problem and formulation of clear research question.

5.11.3 Research design and Method

The choice of the research methods were identified considering the research questions and the nature of the phenomenon being investigated. The choice of the research strategies was also piloted at ARCOM workshop. Survey and Case studies research strategies were identified to be most suitable for this research;

1. Survey Research

Questionnaires were sent to experienced hands-on professionals in TAM project implementation in 160 continuous process plants in UK. Chapter 6 provides further details of the questionnaire design, data collection and analysis adopted for this study.

2. Case studies

Case studies were conducted in six process plants in the UK. Interviews of key personnels, direct observations and some related organisational documents form the main sources of data. Further details of the case studies (data collection and analysis) are elaborated in Chapter 7.

5.11.4 Development of TAM framework

The TAM framework was developed based on the analysed data from literatures, survey of TAM professionals and case studies of six process plants in the UK. The framework developed satisfied the aims of the research and answered the research questions. Further details of the development of TAM framework are elaborated in Chapter 8.

5.11.5 Validation of TAM framework

The final phase of the research design is the validation of TAM framework. This external validation was carried out using the most proactive TAM professionals. The validation process and the Validation report are detailed in Chapter 9.

5.12 SUMMARY OF THE CHAPTER

The chapter covered the methodological approach adopted for this research. The chapter started with introduction and explanation of research process. It also gave an insight of the two major research philosophical paradigms - Positivism (or quantitative) and Phenomenological (or qualitative) paradigms. The chapter explained the characteristics of these two research paradigms. The three major research approaches; quantitative, qualitative and mixed-method approaches were explained in details.

From the analyses of these research approaches and the details of the literature reviewed, it is evident that neither the qualitative nor the quantitative approach will be very suitable in answering the research questions independently; hence the mixed-method research approach was adopted in this study. The justification for this choice was explained in the chapter.

Further, this chapter explained the various qualitative and quantitative research strategies. The characteristics of these strategies were explored and the survey (quantitative) and Case studies (qualitative) research strategies were chosen. Features of case studies and survey research and data collection methods were also explained in details.

The chapter explained the advantages and uses of pilot studies and further presented the pilot studies adopted for this research.

Also the chapter identified and explained the conceptual theoretical framework that was adopted to guide the research. The research design section in the chapter identified the logical order with which this study was carried out.

6.0: QUANTITATIVE DATA ANALYSIS

6.1 AIMS OF THE CHAPTER

This is the first phase of data collection - Survey research (or the questionnaire survey). The survey was conducted to identify and establish the various propositions relating to TAM project evaluation, TAM critical success factors and management methods for TAM projects. The chapter begins with the method of data collection. The detailed breakdown of responses from the various management positions related to TAM management is given. The methods of data analysis employed are outlined. The analysis is presented under the headings identified for the problems of TAM implementation. The chapter is concluded with the chapter summary.

6.2 QUANTITATIVE DATA COLLECTION.

All engineering facilities including manufacturing industries, buildings, and infrastructural facilities carry out shutdown maintenance at one time or the other. Even engineering equipments such as aeroplanes, trains, ships and motor vehicles are also shutdown for overhaul. This research study, however, is based on shutdown maintenance in continuous running plants. TAM projects have great impact on the operations of continuous process industries as it involves the complete stoppage of all the company operations in most cases.

The respondents targeted for data collection are *experienced hands-on TAM professionals currently working in world class multinational continuous process plants in the UK.*

This choice was to ensure that the respondents are not only experienced in TAM, but are exposed to and armed with the most recent techniques and innovations for managing TAM projects around the globe.

160 continuous process plants in this category were approached through telephones and invitation letters. In most cases the Directors and Head of Human Resource of these organisations were approached to secure their commitment for getting the questionnaires completed by their plant and engineering management professionals who are directly involved in TAM projects.

Self completion questionnaire using Likert scales, 1 - 5 (Strongly agreed=SA, Agreed =A, Possibly =P, Disagree =DA, Strongly disagree =SDA) was used to collect data on propositions identified from literatures and surveys (pilot study I) as being relevant to the implementation of TAM projects. The sample of the questionnaire is attached as Appendix A. The propositions cover issues related to TAM project evaluation, TAM critical success factors and specific management methodologies for TAM projects.

6.3 ANALYSIS OF RESPONDENTS

A total of 133 'completed' questionnaires were returned by the respondents and were used for analysis.

Figure 6.1 shows a chart of completed questionnaires received from the various categories of respondents. As shown, TAM Managers represent 36.8% of the respondents for analysis, followed by the Maintenance Managers 29.3%. Others are Plant Managers (13.5%); Production/Operations Managers (11.3%) and maintenance/Project Planners (9.0%).

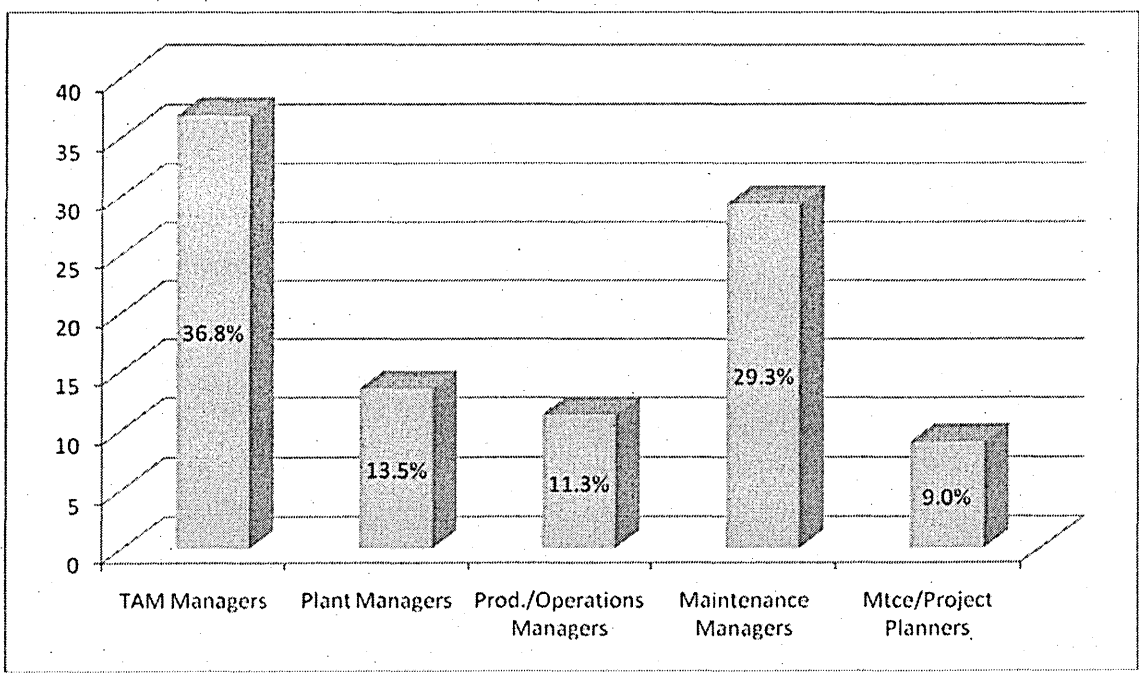


Figure 6.1: Analysis of Respondents (%)

Table 6.1: Cross-tabulation of Industry group and the Respondents

		Respondent group					
		TAM Manager	Plant Manager	Production/Operations Manager	Maintenance Manager	Maintenance/Project Planner	**Total**
Industry Group	Power Plants	22	4	7	16	2	**51**
	Oil Refineries	15	0	1	3	6	**25**
	Petrochemicals	2	1	2	3	0	**8**
	Food & Beverages	2	0	3	8	0	**13**
	Chemical and Steel	1	4	0	7	2	**14**
	Glass	4	4	0	1	0	**9**
	Pulp & Paper	3	1	2	0	2	**8**
	Pharmaceuticals	0	4	0	1	0	**5**
	Total	**49**	**18**	**15**	**39**	**12**	**133**

Table 6.2: Analyses of the working experience of the Respondents

Years (range)	**% of Respondents experience in**							
			TAM Projects as					
	Maintenance Operations & Plant	Engineering & Projects	Management Team	Manager	Consultant/ Contractor	Client/Top Management	UK Experience	International Experience
< 5	2.3	3	11.3	31.6	53.4	53.4	13.5	57.1
6 - 10	3.8	9.8	14.3	18.8	21.1	26.3	13.5	14.3
> 10	94.0	87.2	74.4	49.6	25.6	20.3	72.9	28.6

Table 6.2 shows the analysis of the industries of the respondents and their working experiences are shown in Table 6.3. 94% of the respondents have more that 10years experience in maintenance and operations management of process plants and 87.2% of them in engineering and project management. In TAM projects proper, respondents with more than 10 years experience in various levels, as TAM management team member (74.4%), TAM manager (49.6%), Contractor/consultant (25.6%), Client/Top Management (20.3%). 72.9% of the respondents have more than 10years experience in TAM projects within the UK, while 28.6% have more than 10years experience in TAM projects abroad.

6.4 MODES OF ANALYSIS

Throughout the analysis adequate care was taken to ensure reliability and validity checks of the data were established. The SPSS version 16.0 was used for the analysis of quantitative data.

The first stage involves observing, sorting and grouping the data. Some of the returned questionnaires were rejected. In these cases the respondents had either failed to complete the key questions or there were very critical missing values. A code book was developed for the coding of the propositions.

Double checking of data entry was carried out throughout the process to avoid errors. Descriptive and inferential test statistics procedures were administered for the analyses of data. The statistics tests selected for the analyses were as follows:

(i) <u>Reliability of the measure</u>

The reliability of a measure refers to its consistency. Internal reliability is particularly important in connection with multiple scales. It raises the question of whether each scale is measuring a single idea and hence whether the items that makes up the scale are internally consistent (Bryman & Cramer, 2005). The views of Pallant (2007), de Vaus, (2007), Santos, (1999) and Bryman & Cramer (2005) were used in the choice of Cronbach's Alpha as the most widely used and the most suitable for internal consistency measures. An alpha of 0.7 and above are normally considered to indicate a reliable set of items, but lower thresholds are sometimes used in the literature (de Vaus, 2007; Nunnally, 1978). Cronbach's alpha values are quite sensitive to the number of items in the scale. With short scales (say scales with fewer than ten items) it is common to find quite low Cronbach values (Pallant, 2007). Briggs & Cheek (1986) recommend an optimal range for *inter-item correlation* of 0.2 to 0.4 as acceptable if the Cronbach's alpha is low for scales with few items.

To remain in the scale an item should have an *inter-total correlation* of at least 0.3 (de Vaus, 2007; Pallant, 2007). If any of the values in the column headed *Alpha if item is deleted* is higher than the final alpha value, the item should be deleted from the scale (Pallant, 2007).

Generally as shown from the above,

- a set of items is reliable if the Conbrach's alpha value is ≥ 0.7
- If the items on the scale is lower than 10; lower values of Conbrach's alpha can be accepted provided that:
    1. *the inter-item correction* of all the items on the scale ≥ 0.2;
    2. for an item to remain in the scale, it should have an *inter-total correlation* of at least 0.3; and
    3. an item having values of *alpha if item is deleted* higher than the final value of alpha, the item should be deleted.

(ii) Analysis of median

Analysis of *median* was chosen as a measure of central tendency to draw inferential differences from the values measured. Median is considered to be the most appropriate for the analysis because the level of measurement of the propositions is ordinal (de Vaus, 2007; Hamburg, 1970; Pallant, 2007). Its relative freedom from distortion by skewness in an ordinal distribution makes it particularly desirable average for descriptive purposes and is thus considered a 'typical' observation (Hamburg, 1970). This implies that the *'median'* would provide a more accurate value for the analysis in contrast to *'means'* (* is used to denote median values).

(iv) Analysis of Variance (ANOVA) - The One-way ANOVA

ANOVA is a way of examining differences between the means of groups and of evaluating whether the mean differences found in the sample would hold in the population (de Vaus, 2007; Pallant, 2007). The One-Way ANOVA compares the mean of one or more groups based on one independent variable (Archambault, 2002). It was used to compare the variance mean values between the groups to evaluate the extent of differences or commonality between the perceptions of the respondents on the propositions. The critical value is set at 0.05 (** is used to identify significant results; Sig. ≤ 0.05).

(v) <u>Chi-square Test for goodness-of-fit</u>

This is also known as one-sample chi-square (Bryman & Cramer, 2005). This was undertaken to test the validity of the propositions. It is a non-parametric test that is used to find out how the observed value of a given phenomena is significantly different from the expected value. In Chi-Square goodness-of-fit test, the term goodness of fit is used to compare the observed sample distribution with the expected probability distribution (Hamburg, 1970). The significance (alpha level) value is set at 0.05 i.e., the risk of rejecting a true null was taken at less than 5%.

6.5 DATA ANALYSIS AND FINDINGS

The data collected from the respondents were analysed and the findings identified were summarized in the following sections.

6.5.1 TAM PROJECT EVALUATION

The analyses of data collected for TAM project success measurement were carried out to establish the TAM success measurement criteria. The three major components of success measure used are: Management success, Perceptions of the stakeholders and the Resultant benefits of the TAM project to the organisation.

6.5.1.1 Management Success Evaluation

The data collected for management success evaluation are based on the elements to measure management efficiency of the project. The analyses of the data collected are shown below:

1. <u>Cost Evaluation</u>

From the results shown in Table 6.3, the majority of the respondents agreed that the *total cost of a TAM project should be within budget* (46.6% strongly agreed and 40.6% agreed and median 4*). The respondents also supported the views that *costs associated with emergent scope should be within the contingencies* provided (22% strongly agreed and 60% agreed; median 4*) and that *anticipated jobs should be part of the budget* (27% strongly agreed and 48%; 4*)

Table 6.3: % Scores, Median, ANOVA and Validity analyses of Cost Evaluation

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp.Sig.)
	SA	A	P	DG	SDA			
Total cost within budget	46.6	40.6	10.6	2.3	0	4	.154	.000
Emergent scope cost part Contingencies	22	60	9.8	6.8	0	4	.001**	.000
Anticipated scope cost part of the budget	27.8	48.1	9.8	10.5	3.8	4	.004**	.000

ANOVA test results between the respondents show that there is no significant difference in the mean score values for *Total cost within budget* (sig. 0.154). The ANOVA test results for other propositions (sig. <0.05) show significant differences in the mean scores.

Table 6.3b: Reliability Analysis of Cost Evaluation scales

Propositions	Inter-Item Correlation			Cronbach's Alpha
	Total cost within budget	Emergent scope cost part Contingencies	Anticipated scope cost part of the budget	
Total cost within budget	1.000	.173	.000	0.243
Emergent scope cost part Contingencies	.173	1.000	.147	
Anticipated scope cost part of the budget	.000	.147	1.000	

The Chi-square test results show values (<0.05) for the null-hypothesis to be rejected. This infers that the entire propositions are all valid for evaluating cost in TAM projects. From Table 6.3b, the reliability coefficient, Cronbach's alpha is low (0.243) for the items on the scale. Even the inter-item correlation shows low values (<0.2). This infers that the three elements of measure are actually not compatible.

2. Time Evaluation

Table 6.4 shows that most of the respondents (67% strongly agreed and 25.6% agreed with a median score of 5*) supported that the in TAM project duration (time) evaluation, *the total time for the project has to be within the budgeted time* for the project to be considered successful. The respondents also supported that *emergent scope duration should be completed within the contingency time approved* (9% strongly agreed, 74.4% agreed and median score of 4*) and that *all anticipated jobs should be included in the budgeted time frame* (24.8 % strongly agreed; 50.4% agreed and Median 4*)

The ANOVA test results between the respondents show that there is no significant difference in the mean scores between the groups in *total time being within budget* and *emergent jobs duration to be part of the contingency time approved* (sig. : >0.05). There is however significant differences between the respondents on the proposition *anticipated scope duration part of the budget* (sig. <0.05)

Table 6.4: % Scores, Median and ANOVA and Validity analyses of Time Evaluation

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)
	SA	A	P	DG	SDA			
Total time within budget	67.7	25.6	6.8	0	0	5	.084	.000
Emergent scope duration part of Contingency	9	74.4	6	8.3	2.3	4	.115	.000
Anticipated scope duration part of the budget	24.8	50.4	16.5	4.5	3.8	4	.025**	.000

The Chi-square test results (0.000) confirm that the propositions are all relevant in the evaluation of time in TAM projects.

The Cronbach's alpha coefficient test result shown in Table 6.4b (0.210<0.7) and the inter-item correlation (<0.2) are very low. These infer that the three items in the scale are not measuring the same construct.

This is understandable as the only item of measure is that *total time spent in TAM project should be within the budgeted time* for the TAM project to be considered successful. The other two items are explaining what constitutes the budgeted time.

Table 6.4b: Reliability Analysis of Time Evaluation scales

Propositions	Inter-Item Correlation			Cronbach's Alpha
	Total time within budget	Emergent scope duration part Contingences	Anticipated scope duration part of the budget	
Total time within budget	1.000	.007	.125	.210
Emergent scope duration part Contingences	.007	1.000	.105	
Anticipated scope duration part of the budget	.125	.105	1.000	

3. <u>Quality Evaluation</u>

As shown in Table 6.5, more than 90% of the respondents (57.9% strongly agreed and 34.6% agreed with a median score of 5*) supported that *level of rework* and about 99% of them (53.4% strongly agreed, 45.9% agreed and median score of 5*) supported that *adherence to technical specification* are very significant in evaluating TAM project quality. The respondents also agree that *start-up incidents* (45.1% strongly agreed, 45.9% agreed and a median score of 4*) and *commissioning incidents* (41.4% strongly agreed, 45.9% agreed; median score of 4*) are significant in evaluating quality.

The ANOVA test results of the respondents show concordance for *Adherence to technical specification,* since the result (sig.: >0.05) - implying no significant differences in the mean score values of this proposition between the group. Other propositions, however with ANOVA test result (sig. <0.05) show significant differences in the mean scores between the group.

Table 6.5: % Scores, Median, ANOVA and Validity analyses & Reliability of scales of Quality Evaluation

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's alpha
	SA	A	P	DA	SDA				
Level of rework	57.9	34.6	5.3	2.3	0	5	.000**	.000	0.816
Adherence to technical specification.	53.4	45.9	0.8	0	0	5	.130	.000	
Start-up incidents	45.1	45.9	6.8	2.3	0	4	.011**	.000	
Commissioning incidents	41.4	45.9	8.3	4.5	0	4	.018**	.000	

Chi-square results (0.000) and Cronbach's alpha (0.816) confirms the validity of the propositions and the reliability of the scales used.

4. Functionality

As shown in Table 6.6, 94% (33.1% strongly agreed and 60.9% agreed) of the respondents supported that *Plant/equipment performance* is very suitable for the evaluation of functionality in TAM projects with a median of 4*.

Table 6.6: % Scores, Median and ANOVA and Validity analyses & Reliability of scales of Functionality Evaluation

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's alpha
	SA	A	P	DA	SDA				
Plant/Equipment performance	33.1	60.9	6	0	0	4	.272	.000	0.703
Quality of Output	43.6	48.9	7.5	0	0	4	.118	.000	
Quantity of output per unit time	40.6	39.1	18	2.3	0	4	.042**	.000	

The respondents also supported that *Quality of the output* (43.6% strongly agreed, 48.9% agreed) and *Quantity of the put per unit time* (40.6% strongly agreed and 39.1% agreed) is good measures of functionality.

Between the respondents, the ANOVA test results show significant difference in the mean scores of *Quantity of output per unit time* (sig. :< 0.05) in measuring the functionality of the system on TAM projects. There is however no significant difference in their perception for the other two propositions; *Plant/Equipment performance* and *Quality of Output*, (sig. >0.05) for evaluating functionality. Cronbach's alpha (0.703) shows that the three items in the scale are reliable in functionality measure. The Chi-square test results (0.000) for all the propositions confirm that they are all relevant in the evaluation of functionality in TAM projects.

5. Safety Evaluation

As shown in Table 6.7, the majority of the respondents strongly supported that *personnel safety incidents* (75.2% strongly agreed, 18% agreed), *Plant safety incidents* (61.7% strongly agreed, 33.8% agreed) and *exposure to hazards* (66.9% strongly agreed, 21.8% agreed) with median score of 5^* each for evaluating safety in TAM projects.

Table 6.7: % Scores, Median and ANOVA and Validity analyses & Reliability of scales of Safety Evaluation

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's alpha
	SA	A	P	DG	SDA				
Personnel safety Incidents	75.2	18	6.8	0	0	5	.077	.000	
Plant safety Incidents	61.7	33.8	2.3	2.3	0	5	.001**	.000	
Lost Time due to safety	39.8	30.1	27.8	2.3	0	4	.002**	.000	0.715
Legal Issues due to safety	23.3	24.3	33.8	16.5	2.3	3	.000**	.000	
Exposure to hazards	66.9	21.8	4.5	6.5	0	5	.001**	.000	

There is slightly less support for *lost time due to safety incidents* (39.8% strongly agreed, 30.1% agreed) with a median score of 4*. With a median score of 3* and <50% (23.3% strongly agreed, 24.3% agreed) response scores shows that *Legal issues due to safety* may not be very suitable for safety evaluation.

There is significant disagreement in the perceptions of the respondents (sig. <0.05) on all the propositions as shown in the ANOVA test result except *Personnel safety Incidents* with (sig. >0.05). The Cronbach's alpha (0.715) for the scale and the Chi-square test results (0.000) for each proposition confirms the reliability and the validity of the propositions in evaluating Safety in TAM projects.

6. Environmental Performance

Table 6.8 shows median score of 5* and response score >90% for each proposition; *gas emission level* (66.9% strongly agreed, 23.3% agreed), l*iquid contamination* (67.7% strongly agreed, 27.8% agreed) and *solid waste* (54.9% strongly agree, 35.3% agreed). This affirms that the majority of the respondents strongly agree that environmental impact assessment carried out in the above areas is very adequate in evaluating the environmental performance in a TAM project.

Table 6.8: % Scores, Median and ANOVA and Validity analyses & Reliability of scales of Environmental performance Evaluation

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's alpha
	SA	A	P	DG	SDA				
Gas emissions level	66.9	23.3	7.5	2.3	0	5	.640	.000	0.820
Liquid contaminations	67.7	27.8	4.5	0	0	5	.267	.000	
Solid waste	54.9	35.3	9.8	0	0	5	.362	.000	

ANOVA test result (>0.05) between the respondents infers that there exists no significant differences between their perceptions in the three propositions.

The Chi-square test results (0.000) for each proposition imply that the null hypothesis is to be rejected. This confirms the validity of the propositions. The high reliability coefficient of Cronbach's alpha (0.820) shows that the scales are very reliable.

6.5.1.2 Findings from the analysis

- The above analysis suggest that in evaluating cost in TAM projects, *the total cost of the project has to be within the budgeted cost* for the TAM project to be considered successful. All costs associated to anticipated scope items should be part of the budget. This implies that all costs of known and anticipated scope should be part of the budget. Also the findings show that costs associated with *emergent jobs should be covered by the contingency fund.* During planning contingency fund should be kept aside for emerging scope during the TAM project event. This should also be part of the total cost budgeted for the project. The budgeted cost of a TAM project is therefore inclusive of all cost that has to be incurred during the project.

- For time evaluation, the *total time spent in a TAM project* should be within the time originally budgeted for the project to be considered successful. *Time for anticipated jobs* should be part of the time budgeted and *time for emergent jobs* that imparts on the critical path should be completed within the contingency time allowed.

- The above analysis shows that quality in a TAM project can be evaluated by assessing level of reworks, level of adherence to technical specifications, start-up incidents and commissioning incidents.

- Functionality as a success measure in a TAM project should be evaluated assessing the level of equipment/plant performance, quality of the products, and quantity of the output per unit of time.

- The criteria for the success measurement of safety is found to include the assessment of personal safety incidents, plant safety incidents, lost time due to safety incidents, and exposure to hazards.

- For environmental success measurement in a TAM project, it is found that environmental impact assessment should be carried out in the following areas, level of gas emissions, liquid contamination and solid waste. These need to be within the limits stipulated by the state environment agency for the project management to be considered a success.

6.5.1.3 Perception of Stakeholders

In a TAM project, the stakeholders' perception of success is also considered in the evaluation of the project outcome. The stakeholders identified for this research project are:

1. Client/Top Management.

As shown in Table 6.9, the majority of the respondents supported that the Client/Top management of the organisation considers TAM project successful if the *management is successful* (21% strongly agreed, 54.1% agreed and median 4*) and *the resultant benefits of TAM are achieved* (69.9% strongly agreed, 29.3% agreed and median 5*).

Table 6.9: % Scores, Median and ANOVA and Validity analyses Client/Top Management perception of TAM success

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)
	SA	A	P	DG	SDA			
TAM management is successful	21.8	54.1	21.2	3	0	4	.035**	.000
The resultant benefits are achieved	69.9	29.3	.8	0	0	5	.002**	.000

ANOVA test results for the respondents' groups (sig. <0.05) infer that there is significant disagreement between the groups on the perceptions of the Client/ Top Management of TAM success using the above propositions.

Chi-square test result (0.000) confirms the validity of the above propositions. As shown in Table 6.9b, the Cronbach's alpha (0.424) is low with only two items on the scale. The scales are however considered reliable since the *inter-item correlation* is 0.295 >0.2.

Table 6.9b: Reliability Analysis of Client/Top management perception on TAM success scales

Propositions	Inter-Item Correlation		Cronbach's Alpha
	TAM management is successful	The resultant benefits are achieved	
TAM management is successful	1.000	.295	.424
The resultant benefits are achieved	.295	1.000	

2. Contractors

Table 6.10 shows that the respondents supported the propositions on the perceptions of the contractors on the success of TAM projects; *Relationship with the client* (57.9% strongly agreed, 29.3% agreed and median), *Profit margin* (50.4% strongly agreed, 40.6% agreed), *Delivery of jobs as per contractual agreement* (44.4% strongly agreed, 45.1% agreed) and *Satisfaction of the clients' expectation* (51.9% strongly agreed and 33.8% agreed). This is further confirmed by the median scores of 5* except delivery of jobs as per contractual agreement which has Median score of 4*.

Table 6.10: % Scores, Median, ANOVA and Validity analyses Contractors perception of TAM success

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)
	SA	A	P	DG	SDA			
Relationship with Client	57.9	29.3	12.8	0	0	5	.150	.000
Profit Margin	50.4	40.6	9.0	0	0	5	.138	.000
Delivery of jobs as per contractual agreement	44.4	45.1	9.0	1.5	0	4	.001**	.000
Satisfaction of the Clients Expectation	51.9	33.8	12.8	1.5	0	5	.006**	.000

There are no significant differences in the perceptions of the respondents on using *Relationship with Client* and *contractors* and *Profit Margin* (ANOVA sig. >0.05) by the contractors for evaluating the outcome of a TAM project success. With ANOVA test results (sig. <0.05) for the other two propositions, infer that there is significant differences in the respondents' perceptions.

Chi-square test results (0.000) show that the propositions are valid on how the Contractors' perception of TAM projects success.

Table 6.10b: Reliability Analysis of Contactor perception on TAM success scales - Inter-item correlation.

Propositions	Inter-Item Correlation				Cronbach's Alpha
	Relationship with Client	Profit Margin	Delivery of jobs	Satisfaction of the Clients Expectation	
Relationship with Client	1.000	.166	.342	.633	.622 *(0.716 when profit margin is deleted)*
Profit Margin	.166	1.000	.202	-.028	
Delivery of jobs	.342	.202	1.000	.389	
Satisfaction of the Clients Expectation	.633	-.028	.389	1.000	

Table 6.10b shows that the Cronbach's alpha for the scales is low (0.622) and a negative inter-item correlation of *profit margin* and *satisfaction of the client's expectation.* The Corrected item-total correlation for *profit margin* is very low (0.137) as shown in Table 6.10c. The Cronbach's alpha when the *profit margin* is deleted increases from 0.622 to 0.716, indicating that *profit margin* is not measuring the same construct as the rest of the items in the scale are measuring.

Table 6.10c: Reliability Analysis of Contactor perception on TAM success scales - Item-Total statistics.

Item-Total Statistics					
Propositions	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Relationship with Client	13.10	2.074	.577	.439	.415
Profit Margin	13.14	3.027	.137	.098	.716
Delivery of their jobs as per the contractual agreement	13.23	2.328	.441	.202	.524
Satisfaction of the Clients Expectation	13.19	2.108	.486	.462	.485

3. <u>TAM Management team</u>

Response percentage scores of respondents as shown in Table 6.11, indicates that *Management success* (16.5% strongly agreed, 73.7% agreed), *Satisfaction of top management expectation* (39.1% strongly agreed, 51.9% agreed) and *Satisfaction of users' expectation* (41.4% strongly agreed, 49.6% agreed) are very suitable propositions for measuring the success of TAM projects by the TAM management team as they are well supported by the respondents (Median scores of 4* for each proposition).

Table 6.11: % Scores, Median and ANOVA and Validity analyses of TAM management team perception of TAM project success.

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)
	SA	A	P	DG	SDA			
Management success	16.5	73.7	6.8	3	0	4	.004**	.000
Satisfaction of Top Management expectation	39.1	51.9	9.0	0	0	4	.498	.000
Satisfaction of user's expectation	41.4	49.6	9.0	0	0	4	.849	.000

Between the respondents' group, the ANOVA test result (sig.: 0.004) show significant variation on the suitability of using *Management success* for TAM success evaluation by the TAM management team.

However there is no significant different views regarding the other two propositions (sig.: >0.05); *Satisfaction of Top Management expectation* and *Satisfaction of user's expectation* among the respondents.

The Chi-square test results (0.000) show that the entire propositions are valid. Though the Cronbach's alpha is low (0.616), as shown in Table 6.11b, the inter-item correlation coefficients (>0.2) infer that items on the scale are reliable.

Table 6.11b: Reliability Analysis of TAM management team perception on TAM success scales - Inter-item correlation.

Propositions	Inter-Item Correlation			Cronbach's Alpha
	Management success	Satisfaction of Top Management	Satisfaction of user's expectation	
Management success	1.000	.314	.369	.616
Satisfaction of Top Management expectation	.314	1.000	.363	
Satisfaction of users' expectation	.369	.363	1.000	

4. <u>Plant Users - Plant operators</u>

The response scores results (see Table 6.12) clearly show that the respondents support that Plant users (plant operators) consider *Plant operational performance* (50.4% strongly agreed, 45.1% agreed; median 5*), *Meeting functional performance* (33% strongly agreed, 51.9% agreed) and the *Plant being safe to operate* (65.4% strongly agreed, 34.6% agreed) when evaluating the TAM project success.

Table 6.12: % Scores, Median, ANOVA and Validity analyses Plant operators' perception of TAM success.

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)
	SA	A	P	DG	SDA			
Plant operational performance	50.4	45.1	4.5	0	0	5	.021**	.000
Meeting functional performance	33.1	51.9	12.8	2.3	0	4	.091	.000
Plant being safe to operate	65.4	34.6	0	0	0	5	.122	.000

ANOVA between the respondents registered small value (sig. 0.021) for *Plant operational performance* proposition. This infers significant disagreement between the respondents on the suitability of this proposition for evaluating TAM success by the plant operators. ANOVA test results (sig.>0.05) for the other propositions infer that there are insignificant differences in the mean scores between the respondents group.

The Chi-square test results registered values (0.000) which confirm the validity of the propositions.

The Cronbach's alpha (see Table 6.12b) result show a low value (0.557) but the scale is considered reliable since the inter-item correlation coefficients values are >0.2.

Table 6.12b: Reliability Analysis of Plant operators' perception on TAM success scales - Inter-item correlation.

Propositions	Inter-Item Correlation			Cronbach's Alpha
	Plant operational performance	Meeting functional performance	Plant being safe to operate	
Plant operational performance	1.000	.346	.329	0.557
Meeting functional performance	.346	1.000	.246	
Plant being safe to operate	.329	.246	1.000	

5. Plant Users- Plant Maintenance team

Table 6.13 shows that majority of the respondents supported that the maintenance team considers *Reduction in routine maintenance* (51.9% strongly agreed and 33.8% agreed) and *Reduction in breakdown maintenance* (59.4% strongly agreed and 28.6% agreed) in evaluating TAM project success.

Table 6.13: % Scores, Median and ANOVA and Validity analyses of Maintenance team perception of TAM.

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's Alpha
	SA	A	P	DG	SDA				
Reduction in Routine maintenance	51.9	33.8	14.3	0	0	5	.669	.000	0.784
Reduction in Breakdown maintenance	59.4	28.6	12.0	0	0	5	.030**	.000	

There is no significant difference between the perceptions of the respondents for *Reduction in routine maintenance*, from the ANOVA test results (sig. 0.669). The

ANOVA test value (sig. 0.03) registered for *Reduction in breakdown maintenance* infers significant difference in perception between the respondents groups.

The Chi-square test results (0.000) and the Cronbach's alpha (0.784) for the scale confirms the validity of the propositions and the reliability of the scales.

6.5.1.4 Findings from the analysis

- In evaluating the outcome of a TAM project, the client or the top management of the organisation, assesses the *management success* and *the resultant benefits* of the TAM project and compares these to the overall objective of the project. If the management is successful and the resultant benefits conforms to the overall objective of the organisation, then the TAM project is perceived as being successful by the Top management.

- The negative correlation between the contractors' *profit margin* and the *satisfaction of the client* infers that organisations will if possible expect the contractor to deliver their jobs at no profit at all. The Cronbach's alpha result which only improved to an acceptable level only when the *profit margin* item is deleted infers that profit margin of the contractor is not measuring the same construct as the other propositions. Though contractors may consider profit as a measure of TAM project success, the findings show that organisations do not consider that *profit margin* should be used by contractors to measure TAM success. The relationship with the client, delivery of the jobs as per contractual agreement and satisfying the clients expectation have been shown as elements with which contractors should measure the success of a TAM project.

- For the TAM management team, a TAM project is considered successful; according the above analysis, when the management is successful and the Top management and the users' expectations are met.

- The plant users (operators) measure the success of a TAM project by the assessment of the plant operational performance, how the plant is meeting functional performance and safety of operating the plant.

- The maintenance team on the other hand considers a TAM project successful if there is a reduction in routine and breakdown maintenance during the plants production period before the next shutdown.

6.5.1.5 Evaluation of Resultant Benefits

Analyses below were carried out to assess the best approach to evaluate the resultant benefits (the business impact) of TAM project to the organisation. The criteria analysed are for the entire benefits and the elements that should be used to evaluate these benefits at hand-over.

1. <u>*Resultant Benefit success measurement*</u>

The respondents supported that *Bringing the plant to their original health* (53.4% strongly agreed and 38.3%), *Making the plant machines safe to operate* (64.7% strongly

Table 6.14: % Scores, Median, ANOVA and Validity analyses of assessment of the Resultant benefits of TAM projects.

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)
	SA	A	P	DG	SDA			
Bringing the Plant to their original health	53.4	38.3	8.3	0	0	5	.587	.000
Making the plant safe while in operation	64.7	34.6	.8	0	0	5	.290	.000
Improvement on efficiency and throughput of plant by suitable modification	34.6	57.1	6.8	1.5	0	4	.557	.000
Reduction in routine maintenance costs.	50.4	36.1	13.5	0	0	5	.003**	.000
Availability/Reliability Increase	63.9	33.8	2.3	0	0	5	.040**	.000
Upgrading technology by introducing modern equipment and techniques	17.3	27.1	49.6	6.0	0	3	.980	.000

agreed and 34.6% agreed); *Improvement on efficiency and throughput of plant by suitable modification*,(34.6% strongly agreed and 57.1% agreed); *Reduction in routine maintenance costs* (50.4% strongly agreed and 36.1% agreed) and *Increasing the reliability/availability of equipment during operation* (63% strongly agreed and 33.8% agreed) are all very adequate to assess the benefits of TAM projects. *Upgrading technology by introducing modern equipment and techniques* (17.3% strongly agreed and 27.1% agreed) is less supported by the respondents.

ANOVA test result between the respondents show values (sig. <0.05), for *Reduction in routine maintenance cost* and *increasing the reliability/availability of equipment during operation* inferring significant differences in their perceptions on the propositions. The results of the others registered values (sig. >0.05), which infer that there are no significant differences between their mean scores. Chi-square results (0.000) show that the propositions are valid.

The Cronbach's alpha for the scales for assessing the resultant benefits of TAM projects registered low value (0.553).

From Table 6.14b, the corrected item-Total correlation values <0.3; *Making the plant machines safe to operate* (0.144), *Improvement on efficiency and throughput of plant by suitable modification* (0.0179) and *Upgrading technology by introducing modern equipment and techniques* (0.262), simply confirms that for the scales to be reliable these three items should be removed as they are not measuring the same construct with the others.

Table 6.14c shows the inter-item correlation matrix for remaining items in the scale for evaluating resultant benefits in a TAM projects. Though the Cronbach's alpha is low (0.678), the inter-item correlations has improved (> 0.37).

This confirms that the propositions as shown in Table 6.14c are reliable for assessing the resultant benefits of TAM project.

Table 6.14b: Reliability Analysis of Resultant benefits evaluation for TAM projects- Inter-total statistics.

Propositions	Item-Total Statistics					Cronbach's Alpha
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted	
Bringing the plant to their original health	21.43	3.626	.310	.304	.501	0.553
Making the plant machines safe to operate	21.24	4.260	.144	.065	.563	
Improvement on efficiency and throughput of plant by suitable modification	21.63	3.931	.179	.104	.559	
Reduction of routine maintenance costs.	21.51	2.918	.566	.381	.359	
Increasing the reliability/availability of equipment during operation	21.26	3.786	.354	.254	.489	
Upgrading technology by introducing modern equipment and techniques	22.32	3.281	.262	.227	.538	

Table 6.14c: Reliability analysis of Resultant Benefit evaluation - Inter-Item Correlation

Propositions	Inter-Item Correlation Matrix			Cronbach's Alpha
	Bringing the plant to their original health	Reduction of routine maintenance costs.	Increasing the reliability/availability of equipment during operation	
Bringing the plant to their original health	1.000	.460	.419	0.678
Reduction of routine maintenance costs.	.460	1.000	.375	
Increasing the reliability/availability of equipment during operation	.419	.375	1.000	

2. <u>Hand-Over Benefit Evaluation</u>

Table 6.15 reveals that the respondents support that *Safety of the units* (70.7% strongly agreed and 27.1% agreed), *Management success* (24.8% strongly agreed and 43.6% agreed), *Operational performance of the system* (48.1% strongly agreed and 46.6% agreed), *Quality of end product* (48.1% strongly agreed and 42.9% agreed) and *Output performance* (50.4% strongly agreed and 45.9% agreed) can be used to evaluate the benefits of TAM projects.

Table 6.15: % Scores, Median, ANOVA and Validity analyses of assessment of the Resultant benefits of TAM projects at Hand-over

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)
	SA	A	P	DG	SDA			
Safety of the units	70.7	27.1	2.3	0	0	5	.130	.000
Management success	24.8	43.6	30.1	1.5	0	4	.394	.000
Operational performance	48.1	46.6	5.3	0	0	4	.429	.000
Quality of end product	48.1	42.9	9.0	0	0	4	.535	.000
Output performance	50.4	45.9	3.8	0	0	4	.461	.000

The ANOVA test results; sig.: >0.05 show that there are no significant differences in the perceptions of the respondents on the adequacy of using all the propositions for evaluating the resultant benefits of a TAM project at hand-over.

The Chi-square results confirm that the propositions are valid for evaluating the resultant benefits of a TAM project.

The Cronbach's alpha value for the above scales is low (0.636), but Table 6.15b shows that *Management success* has a low Corrected Item-Total Correlation value (0.211) and also the value of the Cronbach's alpha value becomes higher (0.695) than the final value (0.636) if this proposition is deleted. This shows that *Management success* should be deleted from the scale.

Table 6.15b: Reliability analysis of Resultant Benefit evaluation at Hand-over - Inter-Total Statistics.

Item-Total Statistics						
Propositions	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted	Cronbach's Alpha
Safety of the units	17.20	3.193	.302	.158	.620	0.636
Management success	17.97	2.848	.211	.049	.695	
Operational performance of the system	17.46	2.553	.582	.460	.488	
Quality of end product of the system	17.50	2.449	.561	.420	.490	
Output performance	17.42	2.958	.369	.251	.592	

The new Cronbach's alpha value (0.695) though lower than the expected value (0.7), the corrected inter-total correlation least value (0.302) and inter-item correlation least value (0.218) infer that the items in the new scale are reliable (see Table 6.15c).

Table 6.15c: Reliability analysis of Resultant Benefit evaluation (Hand-over) - Inter-Item Correlation.

Inter-Item Correlation Matrix					
Propositions	Safety of the units	Operational performance of the system	Quality of end product of the system	Output performance	Cronbach's Alpha
Safety of the units	1.000	.224	.396	.218	.695
Operational performance of the system	.224	1.000	.584	.501	
Quality of end product of the system	.396	.584	1.000	.301	
Output performance	.218	.501	.301	1.000	

6.5.1.6 Findings from the analysis

- From the above analysis it is identified that resultant benefits of a TAM project are; bringing the plant to their original health, reduction of plants routine maintenance costs and increasing the reliability and availability of equipment during operation.

- However since the above resultant benefits cannot be assessed on completion of the project at hand-over, this study has found that at hand-over of a TAM project, the resultant benefits of the project can be assessed using:
    a. Safety of the units
    b. Operational performance of the system
    c. Quality of end product of the system
    d. Output performance.

6.5.1.7 TAM Success measurement

To assess the reliability and the validity of the above elements of success measurement criteria, the data was manipulated to derive scores for each of the elements. The analysis of the derived scores is shown in Table 6.16.

Table 6.16: Median, Validity analyses & Reliability of scales of TAM Success Measures

Evaluation elements	Median score	Chi-square (Asym. Sig.)	Cronbach's alpha
Cost evaluation	4	.000	0.805
Time evaluation	4	.000	
Quality evaluation	5	.000	
Safety evaluation	4	.000	
Functionality evaluation	4	.000	
Environmental performance	5	.000	
Client/Top Management	5	.000	
Contractors Satisfaction	5	.000	
TAM Management Satisfaction	4	.000	
Plant Users evaluation - operators	4.33	.000	
Plant Users evaluation - maintenance team	4.50	.000	
Resultant benefits	4.25	.000	
Resultant benefit at hand over	4.50	.000	

The Median scores for each of the TAM project evaluation elements show values ($\geq 4^*$) which implies that the elements are supported by the respondents as being relevant for TAM project evaluation.

The Chi-square square test results (.000) shows significant results inferring that the null hypothesis is to be rejected. Hence the entire measurement criteria elements are suitable for evaluating TAM projects.

The reliability assessment confirms that the entire scale is reliable (Cronbach's alpha: 0.805).

6.5.1.8 Findings from the analysis

- The above analysis confirm that the entire elements of TAM success measurement as shown in Table 6.16 are all relevant in evaluating the outcome of TAM projects.

6.5.2 SELECTION OF TAM MANAGER

It has been identified that qualities of the TAM manager in terms of personal attributes, and management skills/knowledge affects the outcome of the TAM project. Below are the analyses of the data collected from the respondents that will assist process plant operators in the identification and selection of their TAM managers.

6.5.2.1 Personal Attributes

Table 6.17 shows that except for *Empathy* (Median 3^*) all the other attributes Median scores are $\geq 4^*$. The % scores also show that the respondents support that the list of attributes of the TAM manager are all very important for managing TAM successfully.

ANOVA test result between the respondents (position) recorded values (sig. <0.05) for *Good communicator; Honesty; Empathy; Competence; Ability to delegate tasks and responsibilities;*

Table 6.17: % Scores, Median, ANOVA and Validity analyses & Reliability of scales of Personal attributes of a TAM manager

Attributes	Response Sores %					Median	ANOVA (Sig)	Chi-Square (Asymp. Sig)	Cronbach's Alpha
	SA	A	P	DA	SDA				
Shared vision	18.7	57.1	22.6	1.5	0	4	.702	.000	0.816 (**0.812 when *interest in the job is removed***)
Good Communicator	69.2	26.3	4.5	0	0	5	.008**	.000	
Integrity	30.8	53.4	15.8	0	0	4	.080	.000	
Honesty	38.3	57.1	4.5	0	0	4	.013**	.000	
Enthusiasm	46.6	41.4	11.3	.8	0	4	.227	.000	
Empathy	12	32	42.1	12.0	1.5	3	.012**	.000	
Competence	63.9	33.1	3.0	0	0	5	.010**	.000	
Ability to delegate tasks and responsibilities	39.8	49.6	10.5	0	0	4	.029**	.000	
Cool under pressure	36.1	51.9	12	0	0	4	.066	.000	
Team building ability	60.9	29.3	9.8	0	0	5	.008	.000	
Problem solving abilities	24.1	61.7	14.3	0	0	4	.070	.000	
Open minded	21.1	57.1	21.8	0	0	4	.280	.000	
Tolerance to ambiguity	9	62.4	17.3	4.5	6.8	4	.135	.000	
Supportive	38.3	50.4	11.3	0	0	4	.004**	.000	
Patient	12.8	59.4	19.5	4.5	3.8	4	.133	.000	
Determination	46.6	45.1	6.0	2.3	0	4	.089	.000	
Interest in the job	31.6	36.8	31.6	0	0	4	.080	000	
Need to achieve and proactive	27.8	42.1	26.3	3.8	0	4	.013**	.000	

Team building ability; Supportive and *Need to achieve and proactive* and values (sig. >0.05) for the other attributes. These results show that there are significant differences in the mean scores of these personal attributes mentioned above while there are no significant differences in the mean score of others between the group.

The Chi-square test results show that all the propositions are valid except for *interest in the job* which is not considered an attribute with test result of 0.692. The reliability test (Cronbach's alpha value of 0.812) shows that the entire attributes in the scale are reliable.

6.5.2.2 Management Skills

From Table 6.18, except for *Negotiation: Trade unions, Use of computer* and *Administrative skills* with a low value (3*) median score, all the other management skills (Median score ≥4) listed are supported by the respondents as being essential in managing TAM project successfully.

Table 6.18: % Scores, Median and ANOVA and Validity analyses & Reliability of scales TAM Management skills

Management skills	Response Sores %					Median	ANOVA (Sig)	Chi-Square (Asymp. Sig)	Cronbach's Alpha
	SA	A	P	DA	SDA				
Leadership	67.7	31.6	.8	0	0	5	.079	.000	
Managing conflicts and crisis	45.1	54.9	0	0	0	4	.254	.000	
Planning and control	69.9	28.6	1.5	0	0	5	.541	.000	
Organisation	23.3	44.4	32.3	0	0	4	.000	.000	
Time management	65.4	24.1	10.5	0	0	5	.000**	.000	
Negotiation: Contractors	33.8	49.6	16.5	0	0	4	.106	.000	
Negotiation: Suppliers and vendors	7.5	57.9	33.1	1.5	0	4	.098	.000	.691
Negotiation:	21.8	54.9	21.8	1.5	0	4	.772	.000	*(0.891 when the 3 items*

Equipment manufacturers									***are deleted)***
Negotiation: Govt. Agencies and Regulatory Bodies	42.1	38.3	13.5	6.0	0	4	.020**	.000	
Negotiation: Inspection Agencies	35.3	46.6	17.3	.8	0	4	.041**	.000	
Negotiation: Trade Unions.	12.1	39.8	21.1	0	0	3	.503	.000	
Forecasting	51.9	29.3	18.8	0	0	5	.000**	.000	
Motivation	68.4	27.1	4.5	0	0	5	.000**	.000	
Management support building	45.1	34.6	16.5	3.8	0	4	.040**	.000	
Resource Allocation	35.3	49.6	12.8	2.3	0	4	.002**	.000	
Communication/Presentation	59.4	35.3	5.3	0	0	5	.021**	.000	
Decision making	58.6	39.1	2.3	0	0	5	.741	.000	
HSE	75.2	23.3	1.5	0	0	5	.006**	.000	
Use of Computer	18.8	26.3	45.9	9.0	0	3	.044**	.000	
Technical	42.9	42.9	14.2	0	0	4	.014**	.000	
Control	45.9	43.6	10.5	0	0	4	.004**	.000	
Quality Management	62.4	31.6	6.0	0	0	5	.017**	.000	
Risk Management	57.1	31.6	11.3	0	0	5	.183	.000	
Administrative	0.8	9.0	63.9	7.5	0	3	.604	.000	
Human Resource Management	33.1	39.8	21.1	3.8	2.3	4	.025**	.000	
Budgetary Control	65.4	27.8	6.8	0	0	5	.052	.000	
Cost Management	65.4	30.1	4.5	0	0	5	.100	.000	
Supervision of others	24.8	46.6	27.1	1.5	0	4	.491	.000	

ANOVA test result between the respondents recorded values (sig. >0.05) for *Leadership, Managing conflicts and crisis; Planning and control; Negotiation: contractors; Negotiation: Suppliers and vendors; Negotiation: Equipment manufacturers; Negotiation: Trade Unions; Decision making; Risk management; Budgetary control; Cost management and Supervision of others.* These results show that there are no significant differences in the mean score values for these management skills between the groups. The other management skills ANOVA test result values (sig. <0.05) imply that there are significant differences in their mean scores.

The Chi-square test results show values (0.000), implying that all the skills are valid this infers that this two skills are not essential for managing TAM successfully.

The Reliability coefficient (Cronbach's alpha) improved from 0.619 to 0.888 when the administrative skill is deleted. This infers that administrative skill is not measuring the same construct as the rest of the management skills and therefore should be deleted to make the scales reliable. To ensure that all the items are valid, removing *Managing conflicts and crisis* and *Organisation* in addition improved the scale reliability coefficient to 0.891.

Table 6.19: % Scores, Median, ANOVA and Validity analyses & Reliability of scale of Knowledge needed to manage TAM projects.

Knowledge areas	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's Alpha
	SA	A	P	DG	SDA				
Technical	48.1	39.8	8.3	3.8	0	4	$.008^{**}$	.000	
Contractual	12.0	67.7	18.8	1.5	0	4	.367	.000	
Regulatory processes	43.6	46.6	6.0	3.8	0	4	$.012^{**}$	.000	
Tendering	5.3	49.6	37.6	7.5	0	4	.132	.000	
Health & Safety Regulations	71.4	25.6	3.0	0	0	5	$.021^{**}$	.000	0.655
Project Mgt techniques	60.2	30.1	9.8	0	0	5	$.005^{**}$	.000	(***0.701*** *when the highlighted items are deleted)*
Site security	12.8	32.3	47.4	7.5	0	3	.721	.000	
Setting goals & objectives	44.4	49.6	6.0	0	0	4	$.005^{**}$	.000	
Organisation of Communication	57.9	30.1	10.5	1.5	0	5	$.020^{**}$	.000	

6.5.2.3 Knowledge & Awareness

Table 6.19 shows that the respondents agree that the list of knowledge areas (median score ≥ 4*) are very important towards ensuring TAM project success except *Site security* with a median score of 3*.

ANOVA test results between the respondents show values (sig. >0.05) for *Contractual; tendering* and *site security* and values (sig. <0.05) for all the other knowledge areas. This implies that there are no significant differences in the mean scores of *contractual; tendering* and *Site security* between the groups. On the other hand there are significant differences in the mean scores of all the other knowledge areas identified for managing TAM projects.

The Chi-square test results registered values (0.000) for all the knowledge areas implying that the null-hypothesis to be rejected. These show that the knowledge areas identified are valid. The reliability coefficient; Cronbach's alpha is how ever low (0.655). The inter-total statistics (see Table 6.19b) show that Corrected Item-Total Correlation value for *contractual knowledge* (0.051) and *site security* (0.236) are low (values are < 0.3) and therefore need to be deleted to improve on the reliability of the scale. When this is done the Cronbach's alpha value increased (0.701). This infers that the list of knowledge areas is reliable without *contractual knowledge* and *site security.*

Table 6.19b: Item-Total statistics - Knowledge and awareness areas

Item-Total Statistics					
Knowledge areas	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Technical Knowledge	33.25	8.476	.387	.214	.640
Contractual Knowledge	33.67	9.844	.051	.253	.680
Regulatory processes	33.27	8.653	.369	.146	.643
Tendering Strategies	34.05	8.225	.407	.271	.610
Health and safety regulations	32.89	9.161	.300	.374	.636
Project Management techniques	33.07	7.533	.657	.681	.552
Site security	34.07	8.609	.236	.224	.654
Setting objectives and goals	33.19	8.851	.333	.264	.628
Organisation of communication systems	33.13	7.779	.499	.530	.586

6.5.2.4 Qualities of a TAM Manager

The analyses above show that there are three main qualities of a TAM manager; Personal attributes, management skills and knowledge areas. To ascertain the reliability of the three key elements of the qualities required by a TAM manager to manage TAM successfully, the data derived from the personal attributes, management skills and knowledge areas were used to derive scores for the three elements.

Table 6.20: Median, ANOVA and Validity analyses & Reliability of scale of Qualities of a TAM manager.

Quality elements	Derived Median score	Chi-square (Asym. Sig.)	Cronbach's alpha
Personal Attributes	4.18	.000	.865
Management Skills	4.4	.000	
Knowledge areas	4.43	.000	

The data for Table 6.20 were derived scores based on the Personal attributes, Management skills and Knowledge and awareness response data. As shown, the median scores (≥4) infer that there is support for these to be used in assessing the qualities of a TAM Manager towards TAM success.

Chi-square test result values (0.000) for each of the qualities infer that the qualities are necessary for TAM managers and a Cronbach's alpha value (0.865) confirms the reliability of the scales for the TAM manager qualities.

6.5.2.5 Findings from the analysis

- The key quality elements, personal attributes, management skills and some knowledge area as identified above are found to be required for the TAM manager to ensure successful management of TAM project implementation.
- The list of the elements of these qualities as confirmed from the analyses above are shown in Table 6.20b

Table 6.20b. List of Qualities of a TAM project manager

Personal Attributes, Attitude & Traits	Management Skills	Knowledge and Awareness
Shared vision	Leadership	Technical Knowledge
Good communicator	Planning and control	Regulatory processes
Integrity	Time management	Tendering Strategies
Honesty	Negotiation: Contractors	Health and safety regulations (Site safety rules)
Enthusiasm	Negotiation: suppliers and vendors	Project Management techniques
Competence	Negotiation: Equipment manufacturers	Setting objectives and goals
Ability to delegate tasks and responsibilities	Negotiation: Govt. Agencies and Regulatory Bodies	Organisation of communication systems
Cool under pressure	Negotiation: Inspection Agencies	
Team building ability	Forecasting	
Problem solving abilities	Motivation	
Open minded	Management support building	
Tolerance to ambiguity	Resource Allocation	
Supportive	Communication/Presentation	
Patient	Decision making	
Determination	Health, Safety and Environment	
Need to achieve and proactive	Technical	
	Control	
	Quality management	
	Risk Management	
	Human Resource Management	
	Budgetary control	
	Cost Management	
	Supervision of others	

6.5.3 TAM PROJECT CRITICAL SUCCESS FACTORS

In this section, the analyses of data collected from the respondents on the critical success elements were carried out. Basically, the critical success factors of TAM project implementation are grouped into two: Organisational factors and managerial factors. The details of the analyses are shown below.

6.5.3.1 Organisational Factors

As identified in chapter 3, organisational factors include all the critical success factors that are organisation-oriented. These are issues that need to be resolved by the organisation and the top management. Below is the analysis of data collected with regard to these issues.

1. TAM Philosophy

The response scores for *TAM philosophy* show that the respondents supported all the propositions (see Table 6.21) included in the TAM philosophy with a median score of 4* for each proposition.

Table 6.21: % Scores, Median, ANOVA and Validity analyses & Reliability of scale TAM Philosophy

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's Alpha
	SA	A	P	DG	SDA				
Integral part of Corporate Business	43.6	18.8	2.3	0	0	4	.100	.000	0.717
Clear and concise	30.8	58.6	10.5	0	0	4	.046**	.000	
Develop TAM Mgt procedure	42.9	43.6	13.5	0	0	4	.005**	.000	
Integral part of Asset performance Mgt	29.3	57.9	12.8	0	0	4	.046**	.000	
Establish long-range TAM plans	48.1	41.4	10.5	0	0	4	.009**	.000	

The ANOVA test results show value (sig. 0.100) for TAM philosophy being an *Integral part of corporate business*. This confirms that there are no significant differences in the mean scores between the respondents groups for this proposition. There is however significant differences in the mean scores for all the other propositions (ANOVA; sig. <0.05)

Chi-square test result values (0.000) infer the validity of each proposition and Cronbach's alpha value (0.717) show that the scales are reliable.

2. Top management support

The response scores and median scores ≥4*, for the propositions about the Top Management support factor (see Table 6.22) show that the respondents supported the propositions raised as being important on how the Top management should support TAM project to ensure its success.

Table 6.22: % Scores, Median and ANOVA and Validity analyses & Reliability of scale Top Management support.

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's Alpha
	SA	A	P	DG	SDA				
Sharing responsibility	42.1	41.4	15.0	0	0	4	.000**	.000	0.700
Provision of adequate resources	54.9	39.8	5.3	0	0	5	.003**	.000	
Granting authority & support	36.8	59.4	2.3	1.5	0	4	.001**	.000	
Support for adequate resources due to scope change	41.4	53.4	5.3	0	0	4	.000**	.000	
Empowering the TAM manager	42.1	50.4	7.5	0	0	4	.003**	.000	

ANOVA test result values (sig. <0.05) for the propositions, infer that there is significant differences in the mean scores of all the propositions identified across the group on how the top management should support TAM project to ensure success.

The Chi-square results (0.000) and Cronbach's alpha value (0.700) show that the propositions are both valid and reliable.

3. TAM Goals & Objectives

Table 6.23, shows that respondents response scores show clearly that TAM goals and objectives need to *Be established early* (56.4% strongly agreed and 36.1 agreed) and need to *Be clear to the TAM management team* (50.4% strongly agreed and 41.4%

agreed) are considered more critical (median score 5*) as against the other propositions (median score 4*).

ANOVA test results however show that there are significant differences (sig. <0.05) between their mean scores for all the propositions on the goals and objectives of TAM projects except the proposition that the TAM goals and objective *Should be clear to the TAM management* which has no significant difference in its mean score between the respondents group.
Chi-square test result values (0.000) and the Cronbach's alpha (0.724) means that the propositions are valid and the scales are reliable.

Table 6.23: % Scores, Median, ANOVA and Validity analyses & Reliability of scale TAM goals and objectives.

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's Alpha
	SA	A	P	DG	SDA				
To be established early	56.4	36.1	5.3	2.3	0	5	.041**	.000	0.724
To be in line with organisational goals	34.6	59.4	6.0	0	0	4	.000**	.000	
Should be clear to the TAM mgt	50.4	41.4	8.3	31.6	0	5	.343	.000	
Address the key elements to achieve the goals	31.6	66.9	1.5	0	0	4	.000**	.000	
Should be measurable	36.8	51.9	9.8	1.5	0	4	.013**	.000	

4. TAM Manager

Table 6.24 shows that the % response scores for supporting the *Need to appoint the TAM manager at the end of the current TAM* (27.8% strongly agreed and 24.8% agreed) is low, though the median score (4*). The rest of the proposition response scores (>80%) are quite high.

Table 6.24: % Scores, Median and ANOVA and Validity and Reliability analyses for TAM Manager as a factor

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's Alpha
	SA	A	P	DG	SDA				
Need to be appointed at the end of current TAM	27.8	24.8	28.6	18.6	0	4	.003**	.000	0.75 *(0.79 when highlighted item deleted)*
Should be experienced in TAM projects	42.9	42.1	15	0	0	4	.018**	.000	
Have adequate skills & knowledge TAM	51.9	43.6	4.5	0	0	5	.000**	.000	
Should have adequate personal attributes	44.4	48.9	6.8	0	0	4	.017**	.000	
Has adequate Project Management knowledge	47.4	46.6	6.0	0	0	4	.026**	.000	
Has adequate Mtce. Management Knowledge	24.1	55.6	20.3	0	0	4	.004**	.000	

For the ANOVA test results (sig. <0.05) infer that there are significant differences in the mean scores of all the propositions about the TAM manager for TAM project.

The Chi-square tests carried out show value (0.000) for all propositions The results infer that all the propositions are valid for TAM manager as a critical success factor of TAM projects.

However deleting the *Need to appoint the TAM manager at the end of the current TAM* from the scale improved the Cronbach's alpha value (from 0.75 to 0.79).

6.5.3.2 Managerial Factors

TAM managerial factors consist of the critical success factors associated with the TAM project management. These are issues that affect the management of a TAM project and hence require management expertise and skills of the TAM manager and his team to resolve. Below is the analysis of data collected from respondents.

Table 6.25: % Scores, Median and ANOVA and Validity and Reliability analyses for Organisation/organisational structure

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's Alpha
	SA	A	P	DA	SDA				
Define TAM specific organisational structure for TAM	27.8	55.6	15	1.5	0	4	.024**	.000	.825
Identify the management team	30.8	60.9	6.8	1.5	0	4	.001**	.000	
Identify the entire crew to carryout the work	26.3	41.4	21.8	9.0	1.5	4	.558	.000	
Ensure all functions are covered	29.3	58.6	8.3	3.8	0	4	.107	.000	
Ensure minimal duplication of functions	31.6	49.6	15.8	1.5	1.5	4	.003**	.000	
Be hierarchic	10.5	34.6	42.1	11.3	1.5	3	.310	.000	
Ensure one person must be in overall control	46.6	25.6	19.5	8.3	0	4	.001**	.000	
Ensure that single point responsibility is exercised at every stage.	33.1	48.1	14.3	4.5	0	4	.197	.000	
Ensure roles and responsibilities are defined and communicated clearly.	57.9	36.1	6.0	0	0	5	.070	.000	
Support coordination, communication and quick decision making	45.1	48.9	6.0	0	0	4	.000**	.000	
Be flexible and can respond to new conditions particularly during the execution.	39.8	52.6	5.3	2.3	0	4	.386	.000	

1. Organisation/Organisational Structure

Table 6.25 reveals that with the exception of the Organisational structure *Being hierarchic* with a low response score <50% (10.5% strongly agreed, 34.6% agreed and median 3*) of respondents agreeing, all the other propositions have high scores >65% (% strongly agreed + % agreed) and median scores ≥ 4*.

The ANOVA test result values (sig. <0.05) for these propositions: *Define TAM specific organisational structure for TAM; Identify the management team; Ensure minimal duplication of functions; Ensure one person must be in overall control* and *Support coordination, communication and quick decision making*, infer that there are significant differences in the mean scores of these propositions between the respondents. There are however no significant differences in the mean scores for the other propositions (sig. >0.05).

Chi-square test result values (0.000) and Cronbach's alpha value (0.825) infers that the propositions are valid and reliable for what constitutes of organisation and organisational structure for TAM project to be successful.

2. TAM Management Team

As shown in Table 6.26, the respondents (Median score ≥4*) strongly supported all the propositions concerning the TAM Management team to ensure TAM project success except *Contractors' representatives should be members of TAM management team* (Median 3*).

ANOVA test results values (sig. <0.05) for *Members should represent all areas of responsibility* and *Members should have the ability to work as a team* infer significant differences in the mean score values between the group for these propositions. The others however do not have significant differences in their mean score.

Chi-square test results (0.000) confirmed the validity that all the propositions are important for the TAM management team towards ensuring the success of TAM projects. The Cronbach's alpha value (0.761), confirms that the entire items (propositions) on the scale are reliable as they are measuring the same construct.

Table 6.26: % Scores, Median, ANOVA and Validity & Reliability analyses for TAM Management Team.

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's Alpha
	SA	A	P	DG	SDA				
Should be a well motivated and competent team	53.4	46.6	0	0		5	.128	.000	0.761
Members should represent all areas of responsibility.	38.3	51.9	9.8	0	0	4	.004**	.000	
Each member must have the relevant skill set.	21.8	55.6	20.3	2.3	0	4	.428	.000	
Members should have the ability to work as a team.	45.1	44.4	10.5	0	0	4	.015**	.000	
Roles and responsibility of each should be defined to avoid conflict.	38.3	42.1	15.0	4.5	0	4	.294	.000	
Roles and relationships should be defined and communicated clearly	42.1	48.9	6.8	2.3	0	4	.091	.000	
Contractors' representatives should be members.	24.8	23.3	42.1	9.8	0	3	.113	.000	

3. Planning

The majority of the respondents as shown in Table 6.27 supported all the propositions (Median score $\geq 4^{*}$) for planning in TAM projects.

ANOVA test results show values (sig. <0.05) for all the propositions except: *The start-up network* and *Integrated execution plan* that show ANOVA result values (sig. >0.05). These show that there are significant differences in the mean scores of these propositions across the group except for the two mentioned above that have no significant differences.

Chi-square test results (0.000) and the reliability coefficient (Cronbach's alpha: 0.876) infer that the propositions are valid and the scales reliable.

Table 6.27: % Scores, Median, ANOVA and Validity and Reliability analyses for Planning

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's Alpha
	SA	A	P	DG	SDA				
Unique milestone plan - identifying all key TAM planning activities needed prior to execution.	49.6	44.4	6.0	0	0	4	.049**	.000	0.876
Detailed plans of time, safety concerns, human & material resource, regulatory & technical requirements, cost and communication.	67.7	26.3	6.0	0	0	5	.025**	.000	
The shutdown start-up logic.	36.1	46.6	17.3	0	0	4	.024**	.000	
The shutdown network.	36.1	38.3	24.1	1.5	0	4	.032**	.000	
The start-up network	22.6	54.9	21.1	1.5	0	4	.058	.000	
The critical path program.	53.4	35.3	11.3	0	0	5	.000**	.000	
Contingency plans for emergent work.	54.1	37.6	8.3	0	0	5	.000**	.000	
Integrated plan to incorporate the entire TAM activities.	45.9	42.9	11.3	0	0	4	.003**	.000	
Additional work approval plan.	49.6	31.6	18.8	0	0	4	.000**	.000	
Integrated execution plan	36.8	48.1	15	0	0	4	.269	.000	

4. <u>Work Scheduling</u>

The median scores (≥4*) for all the items and the % response scores (see Table 6.28) show that the majority of the respondents agree that all the propositions are relevant in work scheduling in a TAM project.

ANOVA test show results (sig. <0.05) for all the propositions except: *Duration within the available time frame* (sig. 0.425). These imply that there are significant differences in the mean scores for these propositions across the respondents except *Duration within the available time frame* which has no significant difference in mean score across the group.

With the Chi-square test result (0.000) and Cronbach's alpha of 0.770 also confirms that the propositions are both valid and reliable.

Table 6.28: % Scores, Median, ANOVA and Validity & Reliability analyses for TAM Work Scheduling

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's Alpha
	SA	A	P	DG	SDA				
Execution of tasks in logical sequence	54.1	39.1	6.8	0	0	4	.007**	.000	.770
Cost Profile	51.1	24.8	24.1	0	0	4	.004**	.000	
Duration within the available time frame	52.6	30.8	15.8	.8	0	4	.425	.000	
Human resource needs profile	58.6	18.8	17.3	5.3	0	4	.013**	.000	
Economical & sustainable work patterns	42.9	38.3	17.3	1.5	0	4	.000**	.000	

5. <u>Communications</u>

From Table 6.29, the response scores for agreement (strongly agreed SA% + Agreed A %) and the Median scores ($\geq 4^{*}$), show that the entire propositions about communications in TAM projects are supported by the respondents.

Adequate communication reduces delay; Status and progress should reach the personnel; Contractors should be informed of progress and *Adequate Intra-departmental communication* all have ANOVA test result values (sig. >0.05) between the respondents (position) and values (sig. <0.05) for the other propositions. These show that there are no significant differences in the mean scores of the above mentioned propositions while there are significant differences in the others.

Table 6.29: % Scores, Median, ANOVA and Validity & Reliability analyses for Communication

Propositions	Response Scores %					Median	ANOVA(Sig)	Chi-square (Asymp. Sig.)	Cronbach's Alpha
	SA	A	P	DG	SDA				
Adequate communication reduces delay	55.6	42.9	1.5	0	0	5	.000**	.000	.797
Effective communication reduces safety incidents	55.6	38.3	6.0	0	0	5	.226	.000	
Status and progress should reach the personnel	36.1	57.1	6.8	0	0	4	.027**	.000	
Contractors should be informed of progress	26.3	45.9	27.1	.8	0	4	.001**	.000	
Adequate Intra-departmental communication	45.9	37.6	14.3	2.3	0	4	.024**	.000	
Adequate Inter departmental communication	51.1	33.8	12.8	2.3	0	5	.051	.000	
Adequate external communications	37.6	32.3	30.1	0	0	4	.262	.000	

Chi-square test result for the propositions (0.000) is valid for communication as a factor. This shows that the null-hypothesis should be rejected, inferring that all the propositions are relevant in TAM project communication

6 <u>Technical Tasks</u>

The % response scores and Median scores (4*) of Table 6.30, show that the respondents agree with the propositions concerning *technical tasks* as a critical success factor of TAM projects.

ANOVA test results show values (sig. >0.05) for *Tasks are highly specialised* and *Scarce highly skilled manpower resources* and values (sig. <0.05) for other two propositions. These results infer that there are no significant differences in the mean scores of these two propositions across the groups while there are significant differences in the other two.

The null-hypothesis is to be rejected for each proposition according to the Chi-square test result values (0.000). The Cronbach's alpha result (0.754) infers that the scales are reliable.

Table 6.30: % Scores, Median, ANOVA and Validity & Reliability analyses for Technical Tasks

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's Alpha
	SA	A	P	DG	SDA				
Tasks are highly specialised	32.3	40.6	24.8	2.3	0	4	.264	.000	
Special tools and equipment are required	38.3	44.4	17.3	0	0	4	.002**	.000	
Scarce highly skilled manpower resources	33.8	49.6	16.5	0	0	4	.458	.000	0.754
High level dependant on Equipment manufacturers' staff	20.3	33.1	38.3	6.0	2.3	4	.016**	.000	

7. Personnel Recruitment

Table 6.31 shows that the respondents rated *the need for a competent and experienced* (53.4% strongly agreed and 37.6% agreed) the highest (Median 5*) when compared to other propositions for personnel recruitment in TAM projects. They however supported other propositions raised (Median: 4*) as relevant in personnel recruitment in TAM.

ANOVA test results show values (sig. <0.05) for all the propositions. This infers that there are significant differences between the mean scores of all the propositions across the group.

The Chi-square test result for each proposition (0.000) and the Cronbach's alpha (0.721) infer validity of the propositions and reliability of the scale.

Table 6.31: % Scores, Median, ANOVA and Validity & Reliability analyses for Personnel Recruitment.

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's Alpha
	SA	A	P	DG	SDA				
Need for competent and experienced TAM Manager	53.4	37.6	9.0	0	0	5	.001**	.000	.721
Competent and motivated TAM team.	31.6	60.2	8.3	0	0	4	.000**	.000	
Personnel need to be arranged at the earliest possible date.	27.8	53.4	18.8	0	0	4	.034**	.000	
Ensure personnel qualifications and competence in the specific task required.	24.1	63.2	11.3	1.5	0	4	.002**	.000	
Adequate skilled or trained manpower.	36.8	58.6	4.5	0	0	4	.020**	.000	

8. <u>Contract Strategy</u>

The median score (4*) and the % response scores (see Table 6.32) show that the respondents agree that the entire propositions are significant in the Contract strategy to be adopted by any organisation to ensure their TAM project success.

ANOVA test results show values (sig. <0.05) for all the propositions except *Work scope and how it is packaged* with a value (sig. 0.803). These show that there are significant differences in the mean score values for all the propositions across the group except *Work scope and how it is packaged* that has no significant difference

The validity of each item in the construct is equally confirmed (Chi-square result: 0.000). The reliability of the scales used is equally reliable (Cronbach's alpha: 0.762).

Table 6.32: % Scores, Median, ANOVA and Validity & Reliability analyses for Contract Strategy

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's Alpha
	SA	A	P	DG	SDA				
Work scope and how it is packaged	44.4	45.1	9.8	.8	0	4	.803	.000	.762
Strategy depends on the nature of jobs.	21.1	61.7	17.3	0	0	4	.000**	.000	
In-house personnel availability.	33.1	39.8	23.3	3.8	0	4	.000**	.000	
Design of the TAM organisation.	21.1	51.1	26.3	1.5	0	4	.009**	.000	
Availability and competence of contractors	44.4	45.9	9.8	0	0	4	.021**	.000	
Amount of risk the organisation wants to assume.	31.6	46.6	19.5	2.3	0	4	.011**	.000	

9. Logistics

Table 6.33 shows that the respondents agree (Median score of 4*) with all the propositions for logistics as a critical success factor of TAM projects. This is equally shown by the % response scores.

ANOVA test results for the respondents (position) show values (sig. >0.05) for all the propositions except *Disposing of hired equipment and services should be effective.* From these results, we can conclude that there exist significant differences in the mean scores across the group only for the above proposition. There are no significant differences in the mean scores of all the others.

Chi-square test result (0.000) for each proposition shows that each is valid. The Cronbach's alpha (0.751) also confirms the reliability of the scale used.

Table 6.33: % Scores, Median and ANOVA and Validity and Reliability analyses for Logistics

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's Alpha
	SA	A	P	DG	SDA				
Need for a plot plan to ensure the safety, availability and effective mobilization of every item on site.	33.1	48.1	14.3	4.5	0	4	.102	.000	.751
Need to ensure materials, equipment/tools, crane/transportation, utilities and accommodation and facilities are in place.	42.1	49.6	6.0	2.3	0	4	.079	.000	
Adequate mode of receiving items on site	27.8	60.2	12.0	0	0	4	.181	.000	
Proper mode accommodating or storing of objects	24.1	58.6	17.3	0	0	4	.489	.000	
Disposing of hired equipment and services should be effective.	15.0	48.9	34.6	1.5	0	4	.020**	.000	

10. Scope

As shown in Table 6.34, *Most of the jobs are unrelated* and *No end point, there is always jobs to be done* are not well supported by respondents (Median score 3*) but the rest of the propositions have high % agreement response score (Median: ≥4*).

The ANOVA test results show values (sig. >0.05) for all the propositions - inferring that there are no significant differences between the mean score values for all the propositions across the group.

Chi-square test results values (<0.05) confirms that the propositions are all valid. Equally the scales are reliable with a Cronbach's alpha of 0.782.

Table 6.34: % Scores, Median and ANOVA and Validity and Reliability analyses for Work Scope

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's Alpha
	SA	A	P	DG	SDA				
There is large level of scope fluctuations	34.6	45.1	18	2.3	0	4	.188	.000	0.782
There is multiple sources of work	51.1	33.8	15	0	0	5	.537	.000	
Scope is flexible as some activities can be postponed	21.8	45.9	17.3	12.8	2.3	4	.523	.000	
Most of the jobs are unrelated	22.6	23.3	24.8	27.1	2.3	3	.182	.000	
No end point, there is always jobs to be done.	12.8	32.3	22.6	15.8	16.5	3	.244	.003	

11. Environment, Health & Safety

The propositions for Health, Safety and Environmental factor are highly supported by majority of the respondents (see Table 6.35). Except *Industrial hygiene* with a Median score of 4*, all the others have median score of 5*.

ANOVA test results show values (sig. < 0.05) for all other propositions except *Establishing safety communication* and *Establishing safety working routine* with values (sig. >0.05). These results infer that there are significant differences in the mean score values for all other propositions except the two mentioned above.

The Chi-square test results value (0.000) and the reliability coefficient of the scales, (Cronbach's alpha: 0.729), confirm that the propositions are valid and the scales reliable.

Table 6.35: % Scores, Median, ANOVA and Validity & Reliability analyses for Health, Safety & Environment.

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's Alpha
	SA	A	P	DG	SDA				
Safety policy need to be put in place	65.4	34.6	0	0	0	5	.023**	.000	0.729
Establishing safety communication	65.4	28.6	6.0	0	0	5	.314	.000	
Establishing safety working routine.	51.1	39.8	6.0	0	0	5	.673	.000	
Safety awareness and training	54.1	39.8	6.0	0	0	5	.038**	.000	
Exposure to hazards needs to be monitored.	57.1	38.3	4.5	0	0	5	.042**	.000	
Industrial hygiene monitoring	41.4	44.4	14.3	0	0	4	.030**	.000	
Environmental monitoring for pollution.	57.9	33.1	9.0	0	0	5	.007**	.000	

12. Technology

Table 6.36 shows that median score for each of the propositions (4*) meaning that majority of the survey respondents supported the propositions as being adequate concerning Technology as a critical success factor for TAM projects.

ANOVA test results between the respondent (position) show values (sig. <0.05) for all other propositions except *Reduction in cost, labour and duration* and *Reduction in work load* which have values (sig. >0.05). These infer that there are significant differences in the mean scores of all the other propositions except the above mentioned two that have no significant differences in their mean scores.

Chi-square test result value (0.000) for each proposition the Cronbach's alpha value (0.870) suggests that the variables are valid and the scales reliable.

Table 6.36: % Scores, Median and ANOVA and Validity and Reliability analyses for Technology Factor.

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's Alpha
	SA	A	P	DG	SDA				
On time completion	26.3	49.6	19.5	4.5	0	4	.001**	.000	.870
Increased productivity	36.1	41.4	22.6	0	0	4	.008**	.000	
Correct alignment of tasks	36.8	42.9	18.0	2.3	0	4	.001**	.000	
Improved communication	38.3	45.1	12.8	3.8	0	4	.008**	.000	
Professional reports	33.8	40.6	15.8	7.5	2.3	4	.007**	.000	
Reduction in cost, labour and duration	19.5	40.6	27.8	7.5	4.5	4	.728	.000	
Reduction in work load.	12.0	39.1	36.8	6.0	6.0	4	.408	.000	

13. <u>Monitoring and Feedback</u>

Majority of the survey respondents favoured all the propositions as shown in Table 6.37. The agreement % >80% (SA% + A %) and median score of 4* are registered for each of the propositions.

Only *Milestone, checkpoints need to be established* has ANOVA test result between the respondents value (sig. >0.05). All the other propositions have ANOVA test result values (sig. <0.05). These results imply that while there is no significant difference in the mean scores of the above proposition across the group, there are significant differences in the mean score of all the other propositions.

The Chi-square test result (0.000), for each proposition and Cronbach's alpha (0.775), for the scales show that the propositions are valid and the scale is reliable.

Table 6.37: % Scores, Median, ANOVA and Validity and Reliability analyses for Monitoring and Feedback Factor.

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's Alpha
	SA	A	P	DG	SDA				
Adequate control mechanisms need to be set up	37.6	53.4	9.0	0	0	4	.006**	.000	.775
Milestone, checkpoints need to be established	41.4	54.4	4.5	0	0	4	.598	.000	
Helps in carrying out corrective measures	27.1	63.2	9.8	0	0	4	.000**	.000	
Ensures that the project is in the right direction.	24.8	66.9	8.3	0	0	4	.045**	.000	
Ensures that TAM project is implemented efficiently and economically	32.3	56.4	11.3	0	0	4	.001**	.000	

14. <u>Adequate Resource Allocation</u>

The % response scores for each proposition is >90% Agreement (SA% +A %) and a Median score of 4* (see Table 6.38). These show that the majority of the survey respondents supported that the propositions important in the adequate resource allocation as a critical success factor in TAM projects.

ANOVA between the respondents (position) show values (sig. <0.05) for ensuring *The right number of personnel are allocated* and *Approval of additional resources if and when the need arises,* all the other propositions show values (sig.>0.05). These results show that while there are significant differences in the mean scores of the above mentioned propositions, there are no significant differences in the mean scores of all the other propositions.

The validity of the propositions and the reliability of the scales are confirmed by the Chi-square test result (0.000) for each proposition and the Cronbach's alpha value (0.753) respectively.

Table 6.38: % Scores, Median, ANOVA and Validity & Reliability analyses for Adequate Resource Allocation.

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's Alpha
	SA	A	P	DG	SDA				
Proper resource planning/scheduling	41.4	52.6	6.0	0	0	4	.502	.000	
The right number of personnel are allocated	39.8	50.4	9.8	0	0	4	.039**	.000	
Availability of tools and equipment for the tasks.	40.6	51.1	8.3	0	0	4	.960	.000	0.753
Adequate materials and money are allocated	49.6	42.1	8.3	0	0	4	.517	.000	
Approval of additional resources if and when the need arises.	42.9	47.4	9.8	0	0	4	.042**	.000	

Table 6.39: % Scores, Median, ANOVA and Validity & Reliability analyses for Troubleshooting

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's Alpha
	SA	A	P	DG	SDA				
Arrangement should be made to handle deviations to plan	41.4	48.1	10.5	0	0	4	.000**	.000	0.191 ***(0.646 when item is deleted)***
Crisis should be expected.	15.8	35.3	21.1	25.6	2.3	4	.079	.000	
Due to scope changes, adequate procedure to handle them should be put in place	51.9	34.6	11.3	2.3	0	5	.007**	.000	

15. Troubleshooting

From Table 6.39, the response score 51% agreed (15.8% strongly agreed and 35.3% agreed) is recorded for *Crisis should be expected* proposition. The others are highly favoured by overwhelming majority of the respondents (score >85% agree).

Except for *Crisis should be expected* with ANOVA test result between the respondents (position) value (sig. >0.05), all the other proposition test result value show values (sig. <0.05). These results infer that there are significant differences in the mean score values for the propositions except *Crisis should be expected* which show no significant difference in the score values for the group.

Table 6.39b: Reliability analyses for Troubleshooting - Inter-Item Correlation Matrix

Propositions	Inter-Item Correlation Matrix	
	Arrangement should be made to handle deviations to plan	Due to scope changes, adequate procedure to handle them should be put in place
Arrangement should be made to handle deviations to plan	1.000	.484
Due to scope changes, adequate procedure to handle them should be put in place	.484	1.000

Though the Chi-square test results for each proposition (0.000) showed validity, the reliability of the scale is very low (Cronbach's alpha: 0.191). When *Crisis should be expected* is deleted, the Cronbach's alpha jumps to 0.646 - which is a good result. Considering that the items on the scale are very few, the inter-item correlation shows a value of > 0.4 (see Table 6.39b), which infers that the scale is reliable when *Crisis should be expected,* is deleted.

16. Regulatory Bodies

There is an overwhelming support from respondents to all the propositions made regarding Regulatory bodies in TAM projects. The response scores >90% agreeing and Median score 5* (see Table 6.40) for each proposition confirms their importance.

Table 6.40: % Scores, Median, ANOVA and Validity & Reliability analyses for Regulatory Bodies.

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's Alpha
	SA	A	P	DG	SDA				
Regulatory requirements should be established early.	66.9	30.8	2.3	0	0	5	.049**	.000	0.756
The requirements should be properly interpreted.	57.1	39.1	3.8	0	0	5	.793	.000	
Clear agreement about the work scope should established	58.6	35.3	3.8	0	0	5	.307	.000	
Details of the restart permission process should be agreed with the regulatory body.	54.9	36.8	6.0	2.3	0	5	.356	.000	
Inspection Agents should agree on the schedules related to inspection.	54.9	37.6	7.5	0	0	5	.080	.000	

For the respondents (position) only *Regulatory requirements should be established early* has ANOVA test result value (sig. <0.05), all the other propositions have values (sig. >0.05). These results show that there are significant differences in the mean score values for *Regulatory requirements should be established early* only, all the others have mean scores with no significant differences.

The null-hypothesis is rejected for each of the proposition since the Chi-square test results (0.000) < 0.05. This infers that the propositions are all valid. The scales used are also reliable (Cronbach's alpha: 0.756).

6.5.3.3 TAM Critical Success Factors

Table 6.41, shows data derived from the propositions making up each factor. The Median scores (≥4*) infer that the entire list of factors are supported by the survey respondents.

Table 6.41: Analysis of Critical Success Factors of T`AM project.

Critical Success Factors	Median score	Chi-square (Asym. Sig)	Cronbach's alpha
TAM philosophy	4	.000	0.921
TAM management support	4	.000	
TAM goals & objectives	4	.000	
TAM manager	4.4	.000	
Organisation/organisational structure	4	.000	
TAM management team	4.17	.000	
TAM planning	4	.000	
TAM scheduling	4	.000	
TAM communications	4.33	.000	
TAM technical tasks	4	.000	
TAM personnel recruitment	4	.000	
TAM contract strategy	4	.000	
TAM logistics	4	.000	
TAM work scope	4	.000	
TAM Environment, Health & safety	5	.000	
TAM Technology factor	4	.000	
TAM monitoring & feedback	4	.000	
TAM Adequate resource allocation	4	.000	
TAM troubleshooting factor	4.5	.000	
Regulatory bodies	5	.000	

Chi-square test carried out for all the factors show values (0.000).This shows that the null-hypothesis is to be rejected for all the factors. Accepting the alternative hypothesis means the confirmation of the validity of all the factors as being critical to the success of TAM projects.

A reliability assessment carried out show a very high Cronbach's alpha value (0.921). This confirms that the entire factors on the scale are reliable for TAM critical success factors.

6.5.3.4 Findings from the analysis.

The following factors as shown in Table 6.41 are the critical success factors of TAM project implementation

1. Organisational Factors.

- The organisation needs to establish *TAM Philosophy*. From the analysis it is clear that the TAM philosophy should be an integral part of the corporate business and asset performance management. There is need for the organisation to develop a TAM management procedure as part of the philosophy. The elements of the philosophy need to be clear and should also incorporate long range plans for TAM projects.

- For a successful TAM project, the organisation needs to ensure that the TAM management team are given adequate *Top management support*. These support according to the above analysis includes:
    1. sharing responsibilities
    2. providing adequate material, human and financial resources
    3. granting authority and support; and
    4. empowering the TAM manager.

  The Top management is also required to support the TAM management with the necessary resources to cope with scope changes.

- The organisation needs to establish *TAM goals and objectives.* These objectives need to be established early and should be in line with overall organisational goals. The goals and objectives should be measurable and clear and understandable to the TAM management team.

- It is also the responsibility of the organisation to ensure that the right person who is experienced and having adequate skills and knowledge for TAM projects is selected as the *TAM manager.* The data analysis also shows that the TAM manager should have adequate personal attributes for TAM projects and should have a good project and maintenance management knowledge.

2. Managerial factors

- *Organisation/organisational structure* of TAM project is one of the critical success factors of a TAM project. For a successful TAM project, the TAM manager should define a TAM specific organisational structure ensuring that all functions are covered. There is a need to identify the management team and the entire crew needed to carryout the work. The roles and responsibilities should be properly defined and communicated to all and ensure:
    1. one person is overall control
    2. minimal duplication of functions; and
    3. single point responsibility is exercised at every stage of the process.

  The organisation/organisational structure should support coordination, communication and quick decision making and flexible and can respond to new conditions especially during TAM execution.

- The analysis has shown that *TAM management team* is another critical success factor of a TAM project. According to the analysis, the members of the TAM team should be a well motivated and competent and should represent all areas of responsibility in the organisation. In identifying members, it is necessary to ensure that each member have the relevant skills and have the ability to work as a team. It is very necessary that the roles, responsibilities and relationships of the members are defined and communicated to each member to avoid conflict.

- *Planning* has been shown from the analysis as one of the critical success factors. For a TAM success, there is need to establish a unique milestone plan which should identify all key planning activities needed prior to TAM execution. Detailed plans of time, safety concerns, human and material resource requirements, and regulatory, technical, cost and communications requirements should be in place. The plan should incorporate the entire activities: maintenance, projects, process and safety related tasks. Planning should also include:

1. shutdown - start-up logic
2. shutdown network
3. critical path program.

Contingency plans for emergent work scope and additional work approval procedure plan should be established.

- *Work scheduling* - an element of TAM planning is identified as a critical success factor of TAM project. The schedule should ensure the execution of tasks in a logical sequence. The work schedule should be used to identify the cost profile, human resource needs profile and should ensure that the duration of the project is within the time frame allowed by the top management. The scheduling should ensure that economical and sustainable work patterns are adopted for the TAM execution.

- From the data analysis, it has been identified that adequate and effective *communication* reduces delay and safety incidents in a TAM project. Adequate intra and inter departmental communication including external communications should be established to ensure the status and progress of the project is communicated to all TAM personnel including the contractors and top management.

- TAM projects success according to the data analysis is affected by the nature of *technical tasks* involved. These tasks are highly specialised and in some cases require special tools & equipment. It is shown that the highly skilled manpower needed for TAM project is scarce and there is high dependent on equipment manufacturers' staff to get some of these tasks done.

- *Personnel recruitment* for the TAM project has been identified as critical to the success of a TAM project. First and foremost there is need for the organisation to select a competent and experienced TAM manager, who will in turn select the right TAM management team. It is necessary to identify and arrange for the personnel at the earliest possible time considering the scarcity of these highly skilled personnel. The personnel identified and recruited should have the right qualifications, skills and competence required for the specific tasks.

- *Contract strategy* adopted for the tasks is also a critical success factor for a TAM project. The analysis has identified that the strategy to be adopted depends on:

    1. the work scope and how it is packaged
    2. the nature of the tasks
    3. the skills and competence of the in-house personnel
    4. the design of the TAM organisation
    5. the availability and competence of contractors; and
    6. the level of risk the organisation wants to take.

  A wrong choice of a contract strategy may lead to a TAM project failure.

- Issues concerning *logistics* affect the outcome of a TAM project. For a successful TAM project, according to the data analysis, there is need for a plot plan to ensure the safety, availability and effective mobilization of every item on site for the TAM project. There is also absolute need to ensure that materials, equipment/tools, utilities, accommodation and facilities are in place. TAM management should establish appropriate procedure for receiving items and accommodating or storing them. Disposing of all hired equipment and services should also be effective for a TAM to be successful.

- The work *scope* in a TAM project is very dynamic and is considered in the literatures as the most critical issue that affects the outcome of a TAM project. This according to the analysis is because there is a large level of scope fluctuations during TAM execution. In a TAM project there are multiple sources of work and the scope is also found to be flexible as some activities can be postponed.

- *Health, safety and environment (HSE)* has been shown according to the analysis as a critical success factor of TAM project implementation. As identified, safety policy and safety communication need to be established. It is also essential that all personnel for the TAM project (especially the contractors' workers) should undertake safety awareness training for the TAM projects. Safety working routine should also be established to ensure safety procedures are strictly adhered to during the project execution. Exposure to hazards and near misses should be monitored and recorded. There is also need to establish adequate monitoring of industrial hygiene and the environment for pollution.

- The level of *technology* available to the TAM management has been identified to affect the outcome of TAM project. As shown from the analysis, adequate technology ensures on time completion of TAM projects and results in increased productivity. Technology also helps in correct alignment of tasks and improves communication. TAM reporting is also enhanced by the use of technology. Technology helps in reducing cost, labour, duration and even the work load.

- Adequate *monitoring and feedback* of TAM project activities ensures that the project is implemented efficiently and economically. This is achieved by ensuring that the project is in the right direction by carrying out corrective measures when there are deviations to the plan. These can be achieved by setting up adequate control mechanisms such as milestones and checkpoints which are used to assess the status of the project.

- The data analysis has shown that *adequate resource allocation* is essential for the success of a TAM project. This can be achieved through:
    1. proper resource planning and scheduling
    2. ensuring that the right number of personnel are allocated
    3. ensuring the availability of tools and equipment for the tasks
    4. adequate materials and money are allocated.

  It is also essential that the top management approves additional resources if and when the need arises.

- *Troubleshooting* is shown according to the analysis above as a critical success factor in a TAM project. It has been shown that for TAM to be successful, adequate arrangement should be in place to handle any deviations to plan. It is also very necessary that suitable procedure to manage scope changes should be established.

- One of the drivers of TAM project is meeting statutory requirement. *Regulatory bodies* oversee the compliance of organisations to these requirements. From the analysis, for TAM to be successful, these regulatory requirements should be interpreted correctly and established early. The work scope involved to ensure compliance should be clearly agreed. It is also important that the details of the restart permission be identified and agreed with the regulatory body. The accredited inspection agents should be informed and agree on the schedules related to inspections.

6.5.4 MANAGEMENT METHODOLOGIES

In this section, the analyses for the management methodologies applicable to TAM projects to ensure its successful implementation are presented. The analyses as presented below:

Table 6.42: % Scores, Median, ANOVA and Validity & Reliability analyses for Scope Management

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's Alpha
	SA	A	P	DG	SDA				
Input should be from different departments.	49.6	43.6	6.8	0	0	4	.021**	.000	
Verified to avoid work duplication	54.1	39.1	6.8	0	0	5	.422	.000	
Validated to ensure only shutdown related jobs are approved.	45.1	37.6	15	2.3	0	4	.397	.000	0.76
Outside maintenance professionals can be used to review the scope.	24.1	36.1	22.6	17.3	0	4	.010**	.000	
Management process for scope changes should established.	57.1	30.1	10.5	2.3	0	5	.000**	.000	

1. Scope Management

Table 6.42 shows that *Outside maintenance professionals can be used to review the scope* has response score 60.1% agreeing, all the other variables has scores > 80%. This shows that the majority of the respondents support that the propositions are relevant in scope management to ensure TAM project success.

Verified to avoid work duplication and *Validated to ensure only shutdown related jobs are* approved show ANOVA test results between the respondents (position) (sig. >0.05) while the other remaining propositions show values (sig. <0.05). These results imply that there are significant differences in the mean score values of all the other propositions except *Verified to avoid work duplication* and *Validated to ensure only shutdown related jobs are approved* which do not have significant differences in their mean scores.

Chi-square test result values (0.000) confirm that the propositions are valid. The reliability analysis result (Cronbach's alpha 0.76) shows that the scale used here for scope management is reliable.

2. Time Management

The percentage response scores > 70% agreeing (%strongly agreed + % agreed) and Median scores of 4* for each proposition (see Table 6.43), show that the majority of the respondents are in favour of all the propositions concerning Time Management in TAM projects.

ANOVA test results show values (sig. >0.05) for *Activities must be defined every time there is a break or change in work content and/or changes in the work crew; Estimates for activity duration and the required resources should be realistic* and *Establishing Schedule development using CPM, GERT or PERT* and values (sig. <0.05) for all the other propositions. The results imply that except these three propositions mentioned, there are significant differences in mean score values of all the other propositions across this group.

Chi-square test result values (0.000) for each proposition and the Cronbach's alpha (0.796) show that the propositions are valid and the scale used is reliable.

Table 6.43: % Scores, Median, ANOVA and Validity & Reliability analyses for Time Management

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's Alpha
	SA	A	P	DG	SD A				
Activities must be clearly defined and should be measurable	46.6	45.1	8.3	0	0	4	.000**	.000	0.796
Activities must be defined every time there is a break or change in work content and/or changes in the work crew.	23.3	49.6	19.5	7.5	0	4	.207	.000	
Activities should be properly sequenced to enhance the optimum utilisation of resources.	40.6	49.6	9.8	0	0	4	.038**	.000	
Estimates for activity duration and the required resources should be realistic.	36.8	51.9	11.3	0	0	4	.942	.000	
Contingency for activity that has been missed but is very critical for the turnaround.	26.3	51.9	18.8	3.0	0	4	.035**	.000	
Establishing Schedule development using CPM, GERT or PERT.	29.3	51.1	15.8	3.8	0	4	.208	.000	
Establishing schedule change control system to handle schedule changes.	30.8	47.4	19.5	2.3	0	4	.001**	.000	

3. Cost Management

As shown in Table 6.44, *Determination of the resources (people, equipment, materials) needed to perform the known scope items of TAM project* is most highly supported by the survey respondents (68.4% strongly agreed and 25.6% agreed) with a Median score of 5*. Each of the other propositions has median score of 4*. These infer that the majority of the survey respondents favour all the propositions to be used in managing cost in TAM projects.

ANOVA test results reveal that there is no significant difference in the mean scores of *Allocating the overall cost estimate to individual work items* (sig 0.097) and *Developing a cost estimate of the resources needed to complete the TAM* (sig. 0.605) between the respondents. All the ANOVA test results for the others (Sig <0.05), however show significant difference in the mean scores between the respondents.

The Chi-square test result values (0.000) for all the propositions infer that they are valid and the scale for the items reliable (Cronbach's alpha = 0.840).

Table 6.44: % Scores, Median, ANOVA and Validity & Reliability analyses for Cost Management

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's Alpha
	SA	A	P	DG	SDA				
Determination of the resources (people, equipment, materials) needed to perform the known scope items of TAM project.	68.4	25.6	6.0	0	0	5	.046**	.000	.840
Determination of the quantities of these materials.	42.9	48.1	9.0	0	0	4	.002**	.000	
Developing a cost estimate of the resources needed to complete the TAM.	48.1	42.9	9.0	0	0	4	.605	.000	
Budgeting for anticipated scope items.	48.1	47.4	4.5	0	0	4	.007**	.000	
Budgeting for contingencies.	34.6	52.6	12.8	0	0	4	.033**	.000	
Allocating the overall cost estimate to individual work items.	24.8	47.4	24.1	0	0	4	.097	.000	
Developing control measures to changes to the TAM project budget.	38.3	46.6	15.0	0	0	4	.001**	.000	
Emergent works should be treated separately.	24.1	45.9	21.8	8.3	0	4	.000**	.000	

4. <u>Quality Management</u>

According to % response scores (see Table 6.45), *the specification of materials and spares should be clearly stated* (60.2% strongly agreed and 36.8% agreed) and *Quality assurance system should be put in place to ensure each tasks conforms to specification* (55.6% strongly agreed and 30.1% agreed) with a median score 5* received an overwhelming support from the survey respondents. The other propositions are also supported by the respondents (Median 4*). This confirms that the majority of the respondents supported that the entire propositions are important towards managing quality successfully in a TAM project.

Table 6.45: % Scores, Median, ANOVA and Validity & Reliability analyses for Quality Management

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's Alpha
	SA	A	P	DG	SDA				
The specification of materials and spares should be clearly stated.	60.2	36.8	3.0	0	0	5	.809	.000	
The requirements of every task must be correctly specified.	47.4	37.6	12.8	2.3	0	4	.167	.000	.789
Standard procedure of carrying out the tasks should be specified and adhered to.	34.6	53.4	12	0	0	4	.026**	.000	
Quality assurance system should be put in place to ensure each tasks conforms to specification.	55.6	30.1	14.3	0	0	5	.310	.000	
Monitoring the specific results to ensure the elimination of deviations to standards.	46.6	42.9	10.5	0	0	4	.322	.000	

ANOVA tests between the respondents show that only *Standard procedure of carrying out the tasks should be specified and adhered to* (sig. 0.026) shows significant differences in the mean scores between the groups. The other propositions do not have significant differences in their mean scores.

Chi-square test results for each proposition (0.000), infers that the propositions are valid. The reliability coefficient, Cronbach's alpha of 0.789 shows that the scale used for Quality management is reliable.

5. Human Resource Management

The response score and Median score (see Table 6.46) for *Roles, responsibilities and reporting relationships should be identified*; (51.1% strongly agreed and 41.4% agreed) and (5*) respectively show that the survey respondents very strongly supported this propositions. The other propositions (Median score 4* each) are also supported to be necessary in managing the human resource towards ensuring TAM success.

Table 6.46: % Scores, Median and ANOVA and Validity and Reliability analyses for H.R Management

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's Alpha
	SA	A	P	DG	SDA				
Roles, responsibilities and reporting relationships should be identified.	51.1	41.4	7.5	0	0	5	.000**	.000	.844
Skills and knowledge required for the roles need to be established	33.8	59.4	6.8	0	0	4	.048	.000	
An organisational structure need to be established for TAM.	39.8	47.4	9.8	3.0	0	4	.010**	.000	
The Acquisition of human resources needed for TAM.	36.1	34.6	22.6	6.8	0	4	.000**	.000	
Enhancement of the stakeholders to function as a team.	24.8	42.9	29.3	3.0	0	4	.001**	.000	
Integrate the project team into the TAM team to form a single organisation.	27.8	49.6	22.6	0	0	4	.001**	.000	
Motivational schemes for the stakeholders.	31.6	38.3	19.5	10.5	0	4	.010**	.000	

The ANOVA test results between the respondents (sig. <0.05) show that there are significant differences in their mean score values in all the propositions except *Skills and knowledge required for the roles need to be established.* Chi-square test result

(0.000) for each proposition and Cronbach's alpha (0.844) of the scales show that the propositions are valid and the scale reliable respectively.

Table 6.47: % Scores, Median, ANOVA and Validity & Reliability analyses for Communications Management

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's Alpha
	SA	A	P	DG	SDA				
Executive Management (summary, schedule, progress)	67.7	18.0	12.0	2.3	0	5	.000**	.000	
TAM management (scope, schedule, progress, manpower).	49.6	41.4	9.0	0	0	4	.001**	.000	
Planning/Scheduling (scope, schedule, progress)	44.4	48.9	6.8	0	0	4	.177	.000	
Inspection (schedule, progress)	35.3	56.4	6.0	2.3	0	4	.174	.000	.913
Operations (scope, schedule, progress)	32.3	57.1	10.5	0	0	4	.083	.000	
Safety (scope, schedule, [permit requirements])	45.9	43.6	8.3	2.3	0	4	.568	.000	
Warehouse (scope, schedule).	27.1	54.9	10.5	7.5	0	4	.022**	.000	
Information dissemination with the supervisors at the end of each shift.	48.9	38.3	11.3	1.5	0	4	.056	.000	
Standard report formats to stakeholders should be adhered to.	41.4	42.9	14.3	1.5	0	4	.037	.000	
Performance information reporting of status, progress and forecasting formats should be established.	51.1	39.8	9.0	0	0	5	.001**	.000	
Performance reports should include; scope, schedule, cost, quality, risks and procurement issues.	32.3	51.1	14.3	2.3	0	4	.173	.000	

5. Communications Management

The response scores (>80% agreement - % SA + % A) for all the propositions for Communications management (see Table 6.47) show that majority of the respondents supported all the propositions.

ANOVA test result for *Performance information reporting of status, progress and forecasting formats should be established, Standard report formats to stakeholders should be adhered to, Warehouse (scope, schedule), Executive Management (summary schedule, progress)* and *TAM management (scope, schedule, progress, manpower)* (<0.05) indicate significant differences in their mean scores results across the group. The ANOVA tests for all the other propositions however show insignificant differences in their mean scores. Chi-square test result (0.000) for each proposition, show that the propositions are valid. Cronbach's alpha value (0.913) for the scale proves it reliable.

Table 6.48: % Scores, Median and ANOVA and Validity and Reliability analyses for Risk Management.

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's Alpha
	SA	A	P	DG	SDA				
Developing a checklist of risk elements.	63.2	24.1	12.8	0	0	5	.002**	.000	.792
Interviewing other stakeholders to identify risks.	42.1	50.4	7.5	0	0	5	.347	.000	
Deciding on the probability of the risk and its relative impact to TAM.	54.9	39.1	3.8	2.3	0	4	.289	.000	
Identifying and establish ways of responding to the risk.	47.4	39.8	9.0	3.8	0	5	.002**	.000	
Organising the team to be risk vigilant in order to respond to risk treats	53.4	25.6	18.8	2.3	0	4	.405	.000	
Ensuring the Security of the plant, workers, equipment and spares.	45.1	49.6	5.3	0	0	4	.143	.000	

6. Risk Management

As shown in Table 6.48, with response score and Median score in favour of the propositions >80% (SA%+A %) and ≥4*, respectively indicate that the majority of the survey respondents agree that the propositions are very significant in managing risk in TAM projects.

For ANOVA test between the respondents the values for *Developing a checklist of risk elements* and *Identifying and establish ways of responding to the risk* (sig. <0.05) show significant results. All the other propositions values (sig. >0.05) do not show significant differences in the mean scores results between the groups.

Chi-square test results (0.000) for all the propositions show that the entire propositions are valid for managing risk in TAM projects.
Cronbach's alpha value (0.792) show that the scale used is reliable.

7. Health, Safety & Environment

The Median score (5*), and response score >90% (SA% + A %) for each proposition (see Table 6.49) shows that the majority of the respondents agree that Health, Safety and Environment can be adequately managed with the propositions identified.

ANOVA test between the respondents (sig. <0.05) on *Safety trainings and awareness programme for worker; identifying all hazards and establishing ways to protect the workers* and *'Job Safety Hazard Analysis' should be carried out for all jobs* show significant differences in the perception of the respondents. ANOVA test result between the respondents (sig. >0.05) on other propositions do not show significant differences. The propositions with Chi-square test result (0.000) for each, infer their validity and the Cronbach's alpha value 0.875 confirms that the scale used is reliable.

Table 6.49: % Scores, Median and ANOVA and Validity and Reliability analyses for Health, Safety & Environmental Management.

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's Alpha
	SA	A	P	DG	SDA				
Safety trainings and awareness programme for workers.	63.2	33.8	3.0	0	0	5	.010**	.000	.875
Safety policy statement, safety communication networks and safety working routine must be established.	57.9	36.1	3.0	0	0	5	.081	.000	
Environmental monitoring to assess level of environmental pollution.	62.4	28.6	4.5	4.5	0	5	.140	.000	
Establishing Safe work permit for all activities and ensuring strict adherence to them.	67.7	27.1	5.3	0	0	5	.044	.000	
Identifying all hazards and establishing ways to protect the workers.	71.4	25.6	.8	2.3	0	5	.002**	.000	
Establishing the procedure to handle any incident	50.4	42.9	5.3	1.5	0	5	.084	.000	
Every safety or Environmental incident should be investigated and reported.	57.9	34.6	7.5	0	0	5	.183	.000	
The use of PPE should not be compromised.	74.4	24.1	1.5	0	0	5	.064	.000	
'Job Safety Hazard Analysis' should be carried out for all jobs.	57.1	36.1	6.8	0	0	5	.032**	.000	

8. <u>Materials Management</u>

The Median score (≥ 4*) and response score >80% in agreement (SA % + A %) for each proposition (see Table 6.50) indicate that the majority of the survey respondents agree that the propositions are important towards managing Materials successfully in a TAM project.

Table 6.50: % Scores, Median, ANOVA and Validity & Reliability analyses for Materials Management.

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's Alpha
	SA	A	P	DG	SDA				
Ensure that experienced personnel are assigned as a materials coordinator.	27.1	54.9	13.5	4.5	0	4	.558	.000	.742
Regular communication established between the TAM team and Materials function.	30.8	53.4	13.5	2.3	0	4	.027**	.000	
Analyzing the work list at the earliest to identify materials needed for the TAM.	38.3	53.4	8.3	0	0	4	.041**	.000	
Identify long delivery, specialty, and unique items and delivery needs.	65.4	28.6	6.0	0	0	5	.608	.000	
Plant- versus Contractor-supplied materials needs to be defined	33.1	63.2	3.8	0	0	4	.126	.000	
Material to be procured must be correctly specified.	51.1	43.6	5.3	0	0	5	.077	.000	
Quality of materials received must conform to specifications	56.4	39.1	4.5	0	0	5	.020**	.000	
Material tracking procedure should be put in place	34.6	55.6	7.5	2.3	0	4	.002**	.000	

ANOVA test results show that four propositions: *Regular communication established between the TAM team and Materials function; Material to be procured must be correctly specified; Quality of materials received must conform to specifications;* and *Material tracking procedure should be put in place* have values (sig. <0.05) each. This signifies that there are significant differences in the mean scores between the respondents group on the above propositions. The value for others (sig. >0.05) do not show significant difference in their mean values. The Chi-square test result value ((0.000) for each proposition confirms their validity. Cronbach's alpha value (0.742) for the scale confirms that the scale is reliable.

9. Contract Management

The Median score (≥ 4*) and response score >65% in agreement (SA% + A %) for each proposition (see Table 6.51) indicate that the majority of the survey respondents agree that the propositions are adequate towards managing contract successfully in a TAM project.

Table 6.51: % Scores, Median and ANOVA and Validity and Reliability analyses for Contract Management.

Propositions	Response Scores %					Median	ANOVA (Sig)	Chi-square (Asymp. Sig.)	Cronbach's Alpha
	SA	A	N	DG	SDA				
Ensuring that the work scope of each contractor is well defined.	53.4	44.4	0	0	0	5	.511	0.000	.481
Thorough assessment of contractor's capability (in terms of manpower, skills	54.1	42.1	3.8	0	0	5	.652	.000	
Reduction of interfaces between contractors and plant personnel.	22.6	45.9	18.0	6.8	6.8	4	.009**	.000	
Payment schedule for the contractors to be properly defined and adhered	28.6	58.6	8.3	2.3	2.3	4	.007**	.000	
Proper assessment in terms quality control and assurance of contractors supplied materials and jobs.	48.1	46.6	5.3	0	0	4	.737	.000	

ANOVA test carried for the respondents, found that there are significant differences in the mean score values for: *Reduction of interfaces between contractors and plant personnel* and *Payment schedule for the contractors to be properly defined and adhered* (sig. <0.05). The results for the other propositions (sig. >0.05), infer insignificant differences.

The entire propositions for managing Contract successfully in a TAM project are valid (Chi-square test results: 0.000). Cronbach's alpha value (0.481) for the scale is very low.

Table 6.51b: Reliability analyses for Contract Management - Item-Total Statistics

Propositions	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Ensuring that the work scope of each contractor is well defined.	16.73	3.760	.268	.162	.430
Thorough assessment of contractor's capability (in terms of manpower, skills etc).	16.74	3.726	.258	.188	.432
Reduction of interfaces between contractors and plant personnel.	17.53	2.902	.137	.101	.582
Payment schedule for the contractors to be properly defined and adhered to.	17.15	2.720	.465	.236	.261
Proper assessment in terms quality control and assurance of contractors supplied materials and jobs.	16.81	3.608	.294	.105	.412

From Table 6.51b, the Corrected Item-Total Correlation value for: *Reduction of interfaces between contractors and plant personnel* (0.137) is very low. Also Cronbach's Alpha if Item deleted increases from the original value of 0.481 to 0.582 for this proposition.

The corrected item-total correlation when *Reduction of interfaces between contractors and plant personnel* is deleted (see Table 6.51c) improved (each >0.3).This infers that the scales are reliable though the Cronbach's alpha value is 0.582.

Table 6.51c: Reliability analyses for Contract Management - Item-Total Statistics 2

Propositions	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Ensuring that the work scope of each contractor is well defined.	13.02	2.007	.387	.156	.499
Thorough assessment of contractor's capability (in terms of manpower, skills etc).	13.03	1.938	.399	.171	.487
Payment schedule for the contractors to be properly defined and adhered to.	13.44	1.461	.399	.167	.496
Proper assessment in terms quality control and assurance of contractors supplied materials and jobs.	13.11	2.034	.304	.098	.554

6.5.4.1 TAM Management Methodologies

Table 6.52 shows data derived from the various propositions for the different management methodologies for the TAM project. The Median scores show values ($\geq 4^*$), implying that the survey respondents supports that all the management methodologies proposed are relevant in managing TAM projects successfully.

Chi-square test carried out found that all the management methodologies recorded values (sig. <0.05), inferring that alternative hypotheses is accepted in all these cases, this confirm validity of the management methodologies.

Conbrach's alpha value (0.877) shows that the entire scale is reliable to be used in managing TAM projects.

Table 6.52: Median and ANOVA and Validity analyses & Reliability of scales of TAM Management Methodologies

Management Methodologies	Median score	Chi-square (Asym. Sig.)	Cronbach's alpha
Scope Management	4	.000	0.877
Time Management	4	.000	
Cost Management	4	.000	
Quality Management	4	.000	
HR Management	4	.000	
Communications Mgt	4	.000	
Risk Management	5	.000	
HSE Management	4	.000	
Material Management	4	.046	
Contract Management	4.5	.000	

6.5.4.2 Findings from the analysis.

The analyses of Section 6.5.4.1 clearly confirm that the list of TAM management methodologies shown in Table 6.52 are required to ensure successful implementation of TAM projects. Details of these methodologies are elaborated below:

- The analysis has shown that for a successful TAM project, adequate *Scope management* methodology need to be in place. First, input of the scope items should be from the various departments. These scope items need to be verified and validated to ensure there is no duplication and that only shutdown dependent jobs are approved. It is also identified that outside maintenance professionals can be used to review the scope items. Finally, since scope changes are a common feature of TAM projects, management process for scope changes should be established.

- Another management methodology needed for a successful TAM is *Time management*. The data analysis shows that for a successful TAM, all activities must be clearly defined and should be measurable. Activities should also be defined every time there is a break or a change in work content and/or changes in the work crew. To enhance optimum utilisation of resources, it has been shown that all activities should be properly sequenced. Realistic estimates for activity duration and the required resources are also identified as critical in managing time. The analyses also show that contingency time should be made available for an emergent scope items that has been missed but is very critical for the success of the turnaround. Schedule development using CPM, GERT or PERT and schedule change control system to handle schedule changes are needed in time management as shown in the analysis.

- *Cost management* methodology is needed for a TAM project success. From the data analysis, it is essential to determine the resources (human and material) needed to perform all the known scope items as the first step in managing cost. A cost estimate is then carried out for these resources. Budget estimates should be made for anticipated scope items. Based on the forecasting skills and experience of the TAM management, contingencies should be budgeted for emergent scope items which will emerge during the project execution. A breakdown of the overall cost estimates into individual work items should be done. This is usually necessary for contractual purposes. Finally, the analysis shows that control measures need to be in place to monitor any deviations.

- In other to ensure TAM success, adequate *Quality management* methodology should be established. From the data analysis, the specification of material and spares needed for the project should be clearly stated. The requirements of every task and the standard procedure of carrying them out should be correctly specified and adhered to. For TAM quality management, a quality assurance system should be put in place to ensure each task execution conforms to specifications. The analyses also show that adequate quality control and monitoring measures should be established to ensure the elimination of deviations to standards.

- TAM specific *Human Resource management* methodology should be in place for TAM project to be successful. The data analyses show that roles responsibilities and reporting relationships of all the personnel involved in the event should be identified and an organisational structure for TAM projects established. Further the skills and knowledge required for the roles need to be recognised. Based on the above, the TAM management should set up a procedure for the acquisition of the personnel needed for the project. The analyses show that there is absolute need for the enhancement of the stakeholders to function as a team ensuring that project team is part of the TAM project team. It is also clear from the analysis that motivational scheme for all the TAM stakeholders (especially the workers and contractors) will go a long way towards ensuring TAM success.

- Adequate *communications management* methodology should be established to ensure a successful TAM project. Generally, from the analyses, basic information dissemination needs to be place for all the stakeholders in a standard report formats. Performance information reporting to the stakeholders should include status, progress and forecasting on scope, schedule, cost, quality, risks and procurement issues. A breakdown of these is for the different stakeholders and issues are also identified by the analyses to include:
    1. Top management (summary, schedule and progress)
    2. TAM management team (scope, schedule, progress and manpower)
    3. Planning/Scheduling (scope, schedule and progress)
    4. Inspection (schedule and progress)
    5. Safety (scope, schedule and permit requirements)
    6. Warehouse or Store (scope and schedule).

  There should be information dissemination and sharing with the supervisory team at end of each shift.

- TAM project constitute a lot of risk. Adequate *Risk management* methodology (as identified by the analysis) is therefore needed to ensure a successful TAM project. For adequate risk management, a checklist of risk elements needs to be developed by interviewing the stakeholders to identify them. There is need to decide on the probability of the risk and its relative impact on the project. The analyses also show that the ways of responding to the risks should be identified and established. Further the team need to be organised to be risk vigilant in other to respond to risk treats. It is also necessary to ensure the security of the plant, workers, equipment and all materials during the event.

- The data analyses show that safety trainings and awareness programme for all TAM workers is very necessary for *Health, safety and environmental management* in a TAM project. Safety policy statement, communication networks and safety working routine need to be established. It is also identified that safe work permit for all activities and the use of personal protective equipment should be established and adhered to. 'Job safety Hazard Analysis' to identify all hazards associated with each task and ways of protecting the workers should be established. Adequate pollution monitoring should also be established to assess the levels of environmental pollution. There is also the need to establish procedures to handle incidents and ensuring that every safety and environmental incidents are investigated and reported.

- *Materials management* according to the data analysis is very critical to the success of any TAM project. It is necessary to ensure that a personnel experienced in TAM projects materials is assigned the Materials coordinator. It is required that regular communication is established between the TAM management team and the Materials function before and during the execution of the project. To ensure adequate management of materials, the work list for the TAM need to be analysed at the earliest possible time in order to identify the materials needed for the project. This should be done to ensure the delivery of items that require long lead times, speciality and unique items. Materials to be procured need to be correctly specified and quality of the materials received and installed should conform to these specifications. Plant versus contractor supplied materials should be properly defined and adequate tracking procedure should be in place for stock of items and those on transit.

- TAM projects depends mostly on contractors, adequate *contract management* methodology should therefore be in place to ensure TAM success. From the analyses, it is necessary to define the work scope of each contractor. In contractor selection, it is shown that a thorough assessment of the contractors' capability (in terms of man-power, skills, safety records, etc) for the tasks should be carried out before appointment. Proper assessment procedure should also be place to assess the quality of contractors' materials and jobs. It is also of utmost importance to ensure that payment schedule for the contractors are properly defined and adhered to.

6.6 SUMMARY OF THE CHAPTER

The chapter provided the method adopted for data collection. It also provided the analysis and breakdown of respondents who participated in the survey. The chapter explained the methods adopted for the analysis of the data collected. The major part of the chapter was the presentation of the analysis of the questionnaire survey.

The chapter have confirmed the elements needed for the evaluating TAM projects. It further confirmed the TAM critical success factors which affects the outcome of TAM projects. The specific management methodologies required for TAM projects management success were also confirmed.

The chapter identified anomalies in the perceptions of the various respondents (categories) when determining the level of significance of the various elements (propositions) investigated. This means that there exist different perception levels of the various propositions between the different organisational positions. All these were however noted and were included for further investigation in Chapter 7 (Qualitative studies).

7.0: QUALITATIVE DATA ANALYSIS

7.1. AIMS OF THE CHAPTER

This Chapter reports the data collection and analysis of the case studies. The chapter begins with the profiles of the case organisations selected for this research. Further the chapter presents the various method of data collection used in these case studies. The method adopted for the analysis of data collected is also presented.

7.2. PROFILES OF CASE ORGANISATIONS

For the case studies research, six organisations were selected from among the continuous process plants in the UK. Primarily the cases examined in this study were selected because they allowed insights into the different continuous process plants as identified by the impact of TAM projects to their operations. This decision was also based on multinational organisations whose operations imparts on the well-being of the populace as well as the economy of the state. In addition access, location, cooperation, relevance in terms of size, scope and operation and representation of manufacturing industries (which are in continuous operation) in the UK were considered.
A brief description of each case organisation is given in details below.

7.2.1. CASE A

Organisation: Electric Power Generating Station (Power Plant)

Interviewed Staff:

Main: Programme Manager - TAM Manager

Others: Maintenance Manager.

Operations: Generates

- Coal-fired 2000MW
- Natural gas-fired 1400MW+100MW
- Bio-fuel 10MW

Major TAM Drivers:

- Statutory Requirements
- Poor Equipment performance
- Investment opportunity

7.2.2. CASE B

Organisation: Crude Oil Refinery

Interviewed Staff:

Main: TAR Manager

Others: Maintenance Manager

Operations: The refinery is an integrated atmospheric-vacuum distillation, fluid catalytic cracking refinery with a total crude oil and other feedstocks throughput capacity of 192,000 barrels per day.

Major TAM Drivers:

- Statutory Requirements
- Poor Equipment performance
- Anticipated Failure
- Capital Investment for Return
- Minor modifications for improved performance or operability.
- Reputation Issues

7.2.3. CASE C

Organisation: Petro-chemical Plant

Interviewed Staff:

Main: Shutdown Manager - TAM Manager

Others: Plant Manager

Operation Supervisor

Operations: Produces S-PVC production takes place 24 hours a day, 365 days a year, using state-of-the-art polymer reactor technology to convert vinyls chloride monomer raw material into high grade S-PVC resin. - 200,000tons per annum

Major TAM Drivers:

- Statutory Requirements
- Poor Equipment performance
- Business Operations and Reliability

7.2.4. CASE D

Organisation: Soft drinks Bottling (Food & Beverages)

Interviewed Staff:

Main: Overhaul Manager - TAM Manager

Others: Safety Manager
Maintenance Supervisor

Operations: Produces 6000 bottles of soft drinks per minute everyday.

Major TAM Drivers:

- Poor Equipment performance
- Anticipated Failure
- Maintaining Product Quality & Integrity
- Equipment manufacturers specification

7.2.5. CASE E

Organisation: Cement manufacturing (Chemical & Steel)

Interviewed Staff:

Main: Shutdown/Maintenance Manager - TAM Manager

Others: Plant Manager
Asst. Production Manager

Operations: Produces 2.3million tonnes of cement per annum

Major TAM Drivers:

- Poor Equipment performance
- Anticipated Failure

7.2.6. CASE F

Organisation: Hollow Glass Manufacturing

Interviewed Staff:

Main: Shutdown/Maintenance Manager - TAM Manager

Others: Plant Manager

Maintenance Supervisor

Operations: Produces; 1.25 billion units per year.

Major TAM Drivers:

- Poor Equipment performance
- Anticipated Failure
- Root Cause Analysis (RCA) Data.

7.3 TAM PROJECT ACTIVITIES OF CASE ORGANISATIONS

Table 7.1 shows analyses of typical TAM activities in the six case organisations as at 2008. The Organisation B has the highest labour input per day (7142 man-hours per day) and Organisation F with only 761 man-hours per day. As can be seen there is varying intervals between TAM projects in the different organisations. The interval ranges from an annual event for organisations D and E to 4 years for organisations A and B. There are also significant differences in the TAM project duration in the case organisations, while case organisation A completes a typical TAM in 112 days; it takes organisation D only 7 days.

Table 7.1: Analysis of Case Organisations' TAM Activities as at end of 2008

Case Organisation	Industry Group	TAM Activities			
		TAM Intervals (years)	TAM Duration (days)	Labour Input (man-hours)	Labour input per day (man-hours)
A	Power Plant	4	112	704,000	6286
B	Oil Refinery	4	42	300,000	7142
C	Petrochemical Plant	2	21	88,000	4190
D	Food & Beverages	1	7	5515	787
E	Chemical & Steel	1	14	45000	3214
F	Glass	2	21	16000	761

7.4 METHODS OF DATA COLLECTION

Three sources of evidence were used in collecting data from the case organisations for this study; interview, documents and direct observation.

7.4.1 Interviews

Semi-structured interviews (typical formats are given in the Appendix B) with key personnel responsible for the management of TAM projects (TAM Managers) from each organisation were conducted. Some participants were contacted after the interviews transcriptions for clarifications on some issues. They also were agreeable to be contacted should any additional questions arise. Follow-up interviews were conducted to seek information and explanations from other TAM project participants in the case organisations. The profiles (in terms of working experiences) of the key personnels interviewed are shown in Table 7.2. The information from the Table also shows that the key personnel have participated in TAM projects at various levels in terms of position. This is particularly important for the harmonisation of information (data) obtainable from the interview, since the level of the individual in terms of organisational position affects their perceptions on the various propositions as portrayed by the findings of the survey research (see chapter 6).

Both theoretical and snowball sampling approaches were employed in this research study to collect data from other staff of the case organisations. In all a total of 16 personnels were interviewed from the six case organisations covering the Plant Manager, Programme Manager, Turnaround Manager, Maintenance Manager, Safety Manager, Assistant Production Manager, Operation Supervisor and Production Supervisor.

7.4.2 Documents & Reports

Data were also collected from some documentations collected from the case organisations on how they carryout their TAM projects. These includes planning documents, minutes of TAM daily Review meetings, Contractors tender documents and the minutes of final review meetings. Some engineering and TAM project reports of some case organisations were also used for some clarifications.

7.4.3 Direct Observation

After the interview sessions (which were carried out in the case organisations premises), plant tours around the plant of some of the case organisations were carried out. Some of the vital equipment involved in the TAM project activities was critically observed. A tour was taken around the factory of one case organisation during their shutdown maintenance event. This gave an opportunity to observe the actual TAM project implementation in practice.

Table 7.2: Analyses of the Working Experience of the Main Interviewed Staff

Organisation	Current Position of TAM Manager	Years of Experience in								
		Maintenance Operations & Plant Management	Engineering & Projects Management	TAM Projects as						
				Plant Operative	Management Team	TAM Manager	Consultant/ Contractor	Client/Top Management	UK Experience	International Experience
A	Programme Manager	> 15	>15	≈10	>10	>10	>10	≈10	> 10	≈10
B	Turnaround Manager	>15	>15	≈10	>10	>10	>10	≈10	>10	>10
C	Shutdown Manager	>15	>15	>10	>10	>10	>10	>10	>10	≈10
D	Overhaul Manager	>15	>10	>10	>10	>10	≈5	≈5	>10	-
E	Maintenance Manager	>15	>15	≈10	>10	>10	-	>10	>10	-
F	Maintenance Manager	>15	>10	>10	>10	>10	-	-	>10	-

7.5 METHOD OF DATA ANALYSIS

As shown above data for the case studies were collected mainly from interviews of key personnels involved in the management of TAM projects in the case organisations. To ensure the validity of the data, organisational documents/reports and observational information were also collected to triangulate the data collected from the interview.

The interviews were formatted and coded to remove names or reference made to the person or the organisation. The interviews which were digitally recorded were loaded on a computer and transcribed into Microsoft Word format. Adequate care and a lot of patience were taken to ensure that the interview transcription was completed correctly.

Preliminary analysis was carried out on each case organisation based on the themes already identified in the literatures and used in the survey research study in Chapter 6. Data were then analysed using the qualitative research analysis software NVivo version 8 (see screen display of primary nodes; Appendix C). The software supported in coding the data using themes already identified above to develop patterns from the case studies.

7.6 CASE STUDIES ANALYSIS & FINDINGS

This section presents the output; the patterns that emerged from the case studies.

7.6.1. Reasons for TAM Projects

Turnaround maintenance is a proactive maintenance strategy which organisations operating engineering facilities carry out for purposes of preventive maintenance, corrective maintenance and/or plant improvement of their facilities. TAM projects can therefore be carried out because of one or any combination of the above. The participants from the case organisations widely agree that TAM projects are mainly carried out to maintain the reliability and performance improvements of the plant. This view is supported by Mclay (2003) who acknowledged that increase in plant asset reliability is one of the positive impacts of carrying out a TAM project

In all continuous process plants, the equipment conditions impart directly on the performance and the reliability of the units drives TAM projects. For equipment that is running continuously 24 hrs-a-day and 7-days-a-week, the components tend to wear and this reduces the efficiency of their performance. The Plant Manager in Organisation C, explained: *"Shutdown maintenance is predominantly in our industry because we run 24/7. It is not possible to run a piece of equipment for ever without an overhaul or maintenance. Most of these equipments are rotating equipment running 24/7, what one can do while the equipments are in operations is running inspections"*.

TAM projects are also driven by statutory inspection requirements. These are basically for safety related problems. Some equipment operates under high pressures and required by law to be opened up for inspection at predetermined intervals or when running under specific conditions. This is predominant in the Power, Oil refining and petrochemical plants. *"The TAM projects are all part of a programme driven by statutory inspection requirements, unit performance, unit reliability and plant upgrades driven by statutory requirements"*, said a TAM manager. This is supported by the TAM Manager of organisation A. In his words, *"Our shutdowns are driven by statutory requirements or reliability of the equipment"*.

Another reason for a TAM project can be due to the equipment manufacturers' specification especially when the equipment is still under warranty. The Overhaul Manager of organisation D stated that' *"Really we need to maintain the performance of the lines, so we try to do what we can to protect the lines for 12 months till next shutdown. The main drivers though are manufacturer's specifications and Poor Equipment performance"*.

A TAM project can also be carried out for the purposes of up-grading the plant (technological improvements) and plant refurbishments. As the Maintenance Manager of organisation F put it; *"The major reasons for our shutdowns are for plant up-grading, performance improvement and refurbishment"*.

7.6.2. Avoiding TAM projects

All the participants from the case organisations are in agreement that TAM projects cannot be avoided. In the view of the participants, continuously postponing turnarounds will eventually result in a failure. Such unplanned shutdowns would take more time to repair and will be extremely expensive. In the words of a TAM manager; *"There is no way; you cannot run without taking the equipment out for shutdown maintenance. Otherwise you will end up with the most expensive operating plant, because it will constantly be in a breakdown situation"*. The intervals can be extended by innovations and improvements on the equipment components but the plant will surely be shutdown for one or a combination of the above situations. The participants especially the Maintenance Managers insist that the plant must have to be shutdown one time or the other for an overhaul. As one of them put it, *"You can for instance prolong the intervals by some innovations, but by and large you have to shutdown sometime to avoid catastrophic failure of the system"*.

7.6.3. Barriers of Managing TAM projects

As confirmed in chapter 6, most of the jobs done during shutdowns are very technical and in most cases require highly skilled man-power resources and special tools and equipment. The common barrier which all the case organisations acknowledged they are facing in the implementation of TAM projects is lack of adequate human resource with the relevant skills to carryout the tasks involved. In order to reduce elapsed time of an outage because of non availability of enough personnel in-house, lack of skills and sometimes lack of appropriate licence for some jobs, organisations depend on the contractors to ensure the success of TAM projects. Most of these contract organisations do not have enough and appropriate skilled personnel for the tasks in a TAM project. *"In the UK, the problem we are having is getting the right type of skilled labour, contract labour to come and do the work"*, the TAM Manager of organisation E explained.

This problem is currently affecting the entire case organisations and has resulted in some organisations looking for contractors abroad. This has its own short comings.

The TAM Manager of organisation C acknowledges communications as the major barrier facing their TAM projects. This is as a result of bringing workers from abroad during the event. According to him; "*Communications and interactions is a barrier here, the company operates in about 50 countries and move personnel about. In a site for instance there are workers from Poland, Mexico, Venezuela, and England ....etc. This implies a multi-cultural environment. There is therefore the need to think about communications and interactions. Its not on the physical thing with the person but interpretation - this implies that one can really say something that means different thing to different individuals. This is really a major barrier in our shutdown projects*".

Other barriers that can affect TAM projects include as recognised by the organisations include;

- change in employees

- change in head count
- change in knowledge.

Material delivery is yet another barrier to a successful TAM project. This problem is recognised as having direct impact on the success of a TAM project as organisation try as much as possible to reduce material stock levels. As one Maintenance manager explained:

"One of the biggest issues is the quality of labour. The other one is the delivery of parts. You have to make sure you order many months before the shutdown to make sure you get the delivery of the parts, especially specialised components, as we are under pressure to reduce our stocking levels".

In some organisations the time (duration) usually approved for the TAM projects is short. This is mainly caused as a result very high demand for their products. Timely decision making concerning shutdowns also is a major barrier to some organisations. As one of the TAM Manager explained, *"Primary barrier is timely decision making as part of business planning cycles. Senior staff wants to leave key decisions as late as possible, whilst the business needs earlier decisions, especially when trying to plan investments work".*

Cost is also identified as a problem facing the shutdown maintenance projects as organisations tend to trim down cost as much as possible.

7.6.4. Solutions to the barriers

Adequate and effective project management disciplines are recognised by the participants as ways towards solving the problems posed by the barriers and problems facing TAM projects in the UK. This implies adequate planning and using the experienced in-house personnel to supervise the contract workers. In his explanation, a TAM manager stated that; *"The strategy is now to split the work into packages and use multiple contractors working with a common service resource pool such as carnage, scaffolding, lagging, NDT and the like. This requires more management and supervision effort and expense but is more readily".*

Adequate planning and pre-outage reviews and supervision are highly recommended as a way of resolving some of these barriers. *"The most important thing is that you do enough pre-emptive discussion, pre-outage reviews, comprehensive project plans. . . . . . There are well defined area ownership, at mechanical level, at* *production level, at electrical and there is always a senior figure head to actually manage the shutdown itself., that person needs to have exposure into environmental, people management, because most of the failures is not actually in planning but in not following the plan",* explained a Shutdown Maintenance Manager.

Depending on the lead time for the material, adequate time is taken to ensure the spares are on site before starting the shutdown. *"We basically plan for three months before the shutdown, so that you can get all the parts ordered in time, getting all the labour organised. During the execution we review it to see if we could do better. I believe proper planning is the best way of resolving these barriers",* described one TAM Manager.

In order to ensure that the right skills are used during the event, one TAM Manager suggests that contractors should recruit individuals that are known from past shutdowns or those working in a similar industry with the relevant skill set. As he put, *"The contractors should as much as possible be requested to hire individuals who are known in the industry with the right skills and knowledge".*

Good communication strategies need to be put in place to ensure that the contract workers understand what is required of them during the event.

Proper timing of the project is another way of resolving the problem of having enough skills from the contractors. Experience has shown that most of the organisations carry out their TAM projects at the same time. This means that the lean resources of the contractors are shared.

7.6.5 TAM PROJECTS MANAGEMENT SUCCESS EVALUATION

According to the participants, all the case organisations evaluate the outcome of their TAM projects. The basic elements of measure commonly used are; Cost, Time, Health & safety, Environmental performance and Key stakeholder satisfaction.

At the end of the shutdown, most the case organisations carry out shutdown review meeting. During this meeting all the TAM management team members including the contractors review all the activities of the project. The purpose of these meetings is to assess the actual performance of the project against some key performance indicators. In the words of one TAM manager; *"What we do, we have a shutdown review meeting; we have what we call terms of reference, which details what we look at. So we look at learning from pre-shutdown planning, what we have done in the past, the safety, which* *is a big issue within this industry and others, logistics, any contractor issue, the organisation, planning, the execution then we look at duration vs. plan, expenditure vs. budget and the documentation, did we get it right, what needs changing and then we create logs which is what went well and make sure we capture that, any difficulties. . . . ."*.

The time for this meeting varies from organisation to the other. For organisation D, the review meeting is carried out a week after the shutdown while it is three weeks for organisation C.

Other elements of measure are the plant reliability and performance. According to the organisation D, the plant performance is measured in terms of the production volumes of the lines: *"Basically, the week following the shutdown, we measure our production lines by the daily performance and weekly as well. We also measure the plant utilization performance to know how the lines are utilized (excluding all the planned downtimes). These are measured against the performances of previous one week prior to the Shutdown"*, said the Overhaul Manager.

The criticality of the elements of measure varies from one organisation to the other. In most of the case organisations the most critical elements of success measure are:

- Time
- Cost
- Environmental performance and
- Health and safety.

The above TAM management success elements are also considered by Oliver (2001, 2002) as critical for the evaluation of TAM project success.

In organisation B however, other measures like reliability and operability are considered more critical than cost. In the words of their TAM manager; *"Reliability, operability and performance come before cost and schedule"*.

1. <u>Cost Evaluation</u>

Generally, cost in a TAM project is evaluated by comparing the budgeted cost with the actual cost of the event. TAM project is said to be successful if the actual cost is less or equal to the budgeted cost. This is the measure which the entire case organisations operate on. On the issues of emergent jobs (which is a common feature of a TAM project), Contingencies are usually built into the budget to take care of emergent jobs. In organisation D, the Overhaul manager explained that; *"I build contingency into my budget, obviously I build in say 10% for contingency to take of emergent jobs, - jobs* *that are not planned for. If the contingency is exceeded, I usually go to management for more money".*

This contingency fund varies from one organisation to the other and from one TAM project to the other depending on the level of uncertainty surrounding the job scope.

2. Time Evaluation

As in cost evaluation, the actual duration is usually compared with the budgeted time. According to the organisations, exceeding the budgeted duration is avoided as much as possible in a shutdown project. There is nothing like contingency for time to take care of emergent jobs. According to a Plant manager, *"For the purposes of time, there is usually a way of having some kind of buffer: a lead or lag time to be used to cushion duration of emergent jobs. So we can put in more resource and may even change the working times to ensure we keep to the time scale".* In organisation D however, they build in some time as contingency for commissioning and handling any job that might emerge during the shutdown event. As the Overhaul manager put it; *"In our shutdown scenario, we usually build in 2 days contingency out of 7days. Usually we use 5days to complete the jobs and use 2 days for commissioning and handling any emergent jobs that may come up".*

3. Quality Evaluation

Most of the case organisations do not really evaluate the quality of the TAM projects. Most of the measures they use are based on the functionality of the plant at the end of the shutdown. For instance according to the Overhaul manager of organisation D; *'We use the output performance to measure the quality of the shutdown projects. The product quality and the output performance are basically what we use in measuring TAM quality'.*

Others assess the quality of the project on the reliability, operability and performance of the units. The quality of the project can also be assessed on how quickly the plant will produce the right products. This is explained by a Shutdown maintenance manager; *"Now the overall success of the project will depend on how quickly the plant gets away after warming up. Does it get away without any problem? And how quickly can it get on to making good quality products'.*

High quality usually entails smooth start up of the plant.

4. Safety/Environmental Evaluation

Safety and environmental impact are critical issues in TAM projects, and hence their evaluation is quite necessary to know areas of need in subsequent TAMs. Most of the Participants agree that safety incidents, accidents statistics, near misses can be used in evaluating safety performance, while the result of environmental impact assessment can be used to evaluate the environmental impact. These evaluations are mostly carried out during daily review meetings during the event. According to a Plant manager; *"During these meetings we assess among other things the safety and environmental issues of the event. Are their safety incidents: are there injuries are there near misses and environmental issues?"*

At the end of the project an overall review of all the safety issues are evaluated. 'Zero' safety incidents are usually the target of every organisation.

5. Functionality evaluation

The functionality evaluation is a measure of the level of performance of the plant. Performance of the plant is measured in two ways, the quality of the products and the quantity of product per unit time. In plant D, functionality is evaluated by the production levels as stated by the Overhaul manager; *"Functionality of the system is evaluated on the output performance of the system. If the result of the assessment of the output performance is satisfactory, this implies that the performance of the system is also alright".*

The other case organisations however consider reliability of the system as the best element for measuring functionality. *"Maintenance functionality is all about Reliability. So whether the operation side of the business chose to operate the plant is immaterial. The most important thing is it 'Available' to run and is it 'Reliable' when it does run"*, explained one Maintenance Manager

7.6.6. PERCEPTIONS OF STAKEHOLDERS

1. Contractor

Most of the case organisations do not evaluate how the contractors perceive the outcome of a TAM project.

Some of the participants who have worked as contractors, identified profit margin and how the project has enhanced their reputation as the key elements which contractors use in evaluating a TAM project success. These and other key performance indicators are usually evaluated during the shutdown review meeting. In the words of a Shutdown manager, "*The contractors are part of the Overhaul (Shutdown) review meeting. During this review process, a total review of what job that is done and how well the job is done is evaluated. Here also an assessment is done on how they (the contractors) feel about the outcome of the shutdown*".

Contractors also evaluate their own performance in terms of completing their jobs safely and within the scheduled time frame. They use the review meetings to know how the client rates their performance.

2. Client/Top Management

The client/Top management is considered as the owner of the organisation.

The participants from the entire case organisations agree that the client/Top management evaluation of the TAM project is basically assessed during the post TAM project implementation meeting. It is clear in these entire organisations that the key element of satisfying the client is on performance of the plant throughout the plant's 'campaign' period. However they are also interested in the management success as well. A Plant Manager (Top Management team member) summarised how the Client/Top management evaluates TAM projects. In his words, the Top management uses; *'Cost, Safety performance on injuries or incidents, environmental impact and on top of that did you meet the deadline, did you meet the cost base and the reliability performance of the following running year. You are constantly monitored on the success of that shutdown on its performance through the campaign period'.*

Assessing the Shutdown maintenance throughout the campaign period did not go down well with Shutdown Maintenance Managers. "*A better way of evaluating the plant's performance is needed. Suppose the system fails due to mal-operation, or the maintenance function fails in their duties. This area should be looked into*", outlined a Shutdown Maintenance Manager.

It is therefore apparent that the evaluation should be streamlined to recognise these variables that may impart on the performance of the system during the campaign period

3. TAM Management Team

The TAM management team comprises the TAM Manager and his immediate assistants. Each member is assigned a role (depending mostly on their area of specialisation) to lead others. In most of the case organisations, the TAM management team evaluates the project by the TAM performance out turn. In addition, in organisation D, each of the

TAM management team has a set target of what to achieve before the commencement of the project. At the end of the project, what are actually done is measured against the targets. There are basically two phases when the team usually evaluates the project. These are,

- at plant start-up and
- at the end of the 'campaign' period.

One Shutdown Maintenance manager explained; *"Immediately on completion, we check, if we did not have any accidents, if it was done on time, done on cost. What we then look at is if we had a good start up. And we determine how we start up, do we need to stop again to do a major work. We also look at the campaign life as well. If you have a good shutdown, you have a very good campaign. This will be proved if you have very few stops, reduction in maintenance cost, because you will not have major maintenance work to do during the campaign. So there is an initial judgement and then there is a campaign life judgement. So if there are few problems during the campaign, then we can say we have done an excellent job".*

4. Plant Users (Operators and Maintenance team)

Generally, according to the participants from the case organisations the plant users evaluates the outcome of a TAM project by the plants' performance during the campaign period. For instance according to one TAM manager, the plant users assess the TAM outcome thus: '....... *does the plant run well, are there fewer defects, is the performance enhanced, is it lower cost to run'.*

In some organisations, the plant users use the volume of the output to evaluate the performance of the plant and hence the TAM project outcome. As one Production supervisor explained, *"When we are producing the right volumes of products, we conclude that the shutdown maintenance was successful".* Organisation C's Shutdown maintenance manager confirms that the plant users in their facility also evaluate the outcome of their TAM project by unplanned downtimes associated with the equipment. According to him, *"If they are getting a lot of stoppages (which is an indicator for us), that is jobs that are not planned. If there are a lot of impromptu stops that is affecting the reliability, this makes them feel that the last shutdown was not really successful".*

7.6.7 RESULTANT BENEFITS AT HAND OVER

The case organisations do not have an identifiable mode of assessing the benefits expected of the project at handover. Some of the participants believe that there is no defined way of assessing this. According to one TAM manager, *"At handover for commissioning the project objectives remain unknown".* Some of the participants believe that since the plant is usually handed over to the operations team (who are apparently part of the TAM team), they are in the best position to assess if the problems of the plant are solved or not. One Shutdown Manager explains: *"Throughout the shutdown we run an integrated team. The operations are an integral part of the shutdown, because if they are separated it will be really difficult to cover all the problems in the plant. Because they operate the plant they are usually in the better position to know the real problems they encounter".* Most of the TAM Managers however agree that there is need to identify and agree on some key performance indicators (KPI's) with which to use to assess or evaluate the resultant benefit expected from the project at handover. And these should be acceptable between the TAM Management and the Operations Management and of course approved by the Top Management. Some of the KPI's identified include operational performance of the system and the output performance. As one TAM Manager put it, *"Yes it is quite necessary to have some performance indicators with which to evaluate some of the key objectives of the TAM project. Elements like, the output and how the equipment are performing on start up or more generally the reliability of the system may be used".*

At the end of the TAM project, the plant is handed over to the operations and the core maintenance team to keep the plant running till the next shutdown. In the event of equipment failure (or reduced reliability) it is necessary to carry out root cause analysis to ascertain the actual cause of failure. This is necessary to confirm the real cause of failure; to know if it is due to previous shutdown maintenance or due to operational/maintenance mishaps.

7.6.8 TAM MANAGER & MANAGEMENT SKILLS

The importance of TAM management skills/knowledge and personal attributes has been identified by Duffuaa & Daya (2004), who argued that for a TAM project to be successful, the TAM manager should have adequate TAM management skills and possess the right character traits.

In the case organisations, Management skills, personal attributes or knowledge areas for projects were not used in assessment, selection or appointment of their TAM managers. Maintenance Managers have the added responsibility of the managing the shutdown maintenance projects in organisations, D, E and F. The other case organisations A, B and C have full time TAM managers. In the first group, the organisations recruit/appoint

Table 7.3 Survey Results: Personal Attributes and Management Skills required for TAM Management

Attributes, Attitude & Traits	% Score (Mean)	Management Skills	% Score (Mean)
Good Communicator	92.3	Health, Safety and Environment	94.7
Competence	92	Planning and control	93.7
Team building ability	90.2	Leadership	93.4
Enthusiasm	86.7	Motivation	92.8
Honesty	86.7	Cost Management	92.2
Determination	86.7	Budgetary Control	91.7
Ability to delegate tasks and responsibilities	85.8	Decision making	91.3
Supportive	85.4	Quality Management	91.3
Cool under pressure	84.8	Time management	91
Integrity	83	Communication/Presentation	90.8
Problem solving abilities	82	Risk Management	89.1
Interest in the job	80	Managing conflicts and crisis	89
Open minded	79.8	Control	87
Need to achieve and proactive	78.8	Forecasting	86.6
Shared vision	78.6	Technical	85.7
Patient	74.6	Management support building	84.2
Tolerance to ambiguity	72	Resource Allocation	83.6
Empathy	68	Negotiation: Contractors	83.4
		Negotiation: Inspection Agencies	83.3
		Negotiation: Govt. Agencies and Regulatory Bodies	83.3
		Human Resource Management	79.5
		Negotiation: Equipment manufacturers	79.1
		Supervision of others	78.9
		Organisation	78.2
		Administrative	74.9
		Negotiation: Suppliers and vendors	74.3
		Use of Computer	70.9
		Negotiation: Trade Unions.	66

maintenance managers based on managerial skills and competence of a good maintenance manager whereas in the second group, the appointment of TAM managers are based mainly on the management skills and competencies of a project manager.
The list of Management skills, personal attitudes & traits and Knowledge and awareness areas (see Tables 7.3 & 7.4) identified in the literatures and ranked as per the survey results were presented to the various managers in the case organisations.

Table 7.4 Survey Results: Knowledge and Awareness areas required for TAM Management

Knowledge and Awareness	% Score (Mean)
Health and safety regulations (Site safety rules)	93.7
Project Management techniques	90
Organisation of communication systems	88.8
Setting objectives and goals	87.7
Technical Knowledge	86.4
Regulatory processes	86
Contractual Knowledge	78
Tendering Strategies	70.5
Site security	70

On personal attributes, attitudes & traits, the participants in the case organisations agree that the list is very comprehensive and is very difficult to say one is more important than the other as they are all needed by a TAM manager to be successful in his duties. According to one Shutdown maintenance manager however, different balances of these attributes are required for different outages. *"Every outage is slightly different, the traits listed above would fit one outage but you may need a slightly different balance for another outage",* He explained.

All participants agree that the management skills and the knowledge areas identified are all very relevant to the success of managing a TAM project. A Plant manager however stated that the various skills and knowledge areas are required at different stages of the project. Supporting the importance and the criticality of these skills, another TAM manager emphasised that: *"A manager involved in this type of activity should possess all the skills listed and where shortfalls in individual competence are highlighted look to either develop his/her ability or seek active support for this weakness within the team. A* *manager who knows his own shortcomings is more valuable than one who knows their strengths".*

Another TAM manager emphasised that there is a short fall on the profile provided by the Project Management Institute (PMI) for project managers for managing TAM projects. This is because according to him TAM Manager in addition to possessing the skills of a project Manager must also have other skills and attributes to enable him cope with the extreme pressures associated with TAM projects. *"All are important. PMI provide a good profile of a project manager but in addition turnaround manager must be able to work under extreme pressure whilst providing clear direction"*, he explained. Though the TAM Managers in the case organisations claim that they have the above skills, attributes and knowledge, the Top Management staff of one organisation disagreed and explained that some of these skills, attitudes/traits are lacking in most TAM managers. According to one Plant Manager, *"No, in 2005 we recognised this as an organisation and have been working to address this with training and development centres to address the gap".*

7.6.9. FACTORS AFFECTING TAM PROJECTS & MANAGEMENT STRATEGIES

1. TAM Philosophy

The participants agreed with Mclay (2003) who described TAM philosophy is as a formal recognition of the impact of shutdown maintenance on the corporate business plan. They are all of the same opinion that having a TAM philosophy in place to guide the project is very necessary towards the success of TAM projects. As one participant put it, *"Having a standard procedure (philosophy) in place surely will increase the chances of shutdown success".*

Most of the participants agreed that TAM philosophy is driven by the goals of the organisation and project objectives. *"Philosophy is driven by the goals of an organisation and by the project objectives. Our culture is one of constant improvement which delivers on safety, quality, and cost"*, explained one TAM Manager. The importance of having a TAM philosophy is also recognised by most of the participants. There is need for adequate planning for the works and there is need for financial planning as well. *"Unplanned events/strategies rarely work in the professional TAR* *environment. If it ain't broken don't fix it is a thing of the past. Financial planning is tied round a TAR programme / philosophy",* explained one TAM Manager. In addition to adequate planning, the philosophy also helps in adequate management and control of the event. *'You can get by on not having any philosophy but sooner or later you will be let down, accident statistics start to rise or plans go out of control",* said a TAM Manager.

For organisation E, their TAM philosophy was developed and set up by a renowned TAM trainer and consultant. This has given their TAM projects direction and improvements.

Despite the importance of a TAM philosophy, some of the case organisations have not developed one. Case organisation D for instance does not have a philosophy in place for their shutdowns. According to their Overhaul Manager; *"We have an asset care system in place, but the system is not so robust. What we have currently is for short term maintenance programmes, like for one week and one month. We are at the moment trying to develop a system to take care of the longer term shutdowns like the annual overhauls'.*

Also organisation F is trying to develop a philosophy for their turnarounds. According to their Shutdown Manager; "We *have been doing this shutdown maintenance every year but nobody (including the Top Management) has come up with an exact strategy to follow. But recently however a new strategy is being put in place where one senior management staff is to be responsible of the overall shutdown in all the facilities. This may help in developing a long term philosophy for shutdown projects".*

The participants concur that some of the basic elements of a good TAM philosophy is planning (long range planning), communication and the leadership structure. As one Plant Manager explained, *"The key elements for me is you will be able to communicate what you want to achieve, not necessarily how to achieve it but what the business needs you to achieve, what cost you need to achieve it".* The TAM Managers emphasised that forward planning, pre-shutdown meetings, shutdown review meetings, communications methods the soft wares to be used in managing TAM projects should all be part of a good TAM philosophy. As one Shutdown Manager put it, *". . . forward planning, Pre TAM meetings, Microsoft Project in conjunction with Maximo, Communication, knowledge and leadership should all be included in the philosophy'.*

The Shutdown Managers also want their views to be sought for while developing the philosophy. From their past experiences, they insist they are in a better position to know what should constitute the philosophy. One of the key issues should be sticking to the time frame of the shutdown. Most often because of pressures from sales department, the event's timing is changed. This according to the Shutdown managers affects the success of the event. One Shutdown manager describes how a TAM philosophy should be developed, *"I believe in my opinion, we should have a yearly shutdown, if we got it right; it will really help in the operations during the subsequent year. The senior management team should take our view because we being on ground knows the issues we face. Simply put the strategy should be based on 'have a maintenance strategy, buy into it and stick to it'. This means that fixing the timings of shutdown, and allowing the shutdown to be carried out irrespective of the pressures from customers. This I believe should be embedded in the philosophy".*

2. Top Management Support

The participants acknowledged that the support of the Top management is very paramount to the successful implementation of a TAM project. According to Motylenski (2003), the Top management provides the underlying guidance and support needed by the organisation to ensure a successful and effective TAM. All the participants from the case organisations agree that the Top management support is needed in the following areas:

- Provision of adequate time and agreeing and upholding a starting date.
- Provision of adequate fund.
- Provision of clear objectives

In his explanation, the Shutdown Maintenance Manager of organisation C stated; *"Agreeing to the time line, agreeing to the start date. There is nothing worse than after planning the shutdown for a whole year, and have planned to bring on all your resources, spare parts; bring in all that are required to bring in place, the mechanicals, electricals, instrumentations, and all of a sudden the company decides to defer the shutdown (due to sales pressure) or start it earlier or whatever. This is the worst kind of situation going into a shutdown".*

In addition, the Top management should also intervene on issues regarding the Sales department and stick to the agreed timings, this according to one Shutdown Manager will reduce excessive pressure on the TAM project itself. As he put it, *"I expect an overall management support. If we get an overall time slot for the shutdown, I expect the management to back us up. The management should also intervene in situations on sales, so that there is no excessive pressure on the repair works".*

On scope changes due to emergent jobs, the Top management are also expected to support the project by timely approval of the changes. Unlike most of the other case organisations, organisation B has a defined management system to handle additional work - changes in the work list or emergent jobs. According to their TAM manager, *"An additional work procedure exists for changes to the work list before a shutdown and an emergent work order procedure is used during an event. Both procedures require approval sign off prior to any change".*

In the other case organisations however, the problems of emergent jobs are resolved during daily TAM review meetings. During these meetings, the TAM manager need to explain to the Top management the emergent scope along with the resources required. In all the cases, the Top management are expected to support the project by approving these jobs and all the resources required needed to complete them. As one Shutdown Manager put it, *"They are also expected to make extra fund available in case of emergent jobs which if not done will impart on plant availability/reliability".*

The importance of Top management support in a TAM project has been expressed by Haber, *et al.* (1992), who identified critical Top management functions to include decision-making for prioritization of goals, oversight through presence, clearly defining roles and responsibilities, allocating resources, including financial and personnel, provisions for proactive outage scheduling and planning and developing a mechanism for organisational learning.

3. Goals and Objectives

For a successful Turnaround project the participants from the case organisations agree that there is need for the organisation to have a clear and measurable goals and objectives for their TAM projects. Generally, the goals and objectives should be in line with the corporate business plans. As one Shutdown Manager put it, *"Goals and objectives should be in line with the business. They should be clear".* Some of the case organisations developed guidelines for setting the goals and objectives of their TAM projects. Organisation A for instance has a Programme Registry Document (PRD) developed by the Top management to guide the project. According to the Programme manager, this document should;

- *"Set clear smart targets.*
- *Be specific, realistic and measurable.*
- *Be agreed by the Top management and the TAM management.*
- *Set a timeline to achieve".*

It is very important to set a realist target for the shutdown which is acceptable by both the Top management and the TAM management.

These are also explained by one Plant manager; *"Yes, it has to be measurable for our company; because we do our shutdowns here we are 60% of our UK operations in output so consequently not only we are assessed in UK performance but at the regional level (European Region). So we are constantly viewed by every person in the organisation. Our goals are clearly given to us and very well stated".*

4. <u>TAM Manager Selection</u>

The personal attributes, attitudes and traits as well as management skills and knowledge areas required by a TAM manager to be able to manage TAM successfully has been dealt with earlier.

In the selection or appointment of TAM managers, the organisations have different approaches. For organisation B, the TAM manager is a permanent position and manages TAM projects only. In the case of organisation A, the Programme manager manages the TAM project as well as other areas. In some other case organisations, the Maintenance manager assumes the responsibility of the TAM manager. The Shutdown Managers do not support the idea of appointing a TAM manager from outside (or using a contractor) to manage the event insisting that the contractors' interest is only to deliver the project based on management success alone. Further they explained that in addition, an in-house manager considers the resultant benefits of the event especially the impact throughout the campaign life. As the Plant manager of organisation C put it; *"In-house TAM manager is preferable, for the simple reason that you can respond to changes more quickly, You can respond to knowledge base very, very quickly, but also you have more responsibility because the sense of ownership it generates is because you are here for the rest of the year (the campaign period), the success or not you can make out the situation. If you hire a Shutdown Management (of course you can) they will be looking for that period of time, they have got no responsibility after that they only have responsibility as a contractor".*

Also since the success of the TAM project depends to a large extent to the skills and knowledge base of the organisational in-house personnel, the in-house manager knows the capabilities of the in-house personnel. It is only therefore an in-house manager that will know 'who' to use 'where' during the outage. In the words of one TAM Manager, *"From communication point of view and knowing what skills and knowledge that on ground, a person that works for the business is better option in selecting the TAM* *manager. That will enable him/her to know the right people for particular jobs. Using an external person may work but in my opinion for shutdown maintenance project success is better to use a head from in-house".*

5. Organisation/Organisational Structure

There is a general consensus that the organisation/organisational structure used for a TAM project affects its outcome. Brown (2004) emphasised that any existing organisational structure devised for the day to day activity in a company is wholly inadequate for the coordinated activity required during a shutdown. All the case organisations agree that a separate organisational structure is required for shutdowns. According to one Shutdown Manager, "*It is imperative to have an organisation chart to show who does what, together with a contacts list".*

It is agreed that adequate structure is needed to ensure minimal duplication of functions and also helps in controlling the management and supervision of the works during the event. In the words of a TAM manager, "*Without a structure control is lost. Turnarounds are not the places for transformational structures".*

Most of the participants agree that a cross functional structure is needed during the shutdown, involving workers from all the departments. This implies an organisational structure cutting across the different departments working under different heads. "*Having a structure is paramount; but having a structure where everybody knows what the actual boundaries are, what their requirements are because in that way you are actually putting them back into the actual shutdown",* explained one Plant Manager.

i) *Improvements in Organisation/ organisational structure*

On the areas of improvements, organisation D is looking at having a structure to have the TAM management team carry out review meetings even after the current shutdown. According to the Overhaul manager of organisation D, "*I will like to have more time with the unit heads; this will enable me to analyse properly what they are doing in that particular shutdown. I will like to review with them the jobs that are done and those that are to be done in the next shutdown. This feedback will help in developing a long term strategy to maintain the equipment; for instance knowing what is to be changed and when up to a 6-year period. These are the kind of organisational improvements we are currently looking at. But usually after the shutdown they are back again to their day to day activities'.*

One Shutdown manager explained that individuals in the structure should be charged with defined responsibilities and timeline to deliver. This is because most of the time according to him, *"Individuals need to recognise the need to reach timely decisions when dealing with project preparations. Often they adopt a tomorrow will do attitude which often catches them out as the project deadlines near closer".*

Top management need to support the structure for it to be effective. As a result of changes in leadership, there may be elements of disloyalty. According to a Shutdown Maintenance manager; *"The top management need to contribute towards making the structure work effectively. People need to know that they have to be loyal to their interim leaders during the shutdown".* As with other organisational structures, there is also need to define boundaries according to a TAM manager.

6. TAM Management Team

A management team to manage the TAM project need to be constituted for the project to be successful. It is generally agreed especially among the Shutdown Managers that the team should comprise members from various departments of the organisation. One Shutdown manager explained the need for a TAM team; *"We constitute a management team for TAM projects. We do this to meet our overall business objectives. If you appoint the people too low in the organisation, they are usually task driven. They are usually focused on the job that they are doing or the small area they are working in if you like. They are not looking at the bigger picture; they are not looking at the business impact".*

Duffuaa & Daya (2004); Gupta, *et al.* (1997) and Oliver (2001) suggested that for a TAM to be successful, a competent and motivated people should be selected with great care to forge the strongest organisation for controlling the event.

In most of the case organisations the skills of the individuals are considered before appointing them members of the team. In organisation A, however, the individuals are appointed based on their organisational function and not specifically based on their skills. The Shutdown manager of organisation C stated that technical and people skills are the main basic skills to be considered in selecting the TAM management team, *"In appointing the management team we consider not only their technical skills but also their people skills. Some people are better in leading a team - a large team; some are not confident in speaking out but are technically highly, highly talented".* Although there is wide resentment among some Shutdown managers on including contractors in the management team, but depending on the tasks involved and the size of the outage the contractors should be members. Explaining this one Shutdown Manager stated that, *"Because existing workforce is insufficient to handle shutdown work and contractors have skills not embedded within core teams, some of them can be assigned to manage some tasks/workers during the event as contract managers".*

7. <u>Project Plans/Schedules</u>

Planning has been identified as one of the most critical factors affecting TAM project outcome (Edwards, 1998; Duffuaa & Daya, 2004; Mclay, 2003).

Planning in a shutdown projects involves many different issues, such as coordination of available resources, scheduling, safety concerns, and regulatory and technical requirements for all activities and work undertaken before and during the outage. It is widely supported that planning is the key to a successful implementation of a TAM project. Most of work scopes are based on anticipation. These are because in continuous running plant one can only but anticipate the actual state of most of the equipment based on results of running inspections. One Shutdown maintenance manager explained; *"The actual planning process is based around you pre-inspection; how many on-run inspections can you have, how much you are getting from oil analysis, how much you are getting from you material thickness, how much you are getting from your thermo-graphic camera checks. We do full blown vibration analysis. All these are giving the picture of the jobs (anticipated jobs) for the shutdown".*

Apart from planning for anticipated jobs based on equipment component history and running inspections reports, the participants also agree that the evaluation report of previous TAM projects on component condition of equipment is also critical in ascertaining the scope of work to be done in the current TAM.

Some case organisations do not have any plan for emergent jobs. Organisations A and B however have plans in place based on risk assessment. According to TAM manager of organisation B; *"Emergent jobs can be planned statistically from previous events (Shutdowns and Engineering Work Order Records) and by risk assessment of any unknowns / new work".*

During the planning, it is advisable to plan for the worse case scenario; this will reduce the cases of emergent jobs. Explaining this, the Programme manager of organisation A said; *'The best situation is to build contingency in plans and budgets, plan for a worse case as far as is practical, and then manage the changes'.*

In order to avoid conflicts which can cause project time overruns, the TAM project plan should integrate all the activities (maintenance, inspection and project jobs) during the event (Oliver, 2001, 2002). The TAM manager of one of the case organisations explained that, *"Plans are integrated to avoid interface issues and conflicts, such as safety conflicts or time constraints".*

Whereas some organisations have an integrated plans others are still running maintenance jobs separate from project jobs. Organisations A, B and C have integrated plans for their TAM projects with the TAM manager fully in-charge of all the activities in the TAM project. According to organisation B's TAM manager; *"Our TAM plan is fully integrated and the key project personnel work within the TAM Group".*

Organisations D, E and F are yet to develop full integrated plans for their shutdowns and this has been affecting the operations of their TAM projects. According to Overhaul manager of organisation D; *"We do replace worn out parts mainly during the shutdown, but our engineering department are responsible for all engineering projects; like installation of new machines - capital projects. These don't come under my jobs but they use that time. We need to work together to achieve each other's success. At the main time we don't have an integrated plan for the maintenance and projects jobs".* Also complaining the Shutdown Manager of organisation E explained, *"Most of the problems we encounter in our shutdowns come from outside influence. We need the jobs of the shutdown and engineering to be integrated to ensure a more smooth process and more of alignment of objectives".*

i) *Planning & Scheduling Using Computer softwares*

The case organisations recognize the importance of the use of computer in the management of TAM projects. Currently most of them are using one software for maintenance related jobs and another for planning. Microsoft projects and Primavera P3e and even Excel are commonly used for planning purposes. For maintenance, softwares such as Maximo and SAP are commonly used. According to one Shutdown Maintenance manager; *"We use SAP - that is our maintenance software but we use Microsoft Project for our project purely for the Gantt chart. The finance, the resources and all the work orders are all in SAP".*

Though Organisation D is using Maximo for their maintenance, Excel is used for shutdown planning and this is time consuming according to their Overhaul manager, *"We have Maximo for generating our weekly work others but not for the annual shutdowns. We can integrate Maximo into our plans. I use Excel for all my planning:*

resource, cost etc. This however is very time consuming". The need for adequate software to manage Shutdowns specifically will help towards a successful TAM especially when planning for emergent works.

8. Communication/Communication Management

Effective communication is critical for the successful implementation of TAM projects (Lenahan, 1999; Edwards, 1998; Levitt, 2004; IAEA, 2002, 2006)

The participants have the same opinion that inadequate communication causes delay and safety incidents. For a successful TAM project, organisations are required to put adequate efforts towards ensuring that effective communication is in place, before and during the event. This is necessary so that the project participants will understand the goals and objectives of the project and how these can be realised. According to one Shutdown Maintenance manager, *"Effective communication is needed so that people will understand what the objective is and how to achieve it".*

Various modes of communication have been identified by the organisations as being effective. These includes: meetings, reports, worklists, plans, stakeholder meetings, face to face handovers, video inductions and even radios and mobile phones.

To be effective the case organisations concur with Haber, *et al.* (1992) that there are basically three levels of communication:

a. Pre-shutdown
b. Shutdown
c. External

i). *Pre-shutdown communication*;

Pre-shutdown meetings are very necessary to all the stakeholders to the event. These meetings involve the TAM Management with TAM project participants (the in-house workers and the contractors' representatives) on one hand and the Top management team on the other. According to one Shutdown manager, *"During these meetings, the project participants are informed of the goals and objectives of the project and how their contribution can lead to its successful completion".* The TAM project participants are also informed of the working patterns and the expected date of completion of the project. This is also the right time to inform the participants of incentives (if any) to motivate them during the event.

A meeting between the TAM management team with the Top management is also necessary at this stage. According to one Overhaul Manager; *"The Top management are* *required at this stage to explain to the TAM management on what are expected of them, delivering the project on time, cost, safely and with no environmental impact".* Bonus packages (if any) are promised at this stage to the team if project is deemed successful.

The other pre-shutdown communication that is very fundamental is induction of the contractors' workers. Most of the contract workers are new to the plant and therefore need to be given adequate orientation. These inductions are to familiarize them on the plant and the activities of the shutdown. They are also given an overview of safety issues related to their jobs. Induction is also used to resolve the problem apparent with communication problems due to language differentials. According to organisation E's Shutdown manager;

"Our induction pack is now being translated to various languages; Polish, Portuguese, Italian, Spanish and even German languages, so that each worker from the contractors will understand our safety policies and the shutdown work arrangements"

Most of the case organisations are facing the same problem of language among the contractors' workers as most contractors seek for cheaper labour abroad.

ii) *Shutdown Communication*

During the shutdown proper, effective and adequate communication is very vital. Most case organisations hold shutdown review meetings to review and track the activities of the event. Some of the case organisations hold only review meetings once a day, but case C, hold meetings twice a day as explained by the Plant manager; *"During the shutdown we run with the steering group. We usually hold meetings twice a day during the shutdown (09:00 Senior managers meeting & 16:00 Area managers meeting) so that everybody can see how the shutdown is progressing and make input on the way forward".*

The case organisations agree that it also very crucial to involve the contractor in these meetings and having the supervisors (TAM management team heads) of each unit get the relevant information to their various workers.

iii) *External communications*:

It is also very necessary to keep the Regulatory bodies and inspectors informed about the progress of activities related to their area. This is supported by the case organisations. These external agencies need to be adequately informed about the timings and schedule of work involving them to avoid delays.

iv). *Improvements in Communications Management*

One of the areas of improvement of communication management is to prepare work permits directly from the plan. As indicated by the TAM manager of organisation B; '*Permits written in advance directly from the plan are being considered*'. This will reduce delays.

9. Contract Strategy/Management

All the case organisations use contractors in their TAM projects as the use of contractors is unavoidable in TAM projects (Lenahan, 1999; Levitt, 2004; Brown, 2004). The strategy adopted depends on the type of job; and this affects the TAM project outcome. Various reasons are given on why contractors are involved in a TAM project. One of the key reasons as recognised by the Shutdown Managers is insufficiency in the skills or resources to complete the tasks. According to the Programme manager of organisation A;

"Yes we use contractors because we do not have sufficient skills or resource to complete all of the shutdown work required in a cost effective time frame and contractors have skills not embedded within core teams".

Next is specialist knowledge. The participants also recognise that some of the tasks associated with TAM require specialist knowledge which is unavailable within the in-house core team. The organisation therefore depends on the skills and specialist knowledge of the contractors towards the successful completion of these tasks. Explaining, the Plant manager of organisation C stated; *"We use contractors primarily for resource levelling and to work on our specialist tasks. We don't normally do for instance electronic drives. We have electricians on site but some of these jobs are so technical, considering the skills though we bring specialists like . . . . . for these electronic jobs. So there are specific services that are done by contractors"*. It is apparent therefore that contractors are key part of any shutdown maintenance project.

i) *Types of contract*

The contract strategy adopted varies from one organisation to the other and according to the nature of tasks involved. Organisation C for instance operates on fixed-priced contract (with no bonus) while organisation B is on cost-reimbursement contract (with gain & pain on KPI's). Other case organisations have different strategies for different type of tasks. In organisation A, competitive tendering for work packages and working in alliance with some specialists in the industry forms the core of their strategy.

Combination of different strategies is also adopted by organisation E as explained by their Shutdown maintenance manager;

"We do a combination, on the scaffolding for instance, we do an hourly rate because we found that is more cost effective; with regard to cleaning, if we can determine the extent of the job, we can take the contractor round, we can tell the contractor look this area needs cleaning, ...we can get a price. If it is general cleaning we do that on hourly rate. With regards to electrical if it is like changing a transformer, we go out for a price, and if it is things like maintenance we go on hourly rate. With mechanical side again if it is something that we can define the scope of work, we go on a price, if it is supplementing our people and doing things that are difficult to price, then we will go for hourly rate. So we do a combination". The strategy chosen has its own advantages and disadvantages and organisations need to assess the strategy to be adopted properly against the work package.

ii). *Contractor selection*

The TAM Managers widely agree that one of the problems facing the organisations is in contractors' selection. *"A wrong choice of a contractor can cause time overruns which needs to be avoided in this type of project"*, stated one TAM Manager. The selected contractors should complete their tasks safely and on time too. There are various criteria to be considered in choosing a contractor. More generally, according to one Shutdown Manager, the following need to be considered:

- *"Cost*
- *Competency in carrying out the tasks*
- *Contractors Reputation and*
- *Safety record of their past works".*

The type of work to be done, the labour available to the contractor and the track record of the contractor can also influence the choice of a contractor to be hired. As one Shutdown Manager put it'. *"Track record, type of work, labour availability, manager nomination and cost should be considered during the contractor selection".*

The technical competence and attributes of the individuals in the contractors' team should also be put into consideration while selecting a contractor. One Plant manager explains; *"Basically and predominantly the technical attributes of the individuals. Industrial knowledge, the technical knowledge of the individuals in the contractors' team, the right technical qualification (are they allowed to do what they do) and can they physically do it, mechanical or electrical. I wouldn't want a mechanical fitting* *work to be done by a painter or decorator. The core attribute for a particular job is what is required'.*

In addition to skills & competence in specific equipment, cost and timely delivery of tasks should also be well thought-out in selecting a contractor. Organisation E also considers previous health and safety performance of a contractor in selecting a contractor for their TAM projects. "*Ability to carry out the tasks; First thing we look at is the Health and Safety side, so our Health and Safety Adviser will talk to their Director or Manager and tell him what we expected. We are looking at the standard of work they have done previously, the capability to do the work so that, we know that certain contractors are good in certain tasks, some may be good at fans and some may be good at fabrication, fitting type work etc .. So we choose on price as well, we have to look at the cost and the time scale and previous safety performance*", explained Organisation E's Shutdown Manager.

In practice however, the organisation recognises that they do not really have much choice as there are limited number of competent contractors having workers with relevant skills to choose from. Organisation D contracts out most of their technical jobs to the equipment manufacturers as they base their selection on competence and skill. All the other contractors needed for cleaning or extra resource; cost, competence and skill are considered for the selection of such contractors.

iii) *Improvements in Contract Management*

Though many of the case organisations believed that their current strategies are good enough, organisation C through their Plant manager believes that the best contract strategy is to use contract labour and use the organisational skill and knowledge base to execute the shutdown. He explains that ownership is lost when tasks are handled wholly by the contractors. In his words "*I personally believe the best way to use contractors is on labour, because you have ownership, you got continuity and you have got the skill base is already there. Unfortunately, our business in a position that they are taking down the head count to reduce cost at the bottom line. This makes a situation where you contract out more and more jobs. And ultimately, in some organisation had to contract all the jobs. This is not good for the success of the event. Under this situation, you loose ownership, you loose direction*".

For multinational and world class organisations operating in several locations, specialists can be developed within the system and moved around the plants for their shutdowns.

"In our current organisation, being a multinational, we have specialists and any specialist that is required can always be flown in from other plant locations", one Shutdown Maintenance Manager explained.

10. <u>Human Resource Management</u>

According to Lenahan (1999, 2006) a successful TAM depends on the personnel assembled to manage it and those to carry out the actual tasks, this is widely agreed among the participants from the case organisations that. The issues relating to TAM manager and management team has been addressed earlier. From the views of the participants, the skills, competence and qualifications of in-house technical crew within the organisation for TAM project are known, the major concern are those of the contractors and contract staff.

i) *Personnel assessment.*

Basically, the case organisations assess the contractors' personnel through varying method. Organisations E and F have a more proactive approach towards resolving this. They send a document (questionnaire) to the contracting organisations explaining the skills, competencies and qualifications (certifications) required for the TAM project. For case F according to their Maintenance manager,

"Our Contractor Documents require contractors to forward all skill, training, and mobile plant licence of their personnel". In most jobs however organisation E never depends on the contractors' information as they use in-house personnel to supervise the contractors. The Shutdown manager explains, *"We send out questionnaires (like a checklist) to the contracting companies; this comprises of issues like qualifications and experiences. This we never relied on so much since we have our personnel supervising the area. If we have some specialist job like welding however, we ask for the qualifications of the welders (we ask for their papers)"*.

Generally however the participants supported that the contractors workers should be assessed on individual bases through, training data bases, skills, training certificates and operating licences for specific equipment. Organisation E also uses accredited companies in their assessment as explained by their outage manager; *"We assess our TAM workers through training databases, competency testing, use of accredited companies with proven track records and known history for delivering projects"*.

ii). *Team building*

The entire participants concur that TAM team (management and workers) represents all areas of responsibility in the organisation: administration, operations, engineering, and maintenance; health, safety, and environment (HSE); quality assurance (QA); procurement, planning, and scheduling; and turnaround supervision and the contractors' workers. For the TAM project to be a success, it is necessary to build and maintain a cohesive TAM team. Break down of team spirit is devastating to the success of a TAM project. According to one TAM manager; *"If the TAM is going well team spirit is high. This often breaks down when blame starts to be apportioned no matter how hard you try to stop it".*

In recognition of this, another Shutdown Manager stated; *"We make use of various team building techniques and proactively managing relationships to avoid key staff or groups of staff adversely affecting the outcome of projects".*

Effective communication of the goals and objective of the TAM project together with the roles and responsibilities of each individual clearly defined helps in building an effective team. The Overhaul manager of organisation D explains how he builds team spirit; *"Initially I pull them all together as a group, basically explain to them what we want to do, the objectives of the shutdown - the objectives is of course what we are going to do to keep the plant running for 12months. We go through the roles and responsibilities of each one them. Informing them that the entire job is not my role (responsibility) but it is our role. Try and build that team spirit in them, tell them I am always there to support. They all know their individual role knowing that each has a stake in the company. So it is not difficult to motivate them. It's all about managing people really".*

iii) *Work Patterns*

The case organisations have varying work patterns in place for their TAM projects. During the TAM project, while organisations C and D do two 12-hour shift work pattern everyday throughout the duration of the event on critical path jobs alone, all other jobs are on 8-hour and 10-hour shift for organisation C and D respectively. Organisation F however uses 2 12-hour shift patterns in all the jobs. In his explanation, the Plant Manager of C stated; *"We run 12-hour shift system but it depends. We don't run the whole shutdown on 24/7. Where ever we put the plan the critical path determines the duration, so we know we have to do X, Y and Z on the critical path that is 24/7. Everything else has to fit around it. Like you have lead time or you got lag time,*

these tasks can be done with an 8-hour shift day arrangement, because you have got plenty of float". Organisation D does only 12-hour day shifts only and A does only day patterns within the constraints of the working time regulations. This working arrangement however is affecting the outage duration adversely. In the words of the Programme Manager of organisation A; *"We try as far as possible to work a day based pattern, within the constraints of the working time directive, which is proving more and more difficult to comply with as outage durations extend beyond what might be considered as reasonable. (Circa: 18 weeks$^+$)"*. Organisation B considers 12-hour shift is expensive and not very productive. It operates a two 10-hour shift with a break to carry out non destructive tests (NDT). TAM manager explains of organisation B;
'Two 10 hour shifts with a break for NDT covering 12 days on 2 days off is the preferred shift pattern. 12 hour shifts are expensive and less productive'.

iv) *Motivational schemes.*

All the case organisations do not have defined motivational schemes for the TAM management team and the workers. Some of the case organisations however believe that extra hours approved for the workers during the event increases their take home pay and may be a good incentive. In organisation E for instance an additional hours called 'loo' time is usually approved for the workers after the TAM project. Organisation C recognise that majority of people are motivated by financial reward and insist that most of them are getting enhanced pay during the event through extra hours and supervisory roles and that should be enough motivation. In the words of the C's Plant manager, *"90% of the people are motivated by financial reward; they are being paid for the job they are doing anyway. Most of the workers that do 8-hour per day do 12-hour shift per day during shutdown. Some are even given supervisory role to supervise and manage contractors, this gives them extra pay. Some people are however not motivated by money".*

Organisation B operates a pain & gain contract for contactors but do not have any motivational scheme for any of the workers.

Organisation D believes that getting the workers to work in their areas motivates them as they realise that the more successful the event is the better the plant will run during the next campaign period. According to the Overhaul manager;
'There is no real motivation in place for anybody to do it. Basically the only motivation that I can say that is in place is getting the people who work those areas to carry out the repair jobs. They know the root cause of the problems that are to be repaired. They

also know that if the job is right, they will have a smooth run during the campaign. They best motivation is using the people to work in their areas'.

The supervisors believe that any motivational scheme will definitely improve the workers morale during the TAM event. The incentive may not be necessarily money; any other thing can be put in place as extra remuneration to the workers. As one maintenance supervisor put it, *"I believe the workers will perform better if an extra incentive other than additional hours is in place"*.

For the contractors' workers, organisation A recognises that their various companies offer them different kinds of incentives to get them to deliver their targets on time and safely.

11. Scope/Scope management

All the case organisations acknowledge that one of the special features of TAM project is the fluctuation of the scope of work. Ertl (2005); Levitt (2004) & Lenahan (1999) identified that a large proportion of the work scope is not usually known until right up to the beginning of the project. Some of the case organisations have an established procedure to check and manage emergent scope in shutdown maintenance. One of the ways identified is to establish risks logs for major equipment components to track and monitor their condition. These help in estimating the actual condition of the equipment and hence reduce surprises. Having change management processes in place can also help in managing changes associated to emergent jobs. According to one Shutdown Manager, *"Planning freeze dates are employed and change management processes employed to try to control the changes and the impacts. Risk logs are established for major parts of the project to ensure that emergent work is properly controlled and assessed"*.

Establishing additional work procedure can also enhance the management of emergent work more efficiently. Though this may require an approval before the change but the procedure reduces the time frame to approve the emergent job. As one Shutdown Manager put it, *"An additional work procedure exists for changes to the work list before a shutdown and an emergent work order procedure is used during an event. Both procedures require approval sign off prior to any change"*.

Another method that can be used in reducing the emergent jobs is by carrying out a thorough equipment inspection at the beginning of the shutdown. Based on the reports of running inspections, some critical equipment may be subjected to this process. The first two days should be dedicated to this. This enables the Team to know the actual conditions of the components of these 'suspect equipment' compared to the anticipated scope. The exact jobs are then planned for and approval given. Subsequently, the level of emergent jobs is reduced to the barest minimum. This is explained by one Shutdown manager; "You *plan your scope, you know what you are intending to do, the question is does it turn into reality? Seldom, but the important thing is at the first 2 operating days, you need to have people dedicated to the equipment to find out if there are any surprises. That means by day 2, you should know all your surprises. This is purely inspection of the equipment to know their exact condition compared to what are being expected. This minimises the level of emergent jobs".*

Most of the case organisations do not have an established scope verification or validation procedure. Organisation C however has a well defined way of identifying most of the scope for the shutdown. Pre-shutdown meetings are usually organised and various heads of department use these forum to assess the scope of work they are to embark on using information from these sources:

- Equipment maintenance history
- On-run Inspections
- Oil analysis results
- Material thickness results
- Vibration analyses results
- Thermo-graphic camera checks, etc.

Through these sources a comprehensive anticipated scope of work is developed for the TAM project. According to the Shutdown manager of C; *"We bring the people together; mechanical, electrical, production and our history (maintenance history) from our computerized maintenance management system, the history will be used for instance that particular piece has been in that equipment for five years, it needs replacing. That particular piece needs to be changed every 5years.We always or try to take maintenance to the age especially cost wise with the current economic situation. But the actual planning process is based around your pre-inspection; How many on-run inspections can you have, how much you are getting from oil analysis, how much you are getting from you material thickness, how much you are getting from your thermo-graphic camera checks. We do full grown vibration analysis. All these are giving the picture of the jobs (anticipated jobs) for the shutdown".*

In order to control the scope of work and to ensure that only shutdown specific scope is included; Lenahan (1999) and Motylenski (2003) argued that all scope items should be verified and validated. Verification and validation can be carried out by insisting that the originator and production department endorse the work package. This is then sent to the TAM manager for final approval. According to a TAM manager; "*Buy signature from originator and production on work pack prior to work list final approval*".

The TAM Managers however agreed that the scope of work need to be verified and validated to ensure that the jobs need to be done and can only be done on plant shutdown.

i) *Maintenance management approach*

The participants in the case organisations recognise that the maintenance approach adopted by the organisation for plant affects the level of scope changes during TAM projects. Most of the organisations operate preventive maintenance, using inspections and condition monitoring of critical equipments. Even reports of equipment condition during the previous TAM project are quite important as these help in estimating anticipated scope for the shutdown. "*It is easy to 'do it in the shutdown' is symptomatic of difficult maintenance. Difficult maintenance normally results in additional work as it has not been assessed correctly. Lack of inspections, poor maintenance strategies and inadequate records of previous shutdowns can lead to an increase in man hours*", explained one Shutdown Manager

Adequate equipment historical records also assist in reducing emergent scope. According to one maintenance manager; "*We use inspections and we use condition monitoring; and those are the drivers for the major work, because, you know what you are doing; you can get all the parts. If the bits you cannot inspect, then you go on historical records*". The maintenance strategy used for the plant plays a significant role is assessing the jobs to be carried out during the shutdown maintenance event.

12. <u>Health, Safety and Environment</u>

No facility safety incidents and environmental impact has been identified as measures of TAM project success (Motylesnki, 2003; Levitt, 2004)

'Zero' safety targets and no environmental impact is agreed among the entire case organisation as a must towards a successful TAM project. Most of them also have well established Health, Safety and Environmental departments headed by experienced personnels. Induction of all contract workers is usually carried out to ensure they understand all the health, safety and environment issues concerning the outage. The induction should contain information on the following areas:

- Work permits for all jobs
- Use Personal protective equipment
- Adherence to safe modes of carrying out tasks.
- Chemical handling
- Pollution control methods, etc.

In organisation D, according to the Overhaul manager;

"We have permit to works system. We have a rigorous safety approaches. As the guy in charge at every shift change I usually hold safety briefs for the people concerned, ensuring that everyone is wearing PPE. During the day we do have tours of the plant ensuring that safety is observed and all jobs are carried out in clean environment".

To avoid environmental pollution, organisation E has put in place various strategies towards ensuring no environmental impact during a shutdown project. According to the Shutdown manager;

'We have cleaners on site. What we say is if anybody is working outside, there are the possibility of the components they are working on has some dust in them. First the operation will clean them as much as they can as part of the shutdown procedure, is to clean everything they have. After that we would have a cleaning people in each area with vacuum, so that we can vacuum things like ducts out as much as we can so that we don't have environmental impact on the area. Part of that induction is also an environmental induction to say if people, we tell about noise, the list of chemicals etc to the water course as most of our wastes goes straight to the local river. We tell them about working in high levels, and making sure they don't take dust. Being aware of spills, control sites are and what to do in event of an environmental emergency. They have like a card to call for emergencies'.

To ensure safety and no environmental impact, organisation B uses very crude methods to implement their safety and environmental guidelines. Quoting the organisation B's TAM manager; *"We manage our HSE through targets and threats followed by expulsion".*

i) *Improvements*

To achieve the target of 'zero' accident, everybody in the outage must have the culture and be fully involved. This is explained by the Programme manager of organisation A;

"Health, Safety and Environment targets can be achieved through collaboration and involvement at all levels, only when everybody shares the Zero Accident vision can we consider we are near the holy grail of good outage performance". For the safety target to be attained all must be involved, the Safety Managers can advise and guide but safety actually is everybody's responsibility.

13. <u>Quality Management</u>

As identified in the literature (Lenahan, 1999, 2006; Ertl, 2005) and also agreed by the participants from the case organisations, poor quality work has been identified as one of the causes of outage extensions and hence TAM project failures. It is widely agreed among the participants that the quality of work depends to a large extent to the quality of material used and ability/skill of the worker to perform the task. The attitude of the worker and the skills/knowledge of the supervisor can also affect the quality of the job done.

There is a general consensus among organisations in the use of very rigid inspection and completion procedures to ensure that the jobs are done to the required standard though there are variations from one organisation to another. When using contract labour to supplement the in-house workers, organisation C, assigns an in-house supervisor to monitor and direct the contract workers. According to the Shutdown manager of organisation C, *"If we are using contract labour, then we are use our man as supervisor, for the duration of the shutdown. And they are monitoring the actual work, what is to be done within the task of the equipment, and in additions to that they then take responsibility because they are here for the rest of the campaign period, so if the equipment fails or becomes unreliable, we know where to go to. So well what did we do during the shutdown why did we do that?"*

Using in-house personnel, organisation D ensures sign-offs from the person in charge of the job. Generally, according to the overhaul manager to ensure the quality of the jobs, the right person with the skill should be assigned. In his words; *'For critical tasks we have sign offs. When a job is done the person in charge of the job signs it that the job has been done as per the requirements. In other areas, is all about using the right skills for the right jobs. The people try to (as much as possible for personal integrity) make sure that the jobs are correctly done'.*

Organisation A uses third party inspectors in addition to their in-house inspection team and the quality assurance of the contractors to ensure the jobs are carried out to a good quality standard. For quality control and assurance, Organisation A builds hold points and milestones to all jobs, according to the Programme manager; *"We manage the quality of the outage through in-house inspection management, working closely with 3rd party inspectors and contract QA staff. Also extensive Quality control plans, with milestones and hold points".*

For jobs carried out by in-house personnel, Organisation D interchanges their personnel to check what the other has done. As the Overhaul manager of organisation D put it; *"For the purposes of quality assurance, we have a system where after one person finishes a job, the same job is reassigned to another who carries out checks of what the other person has done".*

For jobs on some critical equipment a unit by unit quality checks are usually carried out to assess the quality of work done. For instance as one TAM Manager put it; *"For some the installation of some spares however (e.g. bearings) we have vibration analysing systems in place for some critical equipment to check to ensure not only the quality of the material but also ensures that they are properly installed".*

i) *Improvements*

Some of the participants acknowledged the shortcoming of the inspection procedure and suggests that the supervisor should have a good time management and technical skill to be able to supervise the contractors. *"We need to have people checking on what the contractors are doing, in fact all things; this means that you need to be at the right time so you have to supervise and have the right mind set to actually to make sure; because what will happen is that the contractor will put the lid on when you are not there. So you need good time management by the supervisor, good skill by the supervisor to make sure he knows what you want"*, explained one TAM Manager.

Another proposal towards ensuring good quality jobs requires the organisation to spell out the procedure of carrying out the tasks and submitting same to the contractor. This will help the contractor to carry out the tasks in a more standard way and to specification and reduce extraneous supervision. *"What we need to spend more time on is actually doing scopes of work and work plan so that you make it so that the contractor knows exactly what he has to do. So that will be; every job brought down to what we need to do. That takes many hours to do. We do it on certain jobs but not all the jobs. So sometimes you may rely on the contractor knowing what he is doing, and that is not really a good idea, we do print out now bearing fitting specification from SKF (bearing manufacturer) for the contractors to follow. This gives the idea on the* *quantity of grease to put for a specific bearing for specific operation, making sure that we are taking bearing clearances rather than leaving them. If we can build all these into total work scope then that will get us to another level"*, described a TAM manager.

14. Risk Management

There are a lot risks inherent in managing TAM projects (Ertl, 2005). These risks according to one outage manager include;

- Resourcing
- Costs
- Emergent works
- Technical risks associated with aging plant and
- Health, safety and Environment risks.

In addition, another TAM Manager identified lack of the relevant skills, arrival of spares, improper planning, missing spares and wrong installation of spares as some of the risks inherent in a TAM project. In his words, *"Not having the right skill for the right jobs; Using the wrong person; Ordered parts not arriving in time. The job to be done is not done correctly; Improper planning; not involving the project dept (not having integrated planning of maintenance and project jobs); Spares missing; Spares not installed correctly and hence being abused"*. Other risks recognised include the proper installation and commissioning of new equipment and properly interacting with the existing ones. According to one Shutdown manager, *"The interaction of new equipment with your existing ones. If for instance you are installing a new plant, you have to make sure you have all the isolation in place correctly, so that people lock-out correctly, you have to make sure the software is interacting with your support ensuring that valves are opening at the right time, to make sure like all the lubrication are done correctly, you have to make sure your documents are there with you"*.

Even there are communication risks; some of the contract workers do not speak English as they come from different countries within the EU. One Manager explains this; *"The risk we faced this time, we brought in a company from Germany to work on the refractory and insulation work, because we know the company and we trust their ability. This time, they have rationalised their head count and hired in Polish workers. They reduced their head count and also because they have other jobs, they now supplemented their workforce with contract labour. The major problem is communication. We had to use an interpreter to give the workers safety induction before they went for actual work"*.

In general therefore there are different types of risks in a TAM project and they vary from one project to the other. *"Each TAM project has its own risks and mitigation strategy. No one answer fits all situations"*, stated one TAM Manager.

Since each TAM project has its own risks, the participants concur that adequate risk assessment should be carried out for each project. Responsibilities need to be shared and defined among individuals to ensure the mitigation of the risks. This is explained by organisation A TAM Manager, *"Variety of measures involving risk matrices and risk logs with individuals responsible for owning risk mitigation actions"*.

The major threat in managing risk is that individuals should understand that apart from logging the apparent risks, they should actively manage and reduce risks, not simply recording them.

15. Material/Logistics

Not having or having the wrong specification of material/spare can cause serious delays to a shutdown project (Motylenski, 2003). The entire organisations agree that all the spares and materials needed for the project should be in place before the commencement of the event. As part of the pre-shutdown programmes, Spares/materials that are needed should be ordered in good time and procurement tracked to ensure their arrival prior to the take off of the project. Most of the organisations have well defined procurement departments. *"Separate procurement plans linked to key suppliers, items procured to arrive before outage begins and tracked through manufacture, sometimes as long as 2 years before an outage. Mostly required for major components"*.

i). *Materials related to Emergent jobs*

The organisations have different approaches for arranging materials/spares needed for emergent jobs. For organisation A, they keep stock of major components and parts to refurbish and also make use of material procurement companies to stock some items. The Programme manager explains; *"For emergent jobs we have stock holdings of major components and parts to refurbish, this increases stock holding but reduces risk of failure to return. Also use of material procurement agencies who demand a premium for short turn around items"*. Most of the participants in the organisations agreed that they usually rely on stock and TAM specific contingency orders to cope for emergent jobs. In situations where spares are not in store or not readily available, the old part is refurbished or the system re-deigned to ensure there is no time overrun. In some situations the organisation can even fall back to their sister company for spares needed for emergent jobs. As one TAM Manager explained, *"Actually we can manufacture any spare locally, but for some emergent jobs, it make come to a point where we can rework or we can get to the point where we can redesign or do some thing to get the plant running. And also because we are a multinational company, there arise a situation where we can fall back to any of our sister companies for some emergent spares".*

ii). *Material Quality*

In order to ensure the right quality of material is used, all the organisations agree that quality of the material should be assessed before use. There are several ways of handling this, but most of the participants have the same opinion that materials should be purchased from only reputable suppliers (if not from the equipment manufacturer). First a clear specification of the material should be sent to the supplier and on arrival the material should be inspected by competent personnel. According to one Maintenance Manager; *"A specification is sent to the supplier, most parts are inspected against the specification when they arrive on site. We need to carry out this process with all non consumable spares".*

If the material/equipment is being purchased abroad, one TAM manager suggests that an improved third party inspection need to be put in place. In his words, *"Improved 3rd party inspection needs to be used especially when sourcing equipment from overseas, ensuring that original; standards are understood and followed'.*

On arrival on site, the TAM managers all insist that all materials should come with test certificates and approval given before equipment shipment or release from stores. This ensures that the quality of the material received is right and used for the right equipment. As one TAM Manager put it, *"All material comes with certificates. All material and equipment is purchased from approved vendors. Release notes are issued prior to shipping equipment and removing anything other than nuts, bolts and gaskets from stores".*

To be very sure of the quality of the materials especially from vendors, some specialised system of inspection need to be put in place. A Maintenance Manager explained, *"We have an issue especially when getting the spares from a local supplier (not the equipment manufacturer), what we have done now they have to take material samples and make it to the original manufacturer specification or even better. It is really very difficult to actually check every thing. But we use to bring in NDT people in to actually check some of our shafts before fitting them in. We also use NDT to test components* *that are already in - shafts, tyres, crankshafts, millers. On some spares we take them apart to inspect to make sure they are correct".*

16. Time Management

Managing time is very difficult in a TAM project considering that the entire scope of work is not actually known during the planning stages (Ertl, 2005).

All the personnel in the case organisations share the same opinion that time overrun must be avoided by every possible means possible.

This is because duration extension has a lot of negative impact on the organisation; these according to most of them include:

- Loss of goodwill of the customers
- Loss of revenue
- Loss of Market share
- Extra overhead cost, etc.

Time overrun is usually a major issue when it impacts on the critical path of the TAM project. One TAM manager explains, *"Time over run is only an issue if it affects the critical path of a project. Often additional costs are incurred simply to progress an activity outside of the critical path and with scope for slippage. A clear understanding of the critical path of any outage and the sub-critical items is essential for successes".*

A lot of problems have been identified as major causes of time overrun by the participants in the case organisations. These include:

- Wrong identification of scope
- Poor planning
- Unavailability of spares
- Emergent work
- Poor quality jobs and or materials.

According to one TAM manager, TAM time overruns can be caused by, *"Unplanned for emergent work which takes the project into areas that had not been anticipated, difficult or unfamiliar work which creates challenges not faced by teams previously, so ability to risk assess is impaired by the lack of knowledge".*

To handle the above scenario is a major problem since most organisations are on 2 12-hour shift 24/7 for critical path jobs. One Maintenance Manager however suggested having some time as contingency in the event the emergent job impacts on the critical path. In his words, *"Because there may be cases where emergent jobs impacts on the* *critical path, it will be necessary to have some time as contingency, this should be built into the budgeted time. This time can only be allowed if and only if the emerging job/task imparts on the critical path".*

17. Cost Management

The participants agreed that the cost management in a TAM project is not as straightforward as that of other EPC projects. According to Lenahan, (1999), creating a budget and managing cost which is hedged around uncertainties is very difficult in a TAM project.

In other projects, the scope of work is known and hence resources to complete the tasks can be known and budgeted for. The TAM Managers also recognise that there are basically three types of scope of work in a shutdown project; known scope, anticipated and unanticipated (or emergent) scope. As one TAM Manager put it, *"You can actually plan for the known scope, and estimate for the anticipated scope but it is really difficult to plan or estimate for the emergent scope".* The general consensus is to plan for the known scope items, plan using estimates for anticipated scope and then allow some contingency for emergent jobs. From the views of the participants, the contingency should be between 10 - 15%.

To avoid cost overrun, it is imperative that the TAM Manager and his team should be able to narrow down the emergent jobs to the barest minimum.

7.7 SUMMARY OF THE CHAPTER

The chapter presented the case studies data collection and analysis for this research project. This is a major phase in this study, especially as the findings from the case studies form the major source of primary data for the development of the TAM project framework.

The chapter started with a brief profile of the case organisations, in terms of their operations, their staff involved in the case studies and the major drivers of their TAM project. Further, analysis of their TAM project activities as at December 2008 in terms of TAM project interval, duration and labour input (man-hours) were also presented. The profiles of the key staff interviewed highlighting their experiences in TAM projects were also presented. The chapter also described the major sources of data: interview of key staff, organisational documents and information gathered through direct observation while on site in the case organisations. The tools and method of data analysis is also presented. The presentation of the themes and patterns which emerged from the case studies data analysis formed the major part of this chapter. In the process industries, there are a lot of issues affecting the successful implementation of their TAM projects. The data analysis further confirmed the critical success factors of TAM projects as identified from the quantitative studies in chapter 6. Apart from these CSFs, the chapter has shown that there are some barriers which organisations are currently facing in their TAM projects.

Most importantly, the chapter has identified *how* TAM projects are being currently managed and has identified improvements on these management methodologies to ensure TAM project implementation success.

8.0 TURNAROUND MAINTENANCE FRAMEWORK DEVELOPMENT

8.1 AIMS OF THE CHAPTER

Chapters 6 and 7 presented the results of finding of the quantitative and case studies respectively from their data analyses. This chapter presents the development of Turnaround Maintenance framework based on these findings and those from the literatures and pilot survey. This chapter begins with the explanation of the sources of data for the framework development. This is followed by some assumptions made for the framework. The TAM Implementation framework is then presented in details. The chapter is concluded with a chapter summary.

8.2 SOURCES OF DATA FOR THE FRAMEWORK

The research project employed both primary and secondary research methods for data collection. The secondary data were gathered through an extensive literature review. Following the issues identified from the literature review, some propositions were developed and used in designing a questionnaire. The questionnaire survey was conducted in 160 major continuous processing plants in the UK. The completed questionnaire received were grouped into eight different manufacturing industries; Power Plants, Oil refineries, Petrochemical plants, Food & Beverages, Chemical & Steel, Glass, Pulp & Paper and the Pharmaceutical industries. They were further grouped into managerial levels (TAM, Plant, Production/Operations and Maintenance and Maintenance & Project planners) in the organisations. The data from the survey was analysed using quantitative research analysis technique. As a second source of primary research, case studies were carried out in six Process plants. This source was basically used to ascertain how best TAM projects can be managed and to clarify some findings from the survey. The case studies data was analysed using qualitative research analysis technique. Based on the analyses of data from all these sources a framework for the successful implementation of TAM project was developed as a best practice guide for organisations operating Engineering facilities for Shutdown maintenance projects. Figure 8.1 illustrates the sources of the data used for the development of the TAM Framework. The framework is presented in the following sections of the chapter.

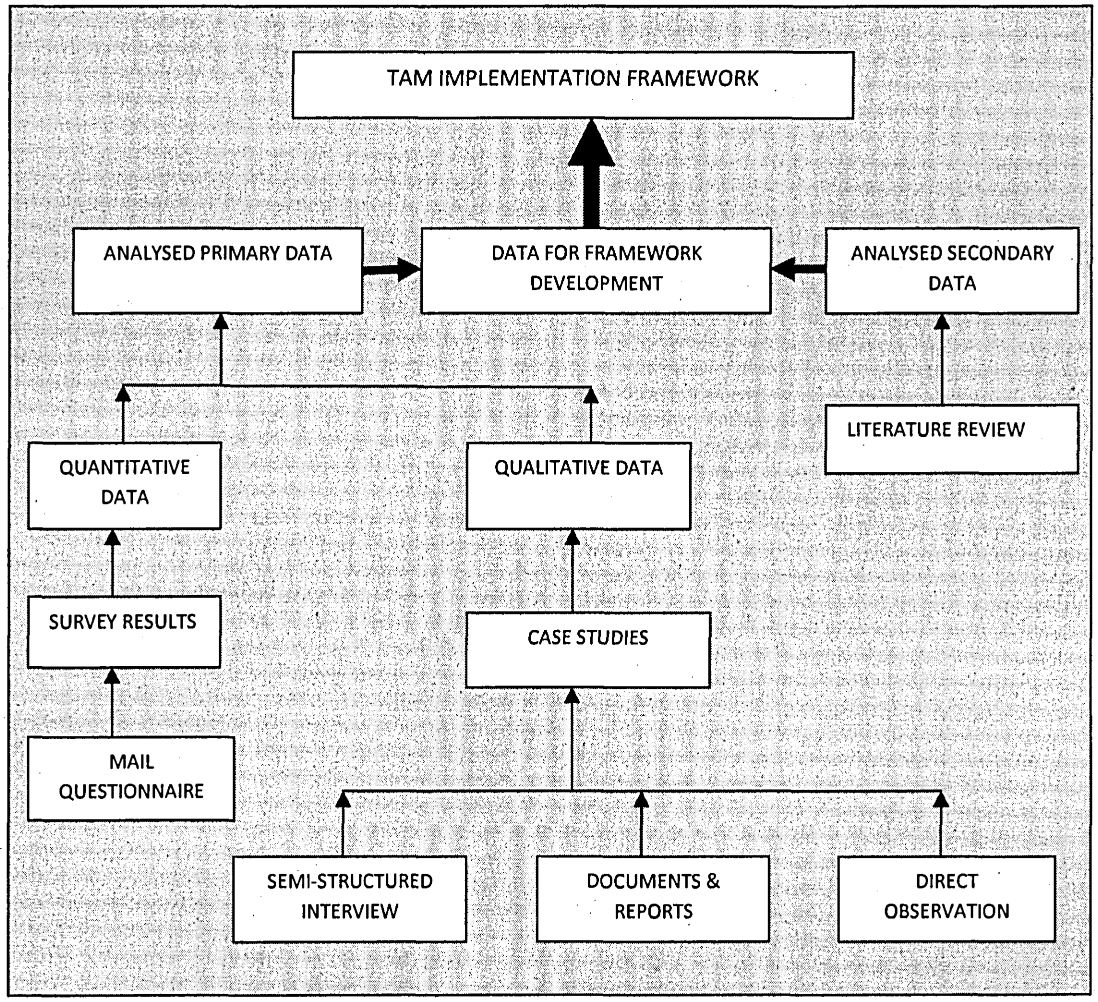


Figure 8.1 Illustration of the various sources of data for TAM framework Development

8.3 INTRODUCTION TO THE FRAMEWORK

This framework for the successful implementation of TAM projects recognises that:

1. Engineering facilities especially process plants are at varying levels in terms of their shutdown intervals, labour input and TAM durations in the implementation of TAM projects, depending on the sophistication of their equipment and operations.

2. Few works have been done in recent times to optimise TAM projects. Most of these are individuals sharing their experiences on specific areas of the TAM implementation process based primarily on reduction in work scope, reduction

in duration, prolonging shutdown intervals and improving on the planning process.

3. This framework is a best practice guide for the successful implementation of TAM projects based on the research conducted in UK manufacturing organisations.

It is also assumed that the organisations, potentially adopting this framework have:

i. Computerized Maintenance Management System (CMMS) for the maintenance management of their plant facility; and
ii. That their TAM Leadership are familiar with PMI Project Management Body of Knowledge.

8.4 TURNAROUND MAINTENANCE IMPLEMENTATION FRAMEWORK STRUCTURE

The framework for managing TAM projects successfully has been divided into five parts as shown in Figure 8.2:

1. TAM Concept
2. TAM Leadership
3. TAM Management Process
4. TAM Post Implementation
5. TAM Improvement strategies.

8.5 TURNAROUND MAINTENANCE MANAGEMENT CONCEPT

This framework has identified some conceptual issues that need to be in place within an organisation to ensure the successful implementation of a TAM project. These issues help to drive the TAM project and include:

8.5.1 TAM Philosophy

Turnaround Maintenance should be formally recognised and aligned to the overall business strategy of the organisation. It has to be seen as an integral part of Asset Performance management. This recognition is the first step in maximising the benefits and reducing the costs when taking the plant for a scheduled shutdown.

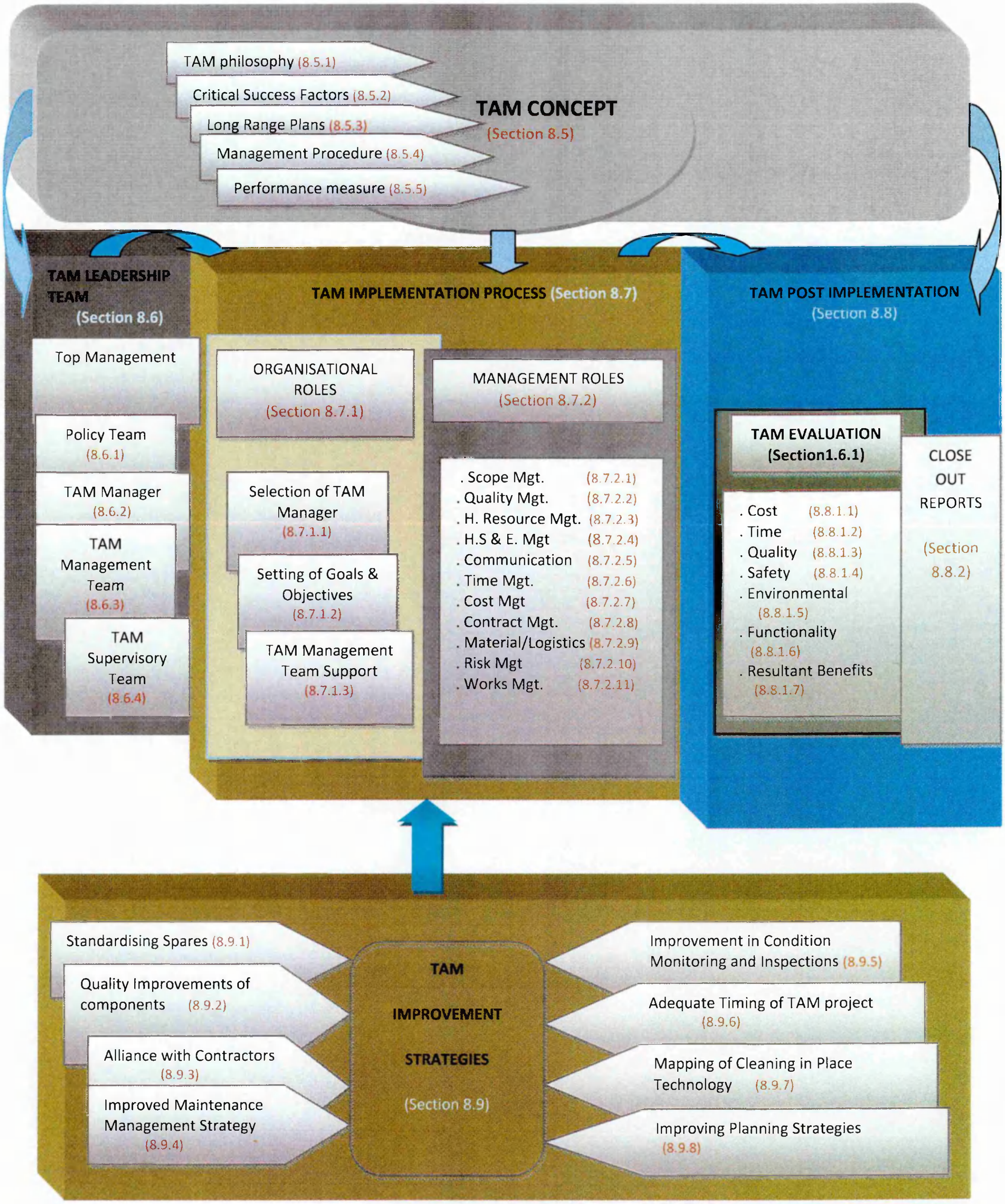


Figure 8.2 The Structure of TAM Project Framework

The philosophy should also be clear and concise with a descriptor of both plant TAM management and shutdown (Mclay, 2003)

TAM Project should not be considered as a single occurrence that is the responsibility of maintenance department. Organisations have to accept the need for multi-functional teams cutting across all the areas of responsibility within the organisation. This multi-functional teams should be responsible for the planning process as well as the need to follow a business work system during TAM planning and execution.

8.5.2 Awareness of Critical Success Factors (CSF) of TAM Project

It is very imperative that Organisations should understand that TAM projects have unique characteristics which are quite different from the conventional EPC projects. In view of these, this framework recommends that organisations should be knowledgeable about TAM critical success factors and how they affect the TAM project. This framework identified that the success of a TAM project depends on organisational and managerial factors as shown in Figure 8.3. The organisational through the Top management and the TAM management team should therefore carry out their roles effectively for TAM to be successful.

8.5.3 Long Range Plans

The organisation should establish TAM long range plans (IAEA, 2002, 2006, Lenahan, 1999). This long range strategic plan should be used to forecast maintenance requirements for a minimum of 10 to 15 years in future. Among its deliverables is a rolling TAM plan for up to 4 TAM projects, TAM schedules, forecasts for each TAM budget (expense and capital) and any long-range improvement plans.

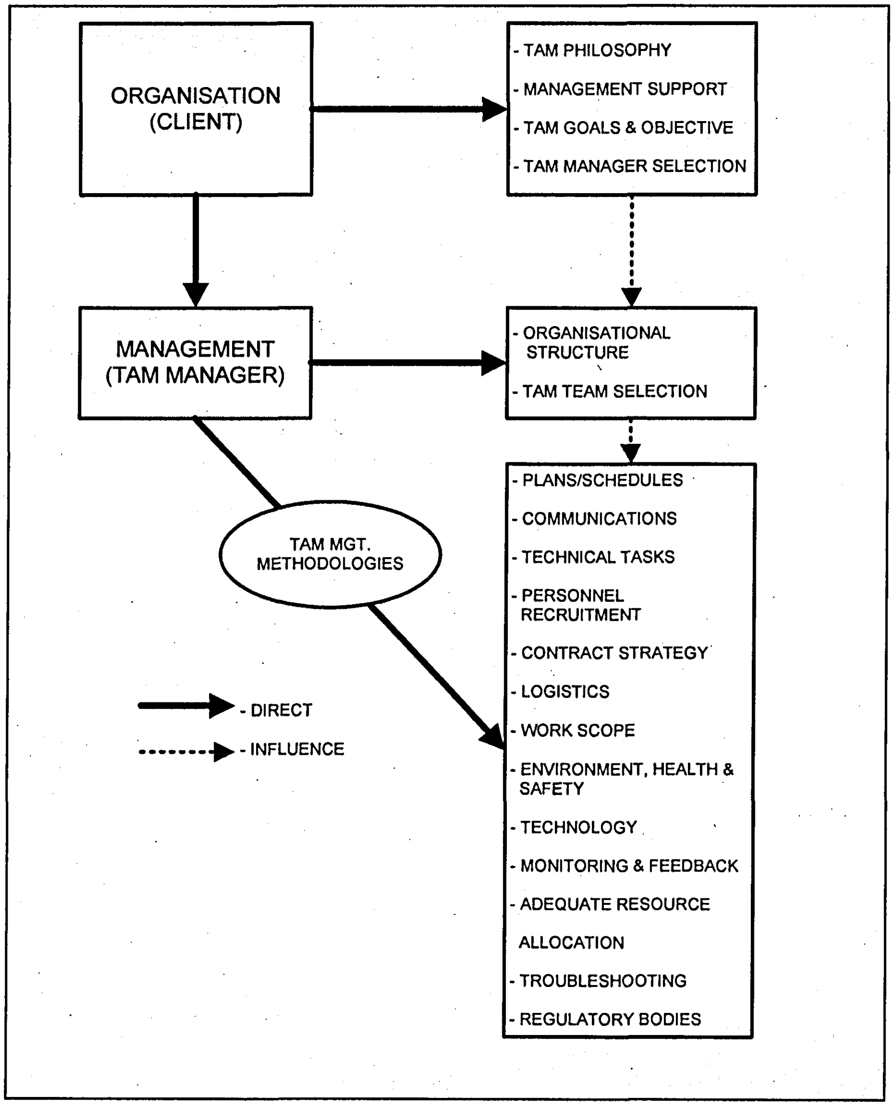


Figure 8.3 Relationship between Organisational & Managerial TAM critical success factors.

8.5.4 TAM Management Procedure

The TAM management procedure should be a guiding document for managing TAM projects. As a standard it should provide consistency from one TAM project to another and should not be restricted to major outages but can be used for any short, partial or rolling plant outages (Mclay, 2003). Each plant however needs to be tailored to the specific needs of the organisation. These needs include the type of plant, the geographical location, and the size of the plant and the general complexity of the TAM project. This document should be dynamic and should be reviewed at the end of each TAM project to ensure that it is consistent with needs of the facility.

To optimise plant run time and avoid major unscheduled outages, a long-term TAM frequency strategy should be developed.

The procedure should recognise that TAM project has four fundamental phases; Initiation, Planning, Execution and Closure forming a cycle. These four phases forms a never ending cycle, implying that the closure phase of one TAM phase marks initiation phase of the next TAM. TAM should therefore be viewed as a continuous process, with the TAM Manager's position and responsibilities overlapping from one TAM project to another. This will guarantee continuity and hence ensure success.

Reviews and Audits should also be included as part of the management procedure. These are to ensure that the planning and execution process should receive appropriate priority and that progress is being monitored. Milestones, checkpoints and hold-points should therefore be built into the process and reviewed and audited at intervals throughout the process.

8.5.5 Performance measurements

This framework recommends that the organisation should develop internal and external performance measurement criteria like 'Key Performance Indicators' to assess the effectiveness, efficiency and the success of the TAM project. These need to be established as part of the TAM management concept.

8.6 TURNAROUND MAINTENANCE MANAGEMENT LEADERSHIP TEAM

The TAM leadership team is very critical to TAM project success. This framework recommends that TAM leadership should include; the policy team, the TAM manager, the TAM management team and the TAM supervisory team (see Figure 8.4) and most importantly should all be made up of in-house personnel. According to Duffuaa & Daya (2004) the Organisation should select the most suitable people with the relevant skills and qualities to forge the strongest possible organisation for managing and controlling the TAM project. The following elements should characterise the organisation:

- A defined organisational structure for TAM project
- Identify the Policy team members
- Identify TAM Management leadership
- Ensure all functions with minimal duplication
- Ensure roles and responsibilities are defined
- Ensure that single point responsibility is exercised at every stage.

- Should support coordination, communication and quick decision making.

The organisational structure defined specifically for the TAM project should:

- Be hierarchic
- Ensure that one person must be in overall control
- Be flexible and can respond to new conditions particularly during the project execution.

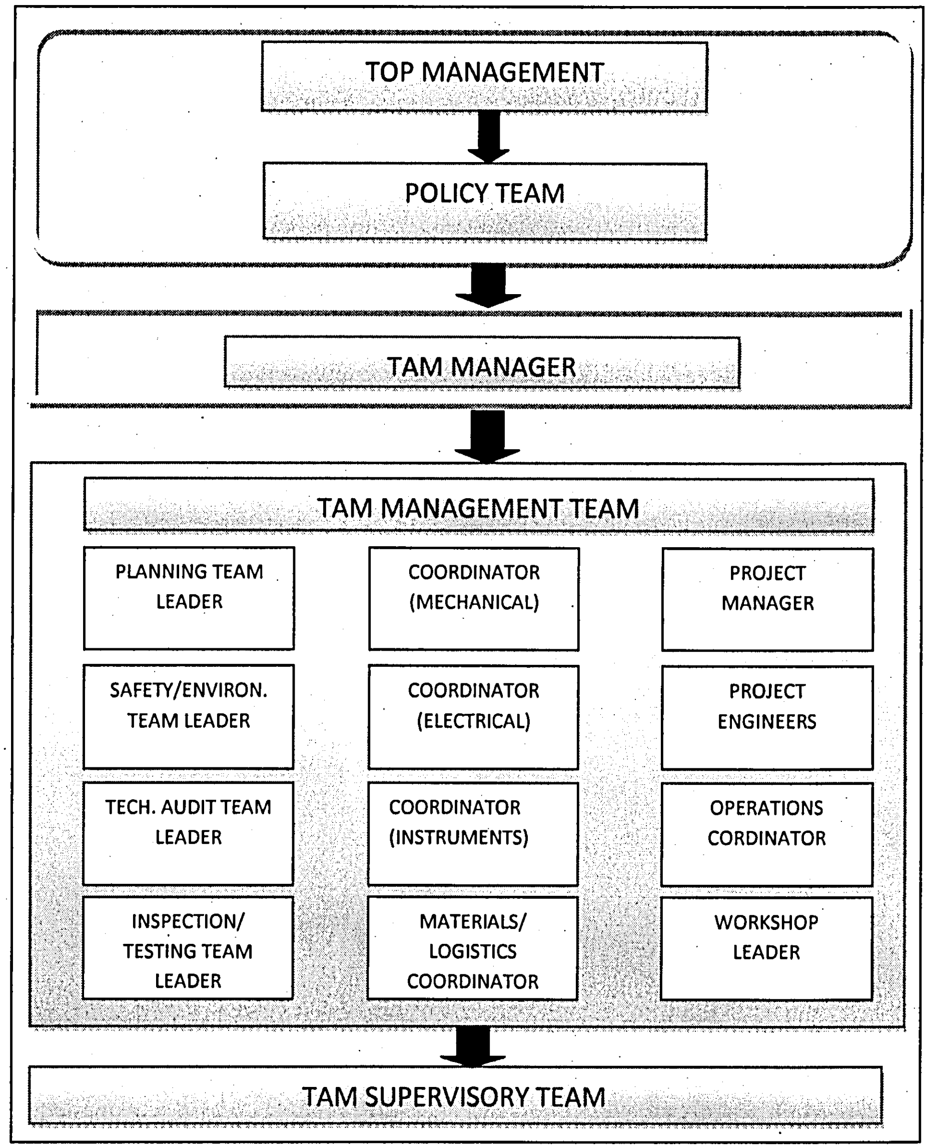


Figure 8.4: The TAM Leadership Team Structure

8.6.1 Policy Team

Considering the complexity of a TAM project, a policy team (or steering group) should be appointed to represent the top management (Duffuaa & Daya, 2004; Lenahan, 1999).

The members should be the most senior management of the organisation. Members should fulfil at least one of the following criteria:

a) They should be 'stake holders', i.e. are directly affected by the turnaround.
b) They should provide the money to pay for the turnaround.
c) They should have authority to make decisions concerning the turnaround.

Typical members from the organisation should include:

1. The Chief executive officer
2. The Chief financial officer
3. The Plant Manager
4. The Operations Manager
5. Head of Human Resource

The duties of the policy team should include:

- The provision of funds for the turnaround
- The balancing of TAM constraints
- The setting of objectives for TAM
- The formulation of the policy to meet the objectives set
- The monitoring of progress against objectives
- The modification, if necessary, of objectives or policy
- Appointment of TAM manager.

8.6.2 TAM Manager

The TAM manager plays a key role to the TAM organisation. His responsibility is to ensure that all the activities are carried out as planned. The TAM manager builds the TAM organisation and appoints specialists who make up the TAM management team (Levitt, 2004; Edwards, 1998; Lenahan, 2006). The TAM Manager should have the relevant skills, attributes and the knowledge areas to manage the project successfully.

8.6.3 TAM Management Team (TAM team)

The TAM team includes representatives from all areas of responsibility: administration, engineering, maintenance; health, safety & environment (HSE); quality assurance (QA); procurement; planning and scheduling and TAM supervision (Mclay, 2003). This framework suggests that members of the team should not be selected considering their roles and responsibilities based on functional and departmental requirements alone. Members of the TAM team should have according to Oliver (2001):

1. The ability to work as a team member
2. Relevant specific technical skills
3. Peoples' Management skills
4. Time management skills.

For TAM projects purposes this framework recommends that organisations should develop TAM management positions for their TAM projects (sample is shown in Figure. 8.4):

1. The roles and responsibilities and reporting relationships attached to each position should be clearly defined and documented.
2. These positions should be occupied by individuals based on the individual's skills, knowledge and personal attributes appropriate for the roles and responsibilities attached to the position.
3. The new position is strictly for the TAM project and has nothing whatsoever to do with the normal organisational responsibilities of the individuals.

8.6.4 TAM Supervisory Team

This is an important group in TAM leadership. They are responsible for:

- Ensuring that the specification or work procedure is strictly followed in carrying out tasks
- Ensuring that safe work permit requirements are met
- Ensuring that the project is on schedule
- Writing the necessary reports on the progress of the job

Considering the above responsibilities, the supervisors should have:

- High level of relevant technical skills on the job
- Good communications skills
- Experience on the tasks being carried out
- Good time management skills
- A good team player.

8.7 TURNAROUND MAINTENANCE MANAGEMENT IMPLEMENTATION

For the success of a TAM project, this framework recognises that the Top Management as well as the TAM Management leadership has different roles and responsibilities towards ensuring the success of TAM. As shown in Figure 8.5, the organisational roles impart directly on the performance of the Management team responsibilities. TAM failures therefore could be as a result of inability of either team to deliver.

8.7.1 TOP MANAGEMENT ISSUES

The Top management (representing the organisation) through the policy team should perform their roles adequately if the TAM has to be a success. These roles are as shown in Figure 8.5 are outlined below.

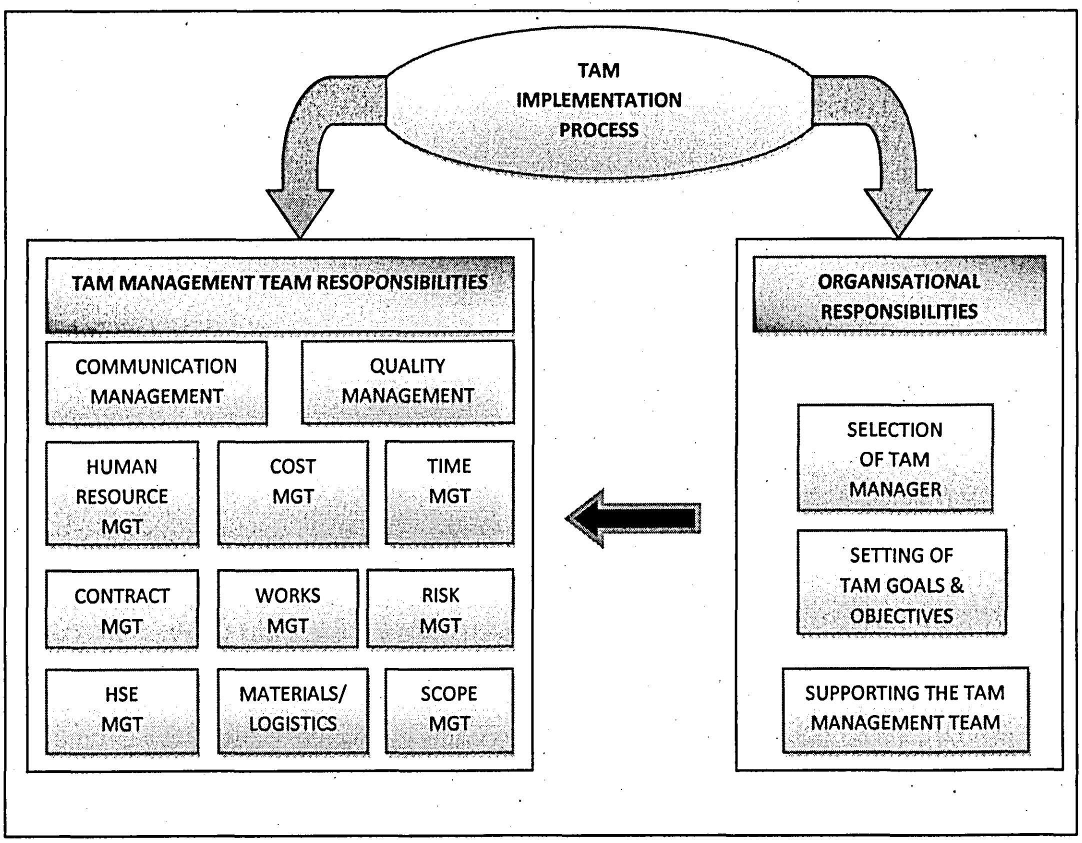


Figure 8.5: TAM implementation showing responsibilities

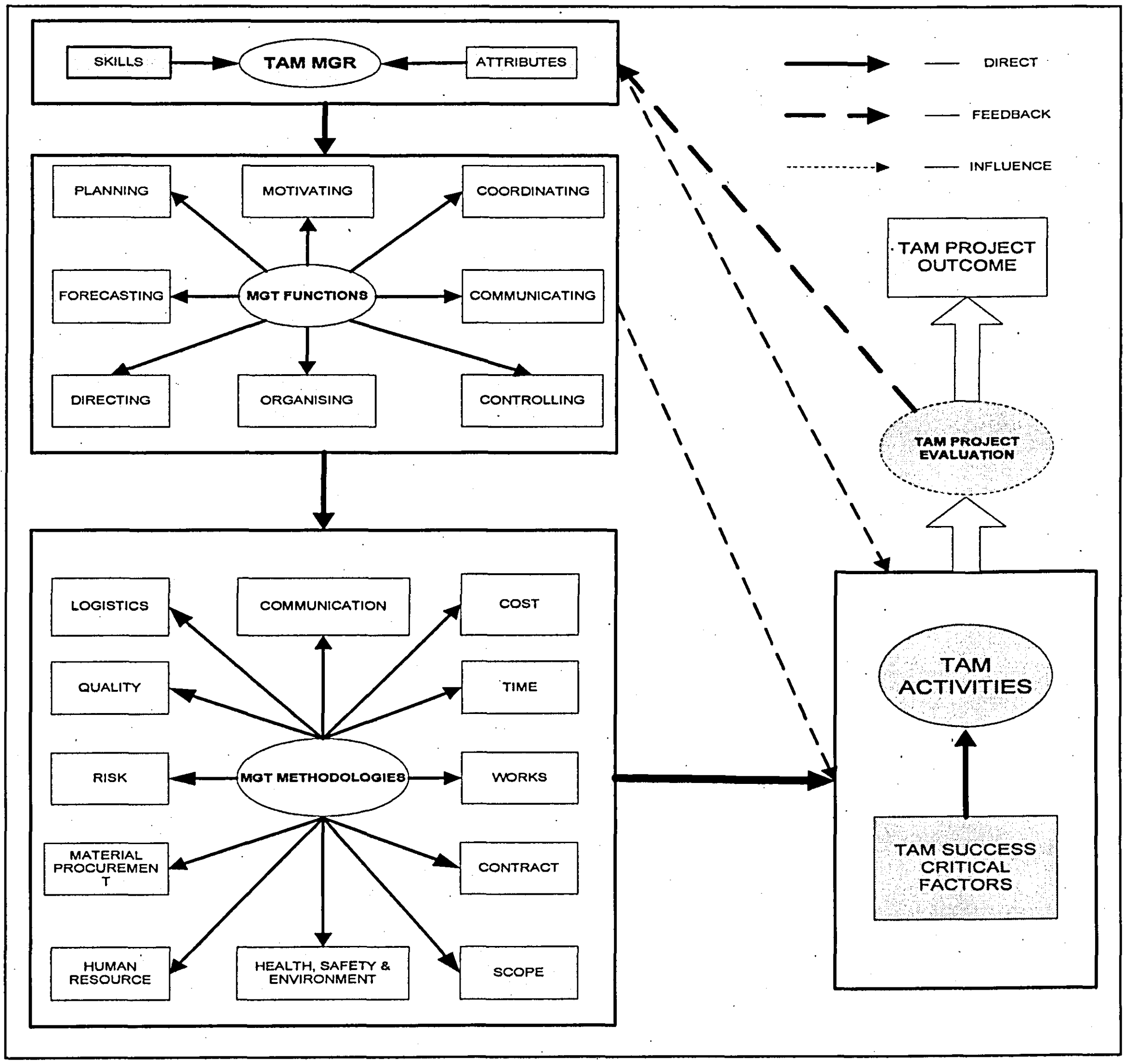


Figure 8.6: Interaction between TAM Manager's Skills, Attributes and Functions with Management Methodologies and TAM project outcome.

8.7.1.1 Selection of a TAM Manager

This framework considers the selection of a TAM manager by the Top management as very critical to the success of the project. The responsibilities of a TAM manager cuts across the four phases of the TAM project cycle (Barry, 2008). The TAM manager is directly responsible for the success or failure of managing the project. Figure 8.6 shows how the TAM manager's roles and responsibilities affect the TAM project outcome. It is therefore imperative that adequate care should be taken in selecting or appointing the TAM manager. To be successful this framework recommends a list of Management skills set, personal attitudes & attributes and some knowledge areas as shown in Table 8.1 should be used as a guide by organisations in selecting and appointing a TAM manager. Generally the TAM manager should have major expertise in shutdowns, Maintenance engineering management, Project Management techniques, Maintenance planning and logistics. A good knowledge of Health Safety & Environmental management, accounting is also required.

Table: 8.1 Personal Attributes and Management Skills & Knowledge areas required TAM Managers

Personal Attributes, Attitude & Traits	Management Skills	Knowledge and Awareness
Good Communicator	Health, Safety and Environment	Health and safety regulations (Site safety rules)
Competence	Planning and control	Project Management techniques
Team building ability	Leadership	Organisation of communication systems
Enthusiasm	Motivation	Setting objectives and goals
Honesty	Cost Management	Technical Knowledge
Determination	Budgetary Control	Regulatory processes
Ability to delegate tasks and responsibilities	Decision making	Contractual Knowledge
Supportive	Quality Management	Tendering Strategies
Cool under pressure	Time management	Site security
Integrity	Communication/Presentation	
Problem solving abilities	Risk Management	
Interest in the job	Managing conflicts and crisis	
Open minded	Control	
Need to achieve and proactive	Forecasting	
Shared vision	Technical	
Patient	Management support building	
Tolerance to ambiguity	Resource Allocation	
Empathy	Negotiation: Contractors	
	Negotiation: Inspection Agencies	
	Negotiation: Govt. Agencies and Regulatory Bodies	
	Human Resource Management	
	Negotiation: Equipment manufacturers	
	Supervision of others	
	Organisation	
	Administrative	
	Negotiation: Suppliers & Vendors	
	Use of Computer	
	Negotiation: Trade unions.	

This framework recommends that organisations should always use in-house personnel as the TAM manager. Where a full time TAM manager is not possible then it is preferable to choose the Engineering Manager of the entire facility as the TAM manager. If there are shortfalls in the skills established for TAM management, the manager should seek to either develop his/her ability (through training and personal development programs) or seek active support for this weakness within the TAM management team. A consultant who is an expert in shutdowns can be brought in to assist the TAM manager if need be.

8.7.1.2 TAM Goals and Objectives

The TAM goals and the objectives need to be set early especially at the Initiation phase of the project (Lenahan, 1999). The goals and objectives as recommend by this framework should:

- Be in line with organisational goals
- Address the key elements to achieve the goal
- Set clear smart targets
- Be specific, realistic and measurable
- Be agreed by the Top management and the TAM management
- Set a timeline to achieve
- Specify Downtime duration and TAM project starting date.

8.7.1.3 Top Management Support

For a TAM project to be successful there is need for adequate support from the Top management to the management team as well as to the project itself (Levitt, 2004; Motylenski, 2003; Oliver, 2002). The Top management should provide support to the TAM management team in the following ways:

- Provision of adequate fund
- Granting authority and support
- Support for resources due to changes in scope
- Provision of adequate time and agreeing and upholding a starting date.

8.7.2 TAM MANAGEMENT ISSUES

This framework recommends the following management methodologies should be adopted for TAM project success;

8.7.2.1 Scope Management

Scope management in TAM project passes through all the phases as outlined by PMBOK for managing projects; scope initiation, scope planning, scope definition, scope verification and scope change control (Ertl, 2005). Scope in TAM projects as shown in Figure 8.7, are usually made up of known scope, large percentage of anticipated scope and emergent scope.

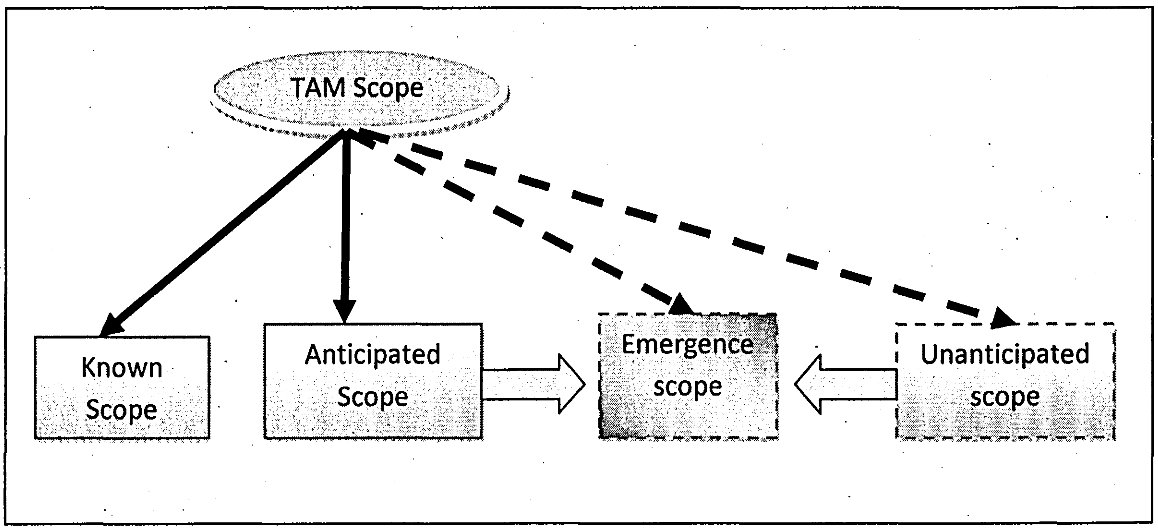


Figure 8.7: Kinds of TAM Work Scope

a) Known and Anticipated Scope

The input of known and anticipated scope are usually from the different departments; projects, process/production, quality assurance, operations, maintenance engineering and safety. The TAM Manager should organise pre-shutdown meetings involving the departmental heads for the validation and verification of the known and anticipated scope. During this meeting each scope item should be subjected to scrutiny. This will eliminate duplication of tasks and ensure the tasks approved for the scope can only be done during a plant's outage. Project works also fall under the category of known scope.

Anticipated scope however, should be approved subject to agreed technical or statistical information of the equipment obtained from any of the following sources:

- Equipment maintenance history
- Evaluation report of previous TAM projects on component condition of equipment.
- Non-destructive tests (NDT)
- On-run Inspections
- Oil analysis results
- Material thickness results
- Vibration analyses results
- Thermo-graphic camera checks, etc.

Through these test results a comprehensive anticipated scope of work is developed for the TAM project.

b) Emergent scope

Emergent work items are a common feature of TAM projects. These are usually work items that are not known and hence not planned for before the execution of the project. Major sources of emergent scope include:

- Scope not anticipated
- Scope anticipated but under estimated
- Scope generated while carrying out the tasks.

Organisations and hence the TAM management should plan on how to handle any emergent job items. This framework suggests the following as ways of managing emergent scope:

1. Identifying a scope freezing date early
2. Establishing an additional work procedure
3. Emergent work order procedure during the event
4. Management process for scope changes should be established.

In order to reduce the level of emergent scope, thorough inspections should be carried out on 'critical' equipment based on running inspections and NDT results at the beginning of the shutdown. This should be done by disassembling the equipment and carrying out assessment of the components. This enables the Team to know the actual conditions of the components of these 'suspect equipment' compared to that anticipated.

The exact jobs are then planned for and approval given. Subsequently, the level of emergent jobs could be reduced to the barest minimum.

8.7.2.2 Quality Management

Poor quality work has been identified as one of the causes of outage extensions (IAEA, 2002). This can be recognized through high level of reworks, start-up incidents and commissioning incidents. Poor quality TAM projects also degenerates to decreasing the reliability and availability of the equipment during operation. Managing quality is therefore very critical towards ensuring a successful turnaround.

Quality management in a TAM project involves; Quality planning, Quality assurance and Quality control - as identified by PMBOK.

This framework suggests the Total quality Management (TQM) dictum "*do it right the first time*" approach should be adopted throughout the entire TAM project. It also recognised the following as the major factors affecting the quality of work in a TAM project;

i) *Skill/Experience of the worker*

The TAM management should ensure that the worker assigned to a task is the right personnel to do the job in terms of skill, training and experience.

ii) *Attitude of the worker*

The workers morale is another area that the TAM leadership should be wary of. If the workers morale is low, this will definitely affect their output. It should be necessary that morale boosting modes like incentives or bonuses be considered.

iii) *Work shift patterns*

In most TAM projects, 12-hour shift pattern is the norm. Most often as the project progresses, fatigue sets in resulting in poor job performance. Working times should be reviewed to avoid fatigue.

iv) *Technical specifications of work*

As much as possible, it will be necessary that the requirements of every task should be correctly specified and then performed to that specification. This may be time consuming, but it makes for easy supervision and quality assurance of the job and ultimately leads to TAM success.

v) *Supervision*

TAM projects involve a lot of contractors and contract staff, TAM leadership should ensure adequate supervision is put in place to ensure that the tasks are performed correctly. TAM leadership should ensure that the worker assigned to supervise the task should have the required technical and time management skills.

vi) *Quality of materials*

There is need that a proper quality assurance system should be in place to ensure that the right quality of the materials or spares is supplied and installed properly too.

a) Managing quality

To manage quality successfully in a TAM project, this framework suggests that:

1. The requirements of every task must be correctly specified
2. Standard procedure of carrying out the tasks should be specified and adhered to
3. Quality assurance system should be put in place to ensure each task conforms to specification
4. Specific results should be monitored to ensure the elimination of deviations to standards.

b) Quality control

For quality control purposes, the framework recommends that the TAM management leadership should set up a technical audit team. This team will be visiting all work stations at regular intervals and carry out proper assessment of on-going tasks. This process will ensure that the standard procedures are strictly adhered to.

c) Quality assurance

For efficient Quality assurance, it is recommended that milestones, checkpoints and hold points be built into the schedules of every activity and used to assess specific results to ensure the elimination of deviations to the specifications. This same assessment should also be carried out on job completion. The quality assurance can be carried out adopting any or a combination of the following methods:

1. Using experienced personnel (in-house inspector, 3rd party inspector or contract QA staff) to check on the job on completion. This can be in the form of test-running the unit or system and assessing its performance.
2. For large turnarounds, this framework suggests setting up an audit technical team to review tasks done on equipment to ensure all the technical specifications are strictly followed.
3. Non-destructive tests can also be used to assess and assure the quality of the job done.
4. Vibration analysis should be used for rotating equipment.

8.7.2.3 Human Resource Management

TAM projects involve a large number of people with diverse skills with different backgrounds working together at the same time (Duffuaa & Daya, 2004). Human Resource management involves, developing an organisation/organisational structure, personnel acquisition, Team building, work patterns and managing the morale of the workers to ensure success.

a) Personnel Acquisition

The issues relating to TAM manager and management team has been addressed in Section 8.6. After identifying the scope of work to be done (known and anticipated) the TAM leadership should assess the skills, knowledge and experience needed to deliver the project. The skills, competence and qualifications of in-house personnel within the organisation for TAM project are known, the major concern are those of the contractors and contract staff.

Irrespective of the contract strategy, this framework recommends the following procedure to acquiring personnel from the contractors:

1. The tender request document to contractors should indicate in clear terms the skills, experience, personal attributes, competencies and qualifications (certifications) of the personnel required for the different jobs.
2. The Contractor should forward the curriculum vitae of all the workers that are to be involved, detailing their qualifications and experiences including their shutdown work experience.
3. On accepting a contractors' bid, it is imperative to assess the workers on individual bases especially on critical jobs. This should be done through training

data bases, skills, training certificates, operating licences and if possible through some practical tests.

b) Team building

The TAM team (management and workers) represents all areas of responsibility in the organisation: administration, operations, engineering, and maintenance; health, safety, and environment (HSE); quality assurance (QA); procurement, planning, and scheduling; and turnaround supervision and the contractors' workers. For the TAM project to be successful it is therefore necessary to build and maintain a cohesive TAM team. Break down of team spirit is devastating to the success of a TAM project. This framework recommends the following approaches should be adopted to ensure that all these diverse group work as a team:

1. Each individual should be made to feel as a valued part of the team with a clear and important mission.
2. The goals and objectives of the TAM project should be communicated to all.
3. Roles and responsibilities of each individual should be clearly defined.
4. They should be made to realise that the success of the project depends on the contribution of each of them.
5. The work patterns that will be adopted should be explained to all.
6. They should be made to be aware of the reporting relationships.
7. The TAM leadership should make them realise that they will always support them and to put them through any confusing issues.
8. Everyone needs to be informed of everything.

The above and other team building techniques should be employed towards building a cohesive team. These can be communicated to individuals through:

- welcome packs
- team briefing sessions

c) Work Patterns

The work pattern in most organisations during the TAM project is two-12-hour shifts per day especially on critical path tasks. The workers are mostly required to do 12hours per day throughout the duration of the outage. For long turnarounds this may be counter productive as this may lead to fatigue and potential loss of attention to detail. The shift pattern does not only affect the output of the personnels involved in terms of volume and quality of tasks performed but also the safety of individual and the equipment.

Organisations should review their outage work pattern to ensure the optimum shift rotation is adopted.

This framework however suggests 2 10-hours per day shift with the 2hours between the shifts used for technical audits of the tasks done. For long outages (duration>7days), 1 day off duty should be included after 7 days work.

d) Motivation

From this study, most organisations have no incentive program in place for in-house personnel for the outage project despite the need to deliver the project successfully. In most organisations, there are production and sales bonus for the production and sales staff respectively when they meet their targets. These bonuses are in place to motivate them to achieve the set objectives.

Motivational schemes for the TAM project personnel are even more desirable considering the nature of tasks and risks involved in a TAM project. Generally incentives are known to;

- increase staff motivation, morale and loyalty;
- boost productivity;
- focus employees on achieving targets; and
- build teamwork.

This framework has identified these different incentives that can be used:

1. Financial incentives
2. Extra holidays (e.g., one vacation day for every five days of TAM).
3. Certificates of recognition.

Organisations should adopt any of the above or fashion out what should be suitable in their own situation.

8.7.2.4 Health, Safety and Environment Management

A TAM project is a hazardous event. It introduces a large number of people into a confined area, to work under pressures of time with hazardous equipment (Lenahan, 1999). In most cases majority of these people are new to the plant. To achieve 'zero' safety targets and no environmental impact organisations should therefore adopt strategies to manage Health, Safety and environmental issues effectively. The following strategies should be followed:

- Safety policy statement, safety communication networks and safety working routine must be established
- Safety trainings and awareness programme for workers should be carried out more particularly to those coming into the plant for the first time
- Establishing Safe work permit for all activities and ensuring strict adherence to them
- Identifying all hazards and establishing ways to protect the workers
- Environmental monitoring to assess level of environmental pollution
- Every safety or environmental incident should be investigated and reported
- 'Job Safety Hazard Analysis' should be carried out for all jobs
- The use of PPE should not be compromised.

To achieve the above objectives, this framework suggests:

a) Induction

Induction of all the outage workers with particular attention to the contract workers should be carried out to ensure everyone understands all the health, safety and environment issues concerning the outage. The induction should contain information on the following areas:

- Work permits for all jobs
- Use Personal protective equipment
- Adherence to safe modes of carrying out tasks.
- Chemical handling
- Pollution control methods, etc.

b) Safety Audit and Reviews

This framework suggests that safety and environmental audit team should be constituted. The team should be moving through the plant and visiting workstations at specified intervals during the outage to ensure that;

1. All tasks in-progress have work permits.
2. The content of the permit is adhered to.
3. The use of PPE is strictly followed.
4. Identifying and reporting any safe acts and 'near misses'.

8.7.2.5 Communications Management

Effective communication is very critical to the successful implementation of a TAM project (IAEA, 2002, 2006). Communication in a TAM project recognises communication planning, information distribution, performance reporting and administrative closure as identified by PMBOK (PMI, 1996). TAM project is however associated with a compressed time frame with a large number of people from different contractors (Ertl, 2005). Adequate communication should therefore be put in place to reduce delays, conflicts and accidents. Effective mechanisms to communicate the status and progress of TAM to the policy team as well as the entire TAM participants should also be in place.

This framework suggests that communication should be grouped into three as supported by Haber, *et al.* (1992):

a) Pre-Shutdown Communications

Organisations should put in place adequate strategies of reaching out to all TAM participants prior to the Shutdown. The TAM management (including the contractors' management) should have a meeting with the policy team. During this meeting, the policy team should explain in simple terms the goals and objectives of the project. A pre-shutdown meeting should also be held between the TAM leadership and all the other TAM workers.

The other pre-shutdown communication that is very fundamental is induction of the contractors' workers. Most of the contract workers are new to the plant and therefore need to be given adequate orientation. These inductions should be aimed at familiarizing them with the plant and on the activities of the shutdown. They should also be given an overview of safety issues related to their jobs. Induction is also used to resolve the problem apparent with communication problems due to language differentials. Some contractors' workers that cannot speak or write English should be identified early and adequate arrangement made to handle them. Induction in the various languages to suit the contractors' workers should be used in this regard.

b) Shutdown Communications

During the shutdown proper, effective and adequate communication is very vital. Shutdown review meetings to report performance, review and track the activities of the event should be in place. Two meetings are suggested in this framework:

1. Morning: 9:00; meeting between the TAM Manager and the Policy team
2. Evening: 16:00; The TAM management team meeting.

The reports of the meetings are passed unto the various workers through their unit heads.

c) External communications

The external bodies like the Regulatory bodies and inspection agencies need to be informed about the progress of activities related to their area. These external agencies need to be adequately informed about the timings and schedule of work involving them to avoid delays.

8.7.2.6 Time Management

Managing time is very critical in any TAM project. Considering the negative impacts of time overrun, TAM leadership should ensure it is avoided as much as possible (Ertl, 2005). PMI (1996) identified the following processes for Time management in managing project:

- Activity Definition
- Activity sequencing
- Activity duration Estimation
- Schedule development
- Schedule control.

These can also be applicable to TAM projects, but it should be noted that Activity definition, sequencing, duration estimates of a TAM project is very dynamic. Unlike EPC projects it is very difficult to have an exact time plan because of scope fluctuations. It should also be noted that time overrun is usually a major issue when it impacts on the critical path of the TAM project. In planning, this framework suggests that the worst case scenario be used for planning on the 'critical' equipment on the critical path. This will eliminate emergent scope along the critical path.

For effective Time management, the following should be put in place:

1. Activities should be clearly defined and should be measurable
2. Activities should be defined every time there is a break or change in work content and/or changes in the work crew

3. Activities should be properly sequenced to enhance the optimum utilisation of resources
4. Estimates for activity duration and the required resources should be realistic
5. Schedule development using CPM, GERT or PERT should be established
6. Schedule change control system to handle schedule changes should also be put in place.

a) Contingency time

This framework suggests that contingency time should also be in place. This is because extra time may be required to handle emergent tasks which might take the project into areas that had not been anticipated, difficult or unfamiliar work which might create challenges not faced by teams previously. All these may result in time extension which could be accommodated within the contingency.

8.7.2.7 Cost Management

TAM project cost management includes the processes required to ensure that the project is completed within the approved budget. PMBOK (PMI, 1996), identified the following major processes towards achieving this; Resource planning, Cost estimating, Cost budgeting and cost control. Creating budget for a project is relatively straightforward if the exact work scope is known (and may not change over the life of the project) and the unit costs of resources, goods and services are known. Unfortunately, this is almost never in the case of TAM projects unlike in generic projects.

As recognised above the major components of scope in a TAM project are 'known and anticipated' scope items.

a) Known scope (KS)

These scope items are mainly project jobs and maintenance jobs that are properly defined. The tasks that make up the scope are known and hence can be planned for and budgeted for.

b) Anticipated scope (AS)

These scope items cannot be finally defined until the equipment is opened, dismantled and inspected. So the cost placed on this group is based on estimates and probabilities.

c) Emergent scope (ES)

These scope items are scope that emerges during the TAM project execution. They are usually not planned nor estimated for. Contingency cost is usually approved by the policy team which can be used for emergent jobs.

d) Cancelled scope (CS)

At the end of the project the cost items need to be reviewed to know the exact cost of the project. This is because at the end of the project, some scope items may be cancelled. These cancelled scopes may be due to over estimation of the deterioration of the equipment in the anticipated scope.

Generally in a TAM project;

Budgeted Cost (BC) *= Known scope (KS) + Anticipated scope (AS) + Contingency …… 1*

Actual Total Cost (AC) *= (KS + AS + ES) - {Cancelled Scope (CS) + Contingency} ….. 2*

8.7.2.8 Contract Management

TAM project depends on the input of various contractors for its successful implementation. Contractors are in TAM projects for varying reasons. These have been identified to include, according to Lenahan (1999); Levitt (2004):

- To reduce elapsed time of an outage
- Unavailability of enough personnel in-house
- Lack of appropriate licence for some jobs
- Work that can be moved off-site should be done by contractors so that it will not strain resources or infrastructure
- Experience and professionalism
- Some contractors are specialized in certain areas
- Productivity, cost and efficiency.

a) Contract Strategy

The organisation may use one main contractor, who will then hire other sub-contractors to manage the outage or use the in-house management as the main management team. Contracts generally fall into three main categories:

1. Fixed price or lump sum contracts
2. Cost reimbursable contracts

3. Unit price contracts.

It has been established that whichever contract arrangement to be adopted depends on one or a combination of the following:

1. The work scope and how it is packaged
2. The nature of the jobs involved
3. Skills and experiences of the in-house personnels
4. Availability and competence of the contractors
5. Amount of risk the organisation is ready to assume.

For contract strategy to be adopted, this framework suggests the following:

i) *Management*

In-house management is recommended to manage the outage. The jobs that cannot be handled by in-house personnel should be contracted out to contract organisations.

ii) *Known Scope*

For a TAM project, *fixed-term or lump sum contracts* should be administered to jobs involving 'known scope' tasks. Here the scope is known and the tasks associated to the scope are well defined. The organisation can easily seek for bids based on scope.

iii) *Anticipated Scope*

Cost reimbursable contracts should be used for 'anticipated scope' tasks in a TAM project. This is because the actual scope is not really known but based on estimates. The contractors are paid the actual cost of delivering the tasks and allowed an agreed percentage as indirect cost.

iv) *Supplementary Labour*

In TAM projects, organisations should administer *Unit Price contracts* where contract staff is used to supplement in-house workers to carry out tasks. This is usually expressed in cost per labour hour.

b) Contractor Selection

One of the most difficult decisions facing TAM Managers is the selection of contractors(s). This is because a wrong choice of a contractor can cause time overruns which needs to be avoided in this type of project.

In selecting a contractor the following should be considered:

- Cost
- Competency in carrying out the tasks
- Contractors Reputation
- Safety record of their past works.
- The technical knowledge and skills of the individuals in the contractors' team.
- Past failures
- Thorough assessment of each contractor's capability (in terms of manpower, skills etc)
- Relationship between the contractor and the organisation.

c) Managing contractors

The following should be in place:

- Reduction of interfaces among the different contractors on one hand and between in-house personnel on the other.
- Pay schedule for the contractors to be properly defined and adhered to.
- Proper assessment in terms of quality control and assurance of contractors supplied materials and jobs.

d) Contractors' incentives

Contractors and their workers form a large percentage of personnel in a TAM project. Failure of the contractor to deliver at the expected time definitely means TAM project failure. This framework suggests that organisation should arrange some motivational schemes with the contactor (s) (depending on the nature of their tasks). Mostly a 'gain and pain' bonus system should be arranged for contracted 'known and anticipated' scope job items.

8.7.2.9 Material/Logistics Management

Non availability or wrong specification of materials/spares can cause serious delays to a shutdown project (IAEA, 2002). Early identification of materials and spares required for the shutdown is very necessary for the success of the event. This will allow for the procurement of the spares especially long lead items.

As part of pre-shutdown activities, all materials (spares and equipment) including equipment for hire should be identified. Orders are then placed for them at the earliest to ensure they are delivered prior to the outage. *"It is advisable not to start the outage until the materials are all on site".* For a successful management of materials (spares) the following should be in place:

1. Appointing experienced personnel in outage materials management to be in-charge of materials procurement.
2. Regular communication should be established between the TAM leadership and the Materials function.
3. The work list should be analysed at the earliest to identify materials needed for the outage.
4. Identifying long delivery, speciality and unique items and their delivery needs.
5. Materials to be procured should be correctly specified.
6. Materials tracking procedure should be in place to ensure adequate follow ups.
7. Quality assurance system must be put in place to assess the quality of materials received to ensure they conform to specification irrespective of their source.
8. All contractors supplied materials need to be inspected and approved before installation.

On arrival of the materials, spares and equipment the following are needed:

1. A plot plan should be in place to ensure the safety, availability and effective mobilization of every item on site.
2. Need to ensure materials, equipment/tools, crane/transportation, utilities and accommodation and facilities are in place.
3. The method of receiving items into the store should be defined.
4. Demobilization of hired equipment should be very effective and should be moved off site as soon as its services are over.

a) **Materials for Emergent jobs**

Materials required for emergent scope that are not in store can cause a lot of problems to the outage. The following approaches could be helpful:

1. Complex items should be identified and placed on standby orders (with expedited prices being established) instead of making blanket purchases before the shutdown.
2. Depending on the location, in UK for instance, most spares can easily be produced on emergency bases from local vendors.
3. Organisations operating in other locations within or overseas can seek help from their sister organisations.

4. The component can be amended and re-used.
5. The system can be re-designed and the failed component by-passed.

8.7.2.10 Risk Management

All projects are inherently risky (APM, 2005). As in all projects, risk management in a TAM project has four basic components as defined by PMI (1996):

- Risk identification
- Risk quantification
- Risk response development
- Risk response control.

TAM projects usually entail a high degree of risk. Because the scope of work is only partially known, managers must prepare for the possibility that the effort to clean or repair equipment may exceed estimates and expectations when the equipment is opened and inspected. Though there are varying risks from one TAM project to the other but the most common ones as suggested by this framework which organisations should be wary of include:

- Human error due to; excessive overtime, shift rotation, rapidly changing plant configurations and organisational changes and assignments
- Emergent works
- Technical risks associated with aging plant
- Health, safety and Environment risks
- Lack of the relevant skills
- Delays in delivery of critical spare (particularly sole source)
- Improper planning
- Missing spares
- Wrong installation of spares
- Communication risks (contract staff coming from overseas with different languages).

Other risks recognised include the proper installation and commissioning of new equipment and properly interacting with the existing ones.

The following strategies should be in place for managing risks:

1. A checklist of risk elements should be developed
2. Stakeholders should be interviewed to identify risks

3. Deciding on the probability of the risk and its relative impact to TAM
4. The TAM leadership should identify and establish ways of responding to the risk
5. Organising the team to be risk vigilant in order to respond to risk treats
6. Ensuring the Security of the plant, workers, equipment and spare.

The major threat in managing risk is that individuals involved should understand that apart from logging the apparent risks, they should actively manage and reduce risks, not simply recording them.

8.7.2.11 Works Management

Works management in a TAM project involves planning, scheduling and managing the entire activities to ensure a successful outage.

a) Planning & Scheduling

The sources of scope items have been dealt with. The project jobs and the TAM jobs should be integrated to form a consolidated TAM project schedule (Oliver, 2001, 2002). Planning in a TAM project should constitute the following:

1. Unique milestone plan - identifying all key TAM planning activities needed prior to execution should be established
2. Detailed plans of time, safety concerns, human & material resource, regulatory & technical requirements, cost and communication should be in place
3. An integrated execution plan to incorporate the entire TAM activities should be established
4. The critical path program should be identified
5. The shutdown network showing all the shutdown activities should be developed
6. The start-up network should be developed showing all commissioning and star-up procedure
7. Additional work approval plan should be in place to ensure emergent jobs are approved with ease.

To facilitate proper planning, this framework recommends that organisations should use the most efficient project planning software along with asset management software tools to manage TAM project. There are also TAM project planning software that can help in faster and more efficient planning.

b) Management/Supervision

For an effective, successful and more efficient TAM project this framework suggests that an in-house TAM management leadership and supervisory team are preferable to a contract management team. In-house management/Supervisory team:

- Responds to changes more quickly
- Responds to the in-house knowledge base very quickly
- Generates more sense of responsibility and ownership since the team will be in the system through the operational campaign period.

8.8 TURNAROUND MAINTENANCE MANAGEMENT POST IMPLEMENTATION

At the end of the TAM projects, this framework recognises two major important issues: TAM project Evaluation and Closeout reports.

8.8.1 EVALUATION

TAM project evaluation is essential to understand and assess the key aspects that make it either a success or a failure. TAM project should be evaluated by assessing the management success elements, the satisfaction of the stakeholders and the resultant benefits of the project to the organisation. Basically all the stakeholders including the top management are satisfied with the TAM project outcome if the management is successful and the resultant benefits expected from the project are realised.

In addition to the above however, the satisfaction of the contractors are met after considering their profit margin and how the project has improved their reputation and credibility.

For TAM success measurement, this framework (as shown in Figure 8.8) suggests the criteria for assessing, cost, time, quality, safety, environmental performance, functionality and the resultant benefits of a TAM Project.

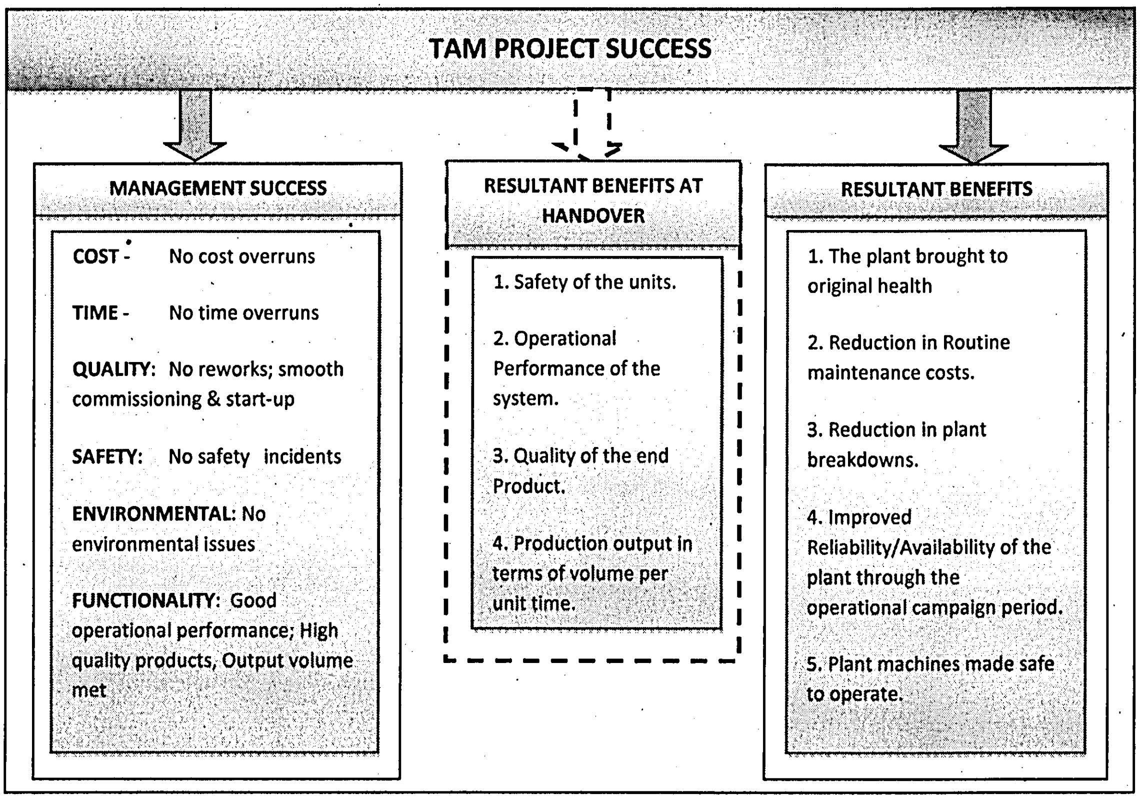


Figure 8.8 Framework for TAM success measurement criteria

8.8.1.1 Cost

TAM project is said to be successful in terms of cost if there are no cost overruns i.e., Actual Total Cost (AC) is less than or equal to the Budgeted Cost (BC).

Budgeted Cost (BC) = Known scope cost (KS) + Anticipated scope cost (AS) + Contingency

Actual Total Cost (AC) = (KS + AS + ES) - {Cancelled Scope cost (CS) + Contingency}

where ES = Emergent scope cost.

Mathematically if $AC - BC > 0$ implies cost overruns

$AC - BC \leq 0$ implies TAM success in terms of cost.

8.8.1.2 Time

Time (or duration) of the project is successful if there are no time overruns.

8.8.1.3 Quality

Quality in a TAM project can be assessed by:

1. Level of rework
2. Start-up incidents
3. Commissioning incidents.

The evaluation will consider the following for each of the quality issue identified above:

- The cause of the poor quality work
- Cost of rectifying the problem in terms of material and labour
- Time taken to resolve the problem.

8.8.1.4 Safety

In TAM project safety performance can be evaluated by a review of the following:

1. Personnel Safety incidents
2. Plant equipment safety incidents
3. Exposure to hazards (radiation, chemicals etc)
4. Near misses.

The following are the elements of measure:

- A detailed safety incident report
- Lost time due to safety incidents
- Legal issues due to safety incidents
- Level of injury or damage done to the equipment.

8.8.1.5 Environmental Performance

For environmental performance of a given TAM project and environmental impact assessment should be carried out to ascertain impact of the following to the environment:

1. Gas emissions
2. Liquid contamination
3. Solid waste.

The levels of pollution are compared to the emission standards as set out by Environmental Protection Act. 1990.

8.8.1.6 Functionality

The functionality of the system can be measured by the level of performance of the system.

Generally the functionality can be measured by the equipment or system reliability, implying being able to deliver and meet the expected:

1. Quality of the products and
2. Quantity per unit time of products.

8.8.1.7 Resultant Benefits

The overall resultant benefits expected of a TAM project are:

1. Bringing the plant to their original health
2. Reduction of plants routine maintenance costs
3. Increasing the Reliability and Availability of equipment during operation.

These are usually measured throughout the plant *'operational campaign'* till the next shutdown. At the hand-over however the following should be used to establish that these resultant benefits are achievable or not:

1. Safety of the units
2. Operational performance of the system
3. Quality of end product of the system
4. Output performance.

In summary it can be said that "*a TAM project is successful if the management is successful and the resultant benefits are achieved*".

8.8.2 CLOSE OUT REPORTS

At the end of the event, a final TAM project review meeting should be carried out between the TAM management and the policy team to evaluate all the elements identified above (Lenahan, 1999). This meeting which is interactive in nature will enable the organisation evaluate the performance of the project in the key areas described above.

This will help in identifying areas that need strengthening in future TAM projects.

Reports on the all critical jobs done are noted. Tasks and scope items not carried out should also be identified. The condition of components of all major equipment should be noted especially those that are expected to fail by the next shutdown. These will form part of the next outage scope items.

8.9 TURNAROUND MAINTENANCE MANAGEMENT IMPROVEMENTS STRATEGIES

Apart from the TAM Concept, Leadership organisation, Management Process and the TAM Post Implementation this research project has also identified some improvement strategies which need to be adopted to improve on the performance and hence the success of TAM projects. The framework hence recommends:

8.9.1 Standardization of Spares/Components

Organisations should request their equipment manufacturers to use as much as practicable standardised components in the design and fabrications of their machines and equipment. This will in no small measure reduce stock holding of spares as these will readily be available from any vendor for outage tasks especially on issues concerning emergent jobs.

8.9.2 Quality improvement of components

There is also need for an improvement on the quality of material content of the critical components of the equipment. Particular attention should be on those components whose failure will entail total shutdown of the plant (Woodhouse, 2002). While condition monitoring and all other NDT strategies are essential it will be worthwhile if the life span of these components coincide with the TAM project interval. This means that during the shutdown, these components should be changed reducing anticipated scope levels. This will increase the levels of known scope items and hence reduce emergent jobs.

8.9.3 Alliance with Contractors

Considering the cost of mobilising contractors on site during each TAM project in the form of inductions, the cost of assessing the credibility and otherwise of contractors and their team, it will be of obvious advantages to stick to known contractors and their crew members. This will also imbibe the spirit of ownership amongst the contractors which may be lacking when they feel the job may be a 'one-off affair'. Long-term partnerships with contractors can even allow for fixed labour rates and discounts based on the successful execution and longevity of their contracts. In some cases, based on the success of the partnership, labour rates might be reduced rather than increased.

8.9.4 Maintenance Management Strategy

The maintenance management strategy used in maintaining the facilities affects the TAM project outcome. Maintenance strategies such as Predictive, Preventive, Reliability-Centred maintenance and most recently Risk-based inspection are known to assist in narrowing down the level of emergent jobs during the execution of the project. Adequate maintenance records and equipment/machine repairs historical records using Computerised Maintenance management software are also required to be kept properly. These will help in reducing the levels of estimates (anticipated work scope) which is a major feature of TAM projects.

8.9.5 Improvement in Equipment Condition monitoring/Inspection methods

The most critical problems facing TAM management usually are emergent scope items as most tasks are based on estimation from condition monitoring and NDT results while the equipment is in operation. Organisations should therefore invest in the best equipment and mapping of methodologies that are capable of verifying the technical condition of process equipment without having to open them. Adequate training of the personnel who will be responsible for monitoring and analysing the results using these tools and equipment should also be put in place.

8.9.6 TAM project timing

Another issue that require attention is the timing of the outage. Most contractors specialised in outage jobs move from one plant to the other. If two or more organisations are carrying out their TAM project same time within the same geographical area, there may be problem in having the right technical resources from these contractors. This may lead them into recruiting personnel of less skills and experience. This will at long run affect the outcome of the organisations outage. Organisations should therefore plan and execute their outage at a time when there are enough resources available to the contractors.

Other outside influences to be taken into consideration include the time of the year, as outages scheduled in very cold and very hot weather are less efficient with increased risks.

8.9.7 Mapping of Cleaning in Place (CIP) technology

A high percentage of tasks related to tanks and pressure vessels involve cleaning. Utilizing and preparing for the use of CIP technology offers the potentially considerable time savings as the equipments involved are not to be dismantled before the cleaning (Thorstensen, 2006). Investments in this area are highly recommended by this framework.

8.9.8 Improving the planning strategies

Planning is recognised as the most critical success factor of a TAM project. Adequate effort need to be put in this area. Most of the maintenance jobs in a TAM projects are repetitive from one TAM to the other (Pokharel & Jiao, 2008). It is recommended by this framework that these jobs (tasks) should be carefully planned for (with the assistant of the equipment manufacturer's information) together with:

1. Details and sequence of the activities to accomplish task
2. The number of personnel, their skills and experience required for the tasks
3. The time frame for the task
4. The spares, tools and equipment needed
5. The safety needs to ensure the usual 'zero' target
6. The environmental impact analysis
7. Assessment procedure to evaluate the job done and
8. Hand-over procedure.

This information should be stored in a data base. Based on the state of the equipment this information can then be amended.

8.10 SUMMARY OF THE CHAPTER

Chapter 8 presented the outcome of the research conducted in the UK process plants using both secondary (in-depth literature review) and primary (survey and case studies) methods of research. The chapter presented a best practice framework developed for the successful implementation of TAM projects in continuous process industries in the UK. The framework was elaborated in five detailed areas; the TAM concept, Leadership Team, Implementation process, Post implementation and Improvement strategies. The chapter highlighted issues that the organisation need to put in place to enable the management team to manage the project successfully. Areas of improvements to enhance the TAM project success were also identified and explained. The next chapter presents the validation of this framework using experienced and hands-on TAM professionals in continuous process plants in the UK.

9.0: TAM FRAMEWORK VALIDATION

9.1 AIMS OF THE CHAPTER

Chapter 8 presented the framework developed for the successful implementation of TAM projects. This chapter presents the validation of the framework. The chapter starts with an introduction which explains the objectives of the validation exercise. The chapter presents the validation process adopted and its justification. The profiles of the individuals who participated in the validation are outlined. The responses received from these verifiers are presented. Each feedback is followed by the analysis of comment or suggestion. Finally, is the summary of findings from the validation and a chapter summary.

9.2 INTRODUCTION

The Turnaround Maintenance Projects Implementation (TAMPI) Framework to be validated is based on the analyses of data from primary and secondary sources from UK manufacturing organisations. It is developed as a best practice guide for organisations operating Engineering facilities (particularly the continuous process plants) for Shutdown maintenance projects to ensure their successful implementation.

The objectives of this validation exercise are:

1. To obtain expert validation of the framework
2. To assess the practicality and applicability of the Framework in TAM projects
3. To examine how TAM Managers and related professionals understand the components of the framework and to assess the relevance of the Framework in TAM projects management
4. To investigate whether the framework would benefit from further modification and if so, to identify the changes which should be considered.

9.3 TAM FRAMEWORK VALIDATION PROCESS

To validate the turnaround maintenance projects implementation framework, it was decided to approach the most proactive individuals in continuous process plants in the UK. The option of an external validation (outside the continuous process plants) was regarded to be invalid and outside the scope of the research work as the framework has been developed for engineering facilities with a continuous processing production system. To ensure a strong validation, the participant (verifier) must be an individual who:

- has vast hands-on experience in TAM management projects
- has in-dept knowledge of TAM management processes for over 20years
- has been involved at different levels in TAM project implementation
- is currently a TAM manager or a TAM Policy team member in a multinational continuous process plant; and
- has been involved in TAM management process outside UK.

The criteria stated above were developed to ensure that only well experienced TAM professionals with vast experience in TAM implementation processes are included in the TAM framework validation exercise. Using the above criteria, six individuals were identified for the validation process:

- Three of them were from some of the organisations who took part in the case studies
- One participated in the survey only; and
- Two were neither involved in the survey nor the case studies.

Table 9.1 Details of the TAMPI framework Verifiers.

Validation I.D	Current Position	Position in TAM	Details
Verifier 1	Shutdown Manager	TAM manager	· Participated in the Case studies for organisation C. (profile already known)
Verifier 2	Planned Events and Contract Manager	TAM Manager	· Participated in the survey. · Has over 20 years of TAM project management experience across Europe.
Verifier 3	Programme Manager	TAM manager	· Participated in the Case studies for organisation A. (profile already known)
Verifier 4	Plant Manager	Policy Team Member	· Currently the Plant manager of a Major Cement manufacturer in the UK. · Has been involved in TAM management processes at various levels for about 35years in the UK and abroad.
Verifier 5	TAR Manager	TAM Manager	· Was on TAM management secondment abroad during the survey. · Has over 30years in TAM management processes · Currently the TAM manager of a major Oil Refinery in the UK.

The feedback from these experienced, proactive and leading edge managers provides a strong validation of the framework. Only five of the individuals (as shown in Table 9.1), however returned with the feedback, representing 83.3% response rate.
Each participant was provided with a copy of the TAM framework and was kindly required to provide their views and comments on:

1. Clarity of the texts and diagrams
2. Suitability, practicality and applicability of the framework in the implementation of TAM projects
3. The relevance of this framework on TAM implementation success
4. Modification and identifiable improvements required to improve on the framework.

This method was chosen to ensure that the validation exercise is void of any bias which can be possible if an interview approach was adopted. It also allowed for considered answers and consultations as the respondents can consult their documents and/or their professional colleague while reviewing the framework. In addition considering the busy schedules of the participants, this method allowed them to review the framework at their own time.

Some possible alternatives were considered for the validation exercise such as the trial of the framework in a live TAM event, organising a workshop and inviting the identified individuals and approaching independent industry practitioners. However, considering the scope and limitations of the research project and the difficulty of getting these individuals together for a workshop, the decision to use the approach above was finalised.

9.4 FEEDBACK AND ANALYSIS

Very encouraging and positive feedback was received on the validation of the TAM projects implementation framework. Nevertheless, the participants made some suggestions to further moderate and improve the framework. The views and comments from each of the participants with their analysis and follow up actions are presented below.

Verifier 1:

- *In the framework, I believe KPIs should be in place as these may be required by senior management to determine the success of the event.*

- *After looking at the TAM leadership structure, I noted that there are other activities such as cleaning, scaffolding, painting, insulation that also needs to be managed but were not mentioned.*

- *I would also suggest that for the membership of TAM Policy team, the following should also be included:*
    1. *Engineering Manager,*
    2. *Procurement Manager*
    3. *Project Manager.*

  Also as some companies may not have all these people in the organisation, many people will have dual roles.

- *Please note that the responsibilities of the supervisory team should in addition:*
    1. *Ensure all emergent work is identified, costed and authorised*
    2. *Ensure environmental issues are identified and controlled*
    3. *Ensure the business safety policy is being adhered to*
    4. *Attend progress meetings.*

- *In pre-shutdown communication, the production team should be made aware of the project, including work scopes and time frame. This will give them the opportunity to comment before the event begins.*

- *For the contractors' incentive scheme, I will add that any incentive must be based upon the amount of rework required and the successful start up of the plant.*

Overall the texts and diagrams are good; a good diagram is easily understood and is often better than using many words. The framework could be used for any type of shutdown, as most large process plants carry out shutdowns they would be familiar with *the structures proposed and how the event is pre-planned, executed and reviewed. As many companies have developed their shutdown methodology over many years it is always good to look at other ideas been put forward and benchmark against current methodology.*

In our case, despite the methodologies we have developed for TAM projects over the years, this framework has proposed new ideas and methodologies which I believe can bring about success and improvements in any TAM project if adapted appropriately. Smaller companies who don't adopt such a structure would find this a very practical guide; although employees would have to take multiple roles due to the number of employees. For new graduate engineers the document would be very valuable as it gives them a structure to work with on their first shutdown event and for experienced TAM professionals the framework will assist them to improve on their current methodologies.

Feedback Analysis (Verifier 1)

- The framework recommended that the organisation should develop internal and external performance measurement criteria like 'Key Performance Indicators' (KPIs) to assess the effectiveness, efficiency and the success of the TAM project as part of the conceptual issues. These KPIs will not only assist in TAM success determination, it will also help assist in ensuring efficient management of resources during the event.

- The TAM leadership structure presented in the framework only showed a sample of what the leadership structure should look like. According to the framework the organisation should develop TAM management positions for their TAM projects according to their operations and nature of the tasks involved.

- The framework has been developed for the purpose of ensuring TAM success. Considering the importance of TAM projects to the organisation, the participation and involvement of the most senior management team was strongly recommended at the policy team level. The list presented by the framework was to identify typical members, the Engineering Manager, according to the framework should be the TAM Manager, and otherwise should be in the Policy team if the organisation has a full time TAM manager. The Project manager and the Procurement managers should be members of the TAM management team. Depending on the size of the event, individuals identified with the necessary skills may have dual roles.

- The framework recommended the inclusion of the supervisory team in the TAM leadership team. As identified in the framework, this team should be responsible for ensuring that the work procedures are strictly followed adhering to all the specifications and safe work permit requirements. They are also to present progress reports on their jobs to the TAM management team. These reports should include not only 'how far' but 'how well' the tasks are carried out and other incidents. These incidents might include emergent works, safety and environmental issues. The supervisory team members should present these reports in the TAM management meeting which the framework recommended should be carried out at 16:00 everyday during the event. It should be noted that for any emergent work to be carried out, the emergent work procedure should be followed as recommended by the framework.

- The TAM leadership should have a meeting with the policy team prior to the shutdown. During this meeting, the policy team should explain in simple terms the goals and objectives of the project. A pre-shutdown meeting should also be held between the TAM leadership and all the other TAM workers. The TAM management team includes representatives from all areas of responsibility, it is very obvious that all the departments including the production team should be involved in the pre-TAM activities and hence should not only be aware of the TAM timeline and work scope but contributed in defining them. These are all recommended by the framework.

- The framework strongly recommended that the organisation should arrange some motivational schemes with the contractor(s) depending on the tasks involved. In most TAM projects contractors form a large percentage of the workers. Developing an incentive scheme with the contractor(s) will induce the contractor to develop a motivational scheme with their workers. 'Pain and Gain' bonus system (which is recommended by the framework) is an out-come based incentive scheme. The success criteria attached to the tasks should therefore be used to evaluate their out-come. These may include the amount of rework, star-up incidents, safety/environmental issues and other issues.

In summary, the participant acknowledged that:

- the texts and diagrams are quite clear and very relevant
- the framework can be used for any type of TAM project
- Organisations that have methodology in place should look at and adapt the 'new' and current methodology being put forward by this framework
- This framework has proposed new ideas and methodologies which I believe can bring about success and improvements in any TAM project if adapted appropriately
- Organisations that do not have any existing methodology in place will find this a very practical guide towards TAM project success
- The document would be very valuable to TAM professionals as it gives them a structure to work with on their first shutdown event.

Verifier 2

- *Timeline for the phases need to be identified in TAM Management Procedure based on the understanding of the man-hour size of the TAM and what consequential effect that this has on the preparation/planning/resourcing/.etc.*

- *TAM management leadership team - When it is not practicable to provide internal resource in key roles, understand. How external resources can be integrated into the team without detracting from the key principles of duplication of functions etc. You may want to have duplication in such circumstance so as to be in a position to carry-on if the individual leaves!!!!*

- *Any site will have multiple Projects/Overhauls in varying states of completion, which should be considered as a whole as well as on the individual basis. Such consideration will also link into a site based strategy that will need to be fully integral into each of the separate TAM Projects.*

- *Scope Management has to be controlled as stated, but it also needs to be quantified at conception. In this way each individual scope of work should be evaluated against control criteria to develop a priority scoring mechanism which will deliver a selection process to identify essential work. Work generated should also be evaluated against the potential for work growth and scaled accordingly (i.e. High/Med/Low). In each case agreement should be reached as to how this would be incorporated into the event budget and execution schedule. The principle of a TAM is that there would not necessarily be an opportunity to pre-inspect equipment by breaking it down into component parts so there will need to be an acceptance of risk associated with scope growth. This should be part of the full gambit of TAM development and agreed up-front by the Steering/Management Team.*

- *Resource selection should have an element of assessment with respect to Competence and Capability to assist on the correct appointments into role. This has to be based against proven Roles & Responsibilities which need to be agreed and shared with individuals prior to selection and appointment into role.*

- *Any Bonus or Incentive needs to be very clearly linked into a performance delivery and under no circumstance should be paid for just on attendance. It should also link into the individual trades and not just the companies involved.*

- *Adequate provision must be made to allow full compliance with the European Working Time Directive. This can often be a conflict when utilising internal resource in management roles as there will be little recovery time available with resource taken out of full time roles. This should be given due consideration for the contract resource and management team consequences.*

In summary I can follow the flowcharts, diagrams etc and can understand what it is that they are portraying. As a framework to work within, on Projects and Turnarounds this would work very well as to how well this would work against the success criteria would need to be assessed against a live event. The key thing for me is to assess how to use the framework to improve on our existing methodology in support of varying sized events.

Any organisation that adopts the framework will definitely expect an improved TAM event.

Feedback Analysis (Verifier 2)

- TAM management procedure document is recommended as a guiding document for implementing TAM projects. According to the framework, this document is not restricted to any specific TAM, but can be used for short, partial or rolling plant outages. Depending on the size and the nature of the event (e.g. man-hour size, the complexity of the event etc.), the organisation should develop the timeline to suit the TAM project.

- The TAM framework strongly recommends that all the members of the leadership should comprise of only in-house personnel. Organisations develop/recruit personnels that will have the relevant skills, knowledge and experience to take up the various positions in TAM leadership based on their TAM project tasks requirements. The framework recommends that all functions should have 'minimal' duplication. The functional duplication if allowed during the event will lead to unnecessary friction which may ultimately affect the TAM outcome. Clear definition of functions (with clearly defined roles and responsibilities) makes it easier to bring in a contract personnel to take up positions where there is no internal resource in the role.
  TAM projects is such a short timed project that whoever that will not be involved will be known before the outage. However, if any of the key personnel should leave during the outage, the management should transfer the roles and responsibilities to the immediate subordinate or bring in a contract staff.

- The TAM framework has been developed based on turnaround maintenance of one manufacturing facility. The facility comprises of different units of equipment and machines and in some cases involves multi-site situation. During the event, maintenance (overhauls) is carried out in these equipment/machines and other project jobs. This implies multiple projects/overhauls going on at the same time. As recommended by the framework the project jobs and maintenance jobs (including a multi-site situation) should be integrated to form a consolidated TAM project schedule. An integrated execution strategy is also highly recommended by the framework. If this is not done, significant sum of money will be wasted on TAM through; redundant scope, labour inefficiencies, multiple mobilisations and demobilisations and schedule issues.

- The TAM framework recommends that TAM Manager should organise pre-shutdown meetings involving the departmental heads for the validation and verification of the known and anticipated scope. During this meeting each scope item should be subjected to scrutiny. From the framework we noted that scope growth (emergent jobs) arise through wrong estimation of the state of the internal components of the equipment, hence the framework recommends an improvement in condition monitoring and inspection strategies. Based on the reliability of the information on the equipment condition, the levels of expected emergent work can be scaled. Since emergent jobs are unavoidable (at least for now!!!). The framework recommended various ways of managing emergent work and establishing additional work approval plan to ensure emergent jobs are approved with ease by the Policy team during TAM execution.

- Resource selection for in-house personnel within the organisation according the framework is usually based on skills, competences and qualifications which are known. For the contractors' personnels, the framework recommends that training data bases, skills tests, training/educational certificates, operating licences, past experiences and if possible interviewing the personnel should be used for their assessment. Based on these, the competence and capability of individual must have been adequately assessed before appointment into a role.

- Usually motivational schemes are attached with achieving set objectives. For TAM projects the framework recommends that organisations should establish some incentives for their in-house TAM personnel and a bonus of 'pain and gain' for the contractors. These should all be linked to performance delivery. The TAM leadership should identify and adopt the strategy that suits their situation.

- The framework recommends that organisations should review their outage work pattern to ensure that optimum shift rotation is adopted in full compliance with the statutory working directive.

In summary, the participant:

- understands the diagrams and what they are portraying;
- agrees that the framework would work very well for TAM projects;
- agrees the framework will be used improve on their existing methodology;
- consents that framework can be adapted to varying sized TAM projects; and
- consents that any organisation that adopts the framework will definitely expect an improved TAM project.

Verifier 3

I have read your report and on the whole I find it a very good piece of work, you have covered all the major points the comments I have made are mostly slight additions.

- *The 'long range plans' forecasting period of 10 to 15 years would seem to be excessive, 3 to 5years is industry norm unless they are specific factors relating to type of industry in question.*

- *The Policy team members seem to be over the top, it is unlikely that unless the work was related to a major retrofit involving significant investment then the CEO & CFO would not be involved for routine shutdown work. The Operations manager would not necessarily be involved but the Engineering Manager & or the Maintenance Manager would be involved.*

- *For TAM management team you need to consider Functional management organisations which use individuals from across an organisation who are not solely dedicated to the shutdown. The dynamics of this type of organisation is very different to one you propose or favour. This may be the basis of a recommendation. Under team member skills you need to record and ability to manage finance, no project survives very long without this skill emended in the team.*

- *You identified Known & Anticipated scope, what about legislative scope such as Pressure systems requirements etc?*

- *In Human Resource Management, your range (for work patterns) is too constricted for some plant outages that are likely to last for 10 to 14 weeks for a conventional station, or 7 to 8 weeks for a Combine cycle plant outage. Often companies work a 10 on 2 off pattern to manage staff workload and keep within the European working time directive.*

- *Your statement is not strictly true about* motivation; *many contracting companies do operate a form of bonus system or priced work as an incentive to complete work in a timely fashion. The difference between the actual time and the tendered time being gain for both the project and the individual. There is cost to this type of mechanism in that staffs often looks to cut corners and HSE goes out of the widow, especially at the end of the project.*

- *Additional item relating to business's financial management timeline being in line with TAM project requirements. Many material requirements need to be ordered sometimes up to 2 years ahead. Any delays in approving project expenditure will impact on the timing of TAM projects. New item relating to usage of existing stock and the management of unanticipated changes.*

In conclusion, I must commend the coverage of this framework as it includes all aspect of TAM project to ensure its success. I must commend you for this work. Generally:
1] The clarity of the text and diagrams are on the whole clear and understandable,
2] The framework is a very good starting point for new TAM professionals and for existing ones to benchmark their performance against.
3] Providing TAM teams follow the framework they can expect to see a marked improvement in TAM performance, my experience suggests that it may take several run through's before this benefit is fully realised which will definitely lead to a successful TAM project.

Feedback Analysis (Verifier 3)

- TAM plans should be developed for long, medium and short terms. In the long term planning, the organisation establishes the frequency and duration of outages based on the plant requirements considering equipment aging, need for backfitting, refurbishment (plants improvements), plants upgrades (including new equipment needs and installation) and regulatory requirements. The long term plan optimizes plant availability, total TAM duration and estimated costs. The long range plan period according to the framework was to have estimates for up to 4 TAM projects, 10 to 15years is not therefore very excessive considering the TAM intervals in most organisations. 3 to 5 years falls within the medium term period, which is more detailed than long term planning and is used to estimate the material and human resources needed and incorporates medium sized backfitting/refurbishment activities.

The short term plan is the detailed planning for the next TAM.

- The framework has been developed for the purpose of ensuring TAM success. Considering the importance the success of TAM projects to the organisation, the participation and involvement of the most senior management team is strongly recommended. The list presented by the framework is to identify typical members. The Engineering Manager according to the framework should be the TAM Manager and should be in the Policy team if the organisation has a full time TAM manager. The maintenance manager (if not the TAM manager) should be a member of the TAM management team.

- The framework strongly recommends that the TAM management team should represent all areas of responsibility of the organisation and developed specifically for TAM projects. The framework recommends that individuals that make up the team have to be assessed and should be suitable for a TAM management role before being appointed and is based on the individual's skills, competence, knowledge and technical skills required for the position irrespective of his/her functional position in the organisation. This implies that individuals can be appointed into a TAM management role irrespective of the individual's normal functional responsibility. A range of management skills for TAM management including financial management (cost management and budgetary control) are recommended for the TAM manager and the TAM management team.

- According to the framework, all jobs for TAM project with a defined scope is categorised as *Known Scope.* This means that *legislative scope* such as pressure systems requirement which usually have defined scope is a *known scope* item.

- Considering the work patterns common to most TAMs and its implication to TAM project outcome, the framework recommended that *organisations should review their outage work pattern to ensure the optimum shift rotation is adopted.* This framework however suggested 2 10-hours per day shift with the 2hours between the shifts used for technical audits of the tasks done and, 1 day off duty should be included after 7 days work (for long outages; duration>7days)

- The framework recommends that a motivational scheme be put in place for in-house personnel and a 'gain and pain' bonus system for the contractors. The issues of motivational scheme for contractors have already been covered in the feedback of Verifier 1. Adherence to HSE management methodology and quality assurance methods proposed by the framework will ensure no cutting of corners by either staff or contractors' workers during the event.

- The problem of not having the spares on site for TAM can be very devastating to the success of the event. The framework summed this with the statement; *"It is advisable not to start the outage until the materials are all on site".* Appointing experienced personnel to be in-charge of TAM material as recommended by the framework should be implemented to ensure materials are ordered in good time. As recommended by the framework, TAM philosophy ensures that TAM is formally recognised and aligned to the overall business strategy, which ultimately ensures that the organisation's financial management time line is in line with TAM project requirements.

In summary, the participant;

- ➢ The text and diagrams are void of any ambiguity.
- ➢ The framework is very useful for new and experienced TAM professionals.
- ➢ Following the framework will result in a marked improvement in TAM performance which will definitely lead to a successful TAM project at long run.

Verifier 4

- *For TAM management team, what about multi-site implication? Capital project implication? The responsibilities of the TAM supervisory team should include reviewing emergent work.*

- *In developing Anticipated scope items, there is need to consider changes affecting life cycle change due to changing inputs, i.e. process changes, chemical attack/erosion, etc.*

- *Cost implication, working time directive, cross country rules should be considered before chosen any shift pattern. It should also be noted that the critical path jobs must be continuous.*

- *In Time management, you cannot plan worse case critical path (that is ideal world, not real world). The framework suggested contingency time to be included, I feel contingency in cost should be allowed only; you can resource up to meet schedule.*

- *For contract management, the TAM team should watch out for contract companies subbing out some or all of work – QA issues??*

- *In contactors selection criteria you suggested past failures in TAM projects, what about past successes? In addition to the list of criteria the contractors' task hourly paid and fixed price need to be considered.*

In conclusion, the above are the issues I believe needs to be considered, however the framework;

1. *Text was clear to understand especially if you have a good in depth knowledge of shutdowns / turnaround events and their structure.*

2. *I would have no doubt that the content of the framework could be easily applied by end users; however be aware that not every company has the resources; people or financial capacity to apply every aspect; to apply the full logic and systematic approach would require extensive training and high level company support to embed in an organisation.*

3. *The framework is relevant; I have no doubt that the TAM implementation would have success if used.*

Feedback Analysis (Verifier 4)

- The TAM management team is the management team appointed by the TAM manager to ensure the successful management of a TAM project. If the TAM project involves multi-site, then managing TAM activities in those sites should be considered while constituting the TAM team. The capital projects going on during TAM should be part of the TAM integrated activities. The project manager according to the framework should be a member of the TAM team. The issues of the responsibilities of the Supervisory team concerning 'emergent scope' are covered in the feedback of Verifier 1.

- The framework recommended a number of ways the condition of equipment can be assessed prior to the event. The condition of the equipment as a result of process changes and chemical attacks/erosion can be tracked by any condition monitoring and inspection strategies identified.

- The issue concerning work patterns have been covered in the feedback of Verifier 3. The pattern selected should be in line with the state working time directives. The framework recommends that the TAM critical jobs should be continuous, but for quality assurance purposes, time is allocated for technical audits between shifts.

- The critical path for any project is used to define the project duration. TAM projects are characterised with emerging scope items during the event, to avoid project duration overruns, the framework suggests that the worse scenario be planned for equipment in the critical path. The framework noted that there are situations where difficult or unfamiliar work emerges which may create challenges that are not faced by the TAM workforce previously and hence suggested that contingency time should be put in place. The contingency time should only be approved under this kind of situations especially where spares/materials as well as the personnel with the relevant skills for the repair may not be available readily. *You can resource up to meet the schedule when the personnel with the right skills and the materials to do the emergent jobs are readily available.*

- The framework recommends that adequate Quality control/assurance be put in place. If this is done with qualified and competent TAM supervisors are in place, it will be difficult for the contractor(s) to 'sub' out some or all of the work.

- In the selection of contractors, the framework suggested some key criteria as a guide. Cost, which is one of these, should cover every issue concerning money such as hourly rate, fixed price (lump sum) and any other cost items. Past failures of the contractor in TAM projects is also identified as this will enable the organisation know the circumstances that led to the failure; this will really help in assessing the competence of the contractor.

Finally the participant;

1. Understands the diagrams and the information they are conveying.
2. The TAM framework will be very useful to end users
3. The framework is relevant in managing a TAM project and will lead to TAM implementation success if used.

Verifier 5

I have read your framework for TAM management; it is quite good and comprehensive. I have read many books and articles on shutdown maintenance; this is all encompassing and has considered all the relevant issues that affect TAM project, I must commend you for that. However I have very few comments to make.

- *What type of 'Key Performance Indicators' are you suggesting?*

- *You mentioned Health, safety and environment (HSE) in various sections of the framework; I am of the opinion that in all situations HSE should be top most. These sections are:*
    1. *Critical Success factors*
    2. *Contractor selection criteria*
    3. *Risk management issues*
    4. *TAM success measurement criteria.*

- *If Long range plans are made, - what if there is a new build and no historic data? What about new equipment/ project / upgrade?*

- *The meeting schedule for shutdown communication you suggest would be OK for short outages but may seem impractical for longer outages, consider providing atonality.*

- *Often in inspection based shutdowns, a menu pricing contract is employed, here a schedule of rates is priced for anticipated work and called off when required following the inspections.*

Finally, I will say I like your diagrams, they are clear and the texts are understandable. As I stated earlier this is the first of its kind and will really help to improve the implementation of TAM projects. There is bound to be a remarkable improvement in TAM project performance and success can be achieved if this framework is adequately followed. To me I see this is a good guide and can be adapted to different sizes of TAM projects.

Feedback Analysis (Verifier 5)

- 'Key Performance Indicators' as recommended by the framework are performance related issues which the organisation should develop depending on their operations to ascertain if the TAM project is progressing as planned. Hold-points, milestones, checkpoints can be built into the plans and used to check the performance of the project. Cost, safety/environmental issues, percentage work done/remaining are some of the indicators that can be used.

- Health, Safety and Environment issues are very crucial in TAM projects. They are major components of TAM success criteria, and hence one of the critical success factors (CSF) of TAM projects implementation. They are also important elements in the criteria of selecting a Contractor as their past HSE records need to be assessed. Overall the framework did not present the elements in each of these areas according to their order of importance. It is the responsibility of the organisation to identify their order of priorities in any of the areas.

- The issues of 'long range plans' have been covered in the feedback from Verifier 3.

- In order to emphasise the need for effective communication at all levels during a TAM project, there is need for regular meetings; between the Policy team and TAM manager on one hand and TAM management team on the other. The framework only suggested the times as a guide. The exact timing to be adopted is an issue the organisation should really decide on.

- Based on inspection results, if there are elements of certainty on the scope, *menu pricing contract* (a hybrid of fixed term contract and unit price contracts) can be applied. To be on the safer side, the framework recommends cost reimbursable contracts on all anticipated scope items.

Finally Verifier 5 explained that:

- The diagrams and texts are clear and understandable
- The framework is very relevant and a remarkable improvement and success is expected if adequately used.
- The framework can be adapted to different sized TAM projects.

9.5 SUMMARY OF FINDINGS FROM THE VALIDATION PROCESS

Overall, a very positive and encouraging feedback has been received from industry practitioners who have vast experience in the TAM implementation processes in process plants both in and outside the UK. The feedback confirmed that the best practice framework and approaches will not only bring about a remarkable improvement in TAM project implementation process but will also ensure that TAM projects are successful. These are exemplified by the following views:

Despite the methodologies we have developed for TAM projects over the years, this framework has proposed new ideas and methodologies which I believe can bring about success and improvements in any TAM project if adapted appropriately. For new graduate engineers the document would be very valuable as it gives them a structure to work with on their first shutdown event and for experienced TAM professionals the framework will assist them to improve on their current methodologies.

(Verifier 1)

As a framework to work within, on Projects and Turnarounds this would work very well as to how well this would work against the success criteria would need to be assessed against a live event. The key thing for me is to assess how to use the framework to improve on our existing methodology in support of varying sized events. Any organisation that adopts the framework will definitely expect an improved TAM event.

(Verifier 2)

The framework is a very good starting point for new TAM professionals and for existing ones to benchmark their performance against. Providing TAM teams follow the framework they can expect to see a marked improvement in TAM performance and will definitely lead to a successful TAM project at long run.

(Verifier 3)

I would have no doubt that the content of the framework could be easily applied by end users; however be aware that not every company has the resources; people or financial capacity to apply every aspect; to apply the full logic and systematic approach would require extensive training and high level company support to embed in an organisation. However, the framework is very relevant to TAM projects; I have no doubt that the TAM implementation would have success if used.

(Verifier 4)

This framework is the first of its kind and will really help to improve the implementation of TAM projects. There is bound to be a remarkable improvement in TAM project performance and success can be achieved if this framework is adequately followed. To me I see this is a good guide and can be adapted to different sizes of TAM projects.

(Verifier 5)

The above confirm that the TAMPI framework developed in this research is a best practice guide to organisations in the implementation of their TAM projects. The views of the verifiers on the clarity of texts and diagrams, the relevance, suitability and applicability of the framework show that the framework:

- diagrams and the texts are very clear and void of any ambiguity and the diagrams explained the structures they are presenting adequately

- The framework is very suitable for TAM projects and is applicable to varied sized TAM projects irrespective of the complexity of the operations and equipment
- Organisation adopting the framework can expect to see a marked improvement in TAM performance
- The TAM implementation would have success if the framework is adequately followed.

Though there may be operational differences in the various plants, organisations benefiting from the framework are envisaged to adopt the process and structure developed according to the requirements of their TAM projects in terms of size, and complexity of their facility.

9.6 SUMMARY OF THE CHAPTER

The above is the report of the industry validation of the framework for TAM projects implementation. In the beginning of the report, the process adopted for the validation was elaborated. The external validation outside the continuous process plants was not relevant owing to the focus of the framework on continuous processing plants. Nevertheless, the report described that proactive managers with vast experience in TAM projects implementation were approached to validate the framework. In the feedback section, the outcome of the validation process was outlined. The validation exercise returned a very positive, supportive and encouraging feedback. Furthermore some suggestions were made and follow up analysis of each suggestion was provided. The summary of the findings from the validations shows that the framework is valid and is not only relevant to TAM projects but will ensure successful TAM implementation if adequately used.

10.0: CONCLUSIONS AND RECOMMENDATIONS

10.1 AIMS OF THE CHAPTER

This is the final chapter of the thesis and presents the conclusions and recommendations that are drawn from this study. It presents the summary of the research work carried out in the research process, and the research findings. The chapter also outlines the preliminary findings which identify the need for the research and the research outcome showing the achievement of the research aims and objectives. The chapter confirms the originality of research findings, (the best practice framework) and its contribution to the body of knowledge. The limitations identified for this research work are explained as well as the applicability of the findings. Areas of further work and research to support the TAMPI framework are presented. The chapter concludes with a chapter summary.

10.2 SUMMARY OF THE RESEARCH PROCESS

This research is aimed at determining the critical success factors of TAM projects and developing a framework to ensure the successful implementation of TAM projects. To achieve these, four major areas of enquiry were set at the onset of the research. These were to identify and determine:

1. the success measurement criteria of TAM projects
2. the critical success factors of TAM projects implementation
3. TAM management specific methodology; and
4. the management skills required for a successful TAM project

These were accomplished by employing three main data sources:

1. *Literature Review*

A comprehensive and systematic literature review was carried out as presented in chapters one to four. Chapter one introduced the problems associated with TAM projects and highlighted the major causes of TAM project failures. It further identified the impact of TAM project failure to the organisation and to the economy of a state.
Chapter two gave an insight to maintenance in engineering facilities. This shows that at some point in the life of every operating plant, the plant must be shutdown for maintenance purposes. Chapters three and four however form the main body literature

on TAM projects. While chapter three were mainly based on identifying the problems of TAM implementation, chapter four dealt on the management issues relating to ensuring TAM success. These as explained in chapter four are the selection of the suitable TAM manager and identifying the TAM project specific management methodologies.

Based on the analysis of literature reviewed, *Pilot study phase I* was carried out. This involved random interviews with some Maintenance Managers working in engineering facilities and presentation of the research proposal at an ARCOM Workshop. The feedback from these helped in confirming the research problem and indentifying mixed-method research (using both quantitative and qualitative approaches) as the most suitable approach for this study.

2. *Quantitative Research Investigation*

As explained in chapter five, the most appropriate quantitative research strategy for the study was survey research. As shown in chapter six, data were collected from experienced hands-on TAM project professionals in about 160 continuous process plants in the UK. Analysis of the data was undertaken using SPSS 16.0.

3. *Qualitative Research Investigation*

Findings from preliminary analysis of the survey data formed part of the issues investigated with qualitative research. Basically, case studies of six world class multinational continuous process industries in the UK were used to investigate on *how* TAM project can be successfully implemented. In-depth interviews of key TAM personnels in these organisations form the major source of data. These were however triangulated using relevant documents and reports collected from the case organisations in addition to some information gathered through direct observation (details are given in chapter seven).

Based on the findings from the analysis of literature review, questionnaire survey and case studies, a frame work for the successful implementation of TAM projects was developed (see chapter 8). The framework developed was validated using very experienced, internationally exposed hands-on TAM project professionals who are currently occupying high profile positions in their organisations.

10.3 SUMMARY OF FINDINGS FROM THE LITERATURE REVIEW

- Manufacturing industry plays an important role in the UK economy. However, the industry performance in maintenance is not very impressive. Maintenance performance in the UK manufacturing still lags behind its European counterparts. There is still too little maintenance planning and too much fire-fighting. It is identified that there is a low level of awareness of modern maintenance techniques of the recent generations of maintenance philosophy and there is still limited connection (if any) between maintenance strategy and business strategy.

- The nature of maintenance work has changed in recent decades as a result of a huge increase in the number and variety of physical assets to be maintained, increasing automation and complexity, new maintenance techniques and changing views on maintenance organisation and responsibilities.

- In order to remain competitive, manufacturing organisations, combine the various maintenance types to develop a strategy that will be most cost effective and ensure that all benefits of a good maintenance system are achieved. One of these maintenance strategies is TAM (shutdown maintenance)

- Organisations are still struggling on how to manage their TAM project as they still manage these projects using methodologies applicable to other EPC projects. There is however peculiar features that set TAM projects apart from other EPC projects and hence requires different methodologies if success is to be achieved.

- Some individuals and organisations have developed strategies and innovations for the improvement of TAM project implementations. These are mainly based on; reduction in the TAM work scope; reduction in the duration of TAM project and prolonging shutdown intervals. But these innovations did not address the core problems of managing TAM projects as there are still reported failures.

- Problems associated with failures of TAM project implementations were identified as organisations do not recognise the 'unique' features of TAM project. These unique characteristics mean that the factors affecting TAM projects success as well as their impact on TAM projects are different from that of EPC projects. These features also imply that TAM projects are wrongly evaluated as the success measurement criteria should be different from what is currently used. Knowledge of these two elements calls for a specific TAM projects management methodology different from EPC projects. These are explained in chapters 3 and 4.

10.4 SUMMARY OF RESEARCH FINDINGS

In meeting the aims of this research as set out in Chapter 1, the objectives set by the research were achieved and the following conclusions can be drawn from this study:

1. *Determination of success measurement criteria of TAM projects*

It was identified that the outcome of TAM can be evaluated using management success evaluation and assessing the resultant benefits of the project to the operations of the organisation.

TAM management is considered successful if the success criteria of cost, time, quality, safety, environmental and functionality as set out in Chapter 8 are met.

In addition to TAM management success, a TAM project is considered successful if the resultant benefits of the project are achieved. These resultant benefits as identified by this research project are:

- bringing the plant to its original health;
- reduction in routine maintenance costs;
- reduction in plant breakdowns;
- improved reliability/availability of the plant; and
- plant being safe to operate.

Most of these benefits can only be assessed long after the project. Elements with which to assess these expected benefits at handover were identified as explained in chapter 8.

The findings confirmed that the satisfaction and meeting the expectations of the stakeholders (client/top management, project participants and plant users) are embedded in these two success criteria elements explained above. In addition to the above however, the satisfaction of the contractors are met after considering their profit margin and how the project has improved their reputation and credibility.

2. *Determination of critical success factors of TAM projects implementation.*

Twenty factors were identified and established as being critical to the success of any TAM project. These critical success factors were of two main groups: organisational and managerial as shown in Figure 3.4 (Chapter 3).

The organisational factors as identified include all the issues that the organisation needs to put in place to enable the management team to implement the project successfully. These include:

- having a TAM project philosophy;
- supporting the TAM manager and the management team;
- selecting and appointing a suitable personnel with the relevant skills/knowledge and personal attributes as the TAM project manager; and
- setting up realistic and measurable goals and objectives early (especially at the TAM initiation phase).

The other sixteen (16) critical success factors are management related and depends on the skills/knowledge and competencies of the TAM manager and the management team.

This research has shown that the success or failure of TAM projects does not depend on the TAM management team alone, but the organisation as well. For any TAM project to be successful, the organisation (through the Top management) and the management team (led by the TAM manager) have to ensure the successful delivery of their responsibilities.

3. *Determination of TAM project specific management methodologies.*

As shown in Section 3.3.1 (Chapter 3), TAM is considered as a project. Due to the complexity of the process and the resources involved, the tools and techniques of project management is uniquely adaptable to activities associated to TAM. The PMI published a guide to the Project Management Body of Knowledge (PMBOK) which should be used as a *guide* in managing projects. This research project has identified and established appropriate TAM management methodologies. These methodologies were identified and developed recognising TAM 'unique' characteristics. TAM projects are characterised of a fluctuations in the scope of work, most management problems are rooted to these emergent scope during the execution of the project.

4. *Determination of management skills/knowledge and personal attributes of the TAM manager for managing TAM projects.*

Considering the unique features of TAM projects, a set of management skills/knowledge and personal attributes of the TAM manager needed for this project was identified by this research study. These include skills/knowledge to manage TAM project which involves maintenance, construction/installation and other engineering activities at the same time. Personal attributes which are required to cope with these high intensity project activities with the associated pressures have been identified. The list of these skills and attributes which were identified and established is shown in Table 8.1 (chapter 8).

5. *Development and validation of an operational framework for successful TAM project implementation.*

The development of a original knowledge based framework for the successful implementation of TAM projects was the principal aim of this research. This best practice framework was developed based on data collected from secondary (literature review) and primary (questionnaire survey and case studies of continuous process industries in the UK) data for the successful implementation of TAM projects. The framework was elaborated in five detailed areas; the TAM concept, Leadership Team, Implementation process, Post implementation and Improvement strategies. This developed framework which is presented in chapter 8 has been validated by experienced industry-based TAM professionals (see chapter 9)

10.5 CONCLUSIONS

Turnaround maintenance is a proactive maintenance strategy and a common feature in manufacturing organisations especially continuous processing plants, irrespective of the other proactive maintenance strategies adopted. There have been reported failures of implementing this maintenance strategy in the manufacturing industries. Organisations have been adopting project management techniques to manage TAM, but are not really adapting the methodologies to suit the specific requirements of TAM project.

Managing TAM projects like other EPC projects has been recognised as the major problem associated with TAM project implementation. Several TAM professionals (sharing their personal experiences) and few scholars have made contributions towards improving the implementation of TAM projects. Some organisations have also invested on innovations to improve the implementation of TAM projects. However, none of these cover the issues thoroughly to work as a guiding document towards ensuring TAM implementation success. All these are all guided towards:

- Reduction in the TAM Work scope
- Reduction in the duration of TAM Project
- Prolonging shutdown intervals.

Despite all these there are still reported cases of TAM implementation failures. This research work sets to solving this problem. Drawing from the best practice based on the original research work carried out through extensive literature review, pilot studies, questionnaire survey and case studies, this research has produced a unique framework for the successful implementation of TAM projects.

This novel knowledge based framework has been validated by the industry practitioners. This research work and the framework enhance body of knowledge in this area of management. The novelty of this research work and its contribution is evident from the fact that during the case studies and questionnaire survey, the participants and the respondents requested for the finding of the research to be sent to them once the work is completed.

In the manufacturing industries, this framework is the only available best practice guide to the successful implementation of TAM projects that draws on original research work and the best practice elements for implementing this maintenance project. The framework (developed and validated) covers the major elements and issues related to TAM, not only for its effective and efficient implementation but most importantly ensuring its successful implementation.

10.6 SIGNIFICANCE OF THE RESEARCH

This research developed and validated a framework that if adapted and adopted will ensure the successful implementation of TAM projects. The importance of this original knowledge based framework and its contribution to the body of knowledge in this area is summarised as follows:

1. *TAM project evaluation*

The research developed success measurement criteria for TAM projects. Instead of comparing performance of TAM projects with previous ones to assess how successful the outcome is, organisations can evaluate their TAM project's performance based on the current TAM using the criteria developed in the framework.

In addition, these success criteria will enable the organisation to evaluate the benefits expected from the TAM project outcome at *hand-over* of the plant from the TAM project Management to the Operations management.

2. *TAM project critical success factors*

With the knowledge of the criteria developed, the framework also confirmed the critical success factors of TAM project implementation and how they influence the TAM process. The knowledge of these factors and adapting them will enable the organisation to ensure they are handled adequately.

3. *Selection of TAM project manager*

Detailed selection criteria for a TAM project manager to ensure a TAM project success is identified by the framework. These include; the management skills, knowledge and personal attributes needed to manage TAM successfully.

4. *Management Methodologies for TAM project*

This research also confirmed management methodologies to be adopted to ensure the successful management of TAM projects using PMI project management guidelines. These methodologies ensured that the various critical TAM features like emergent scope can be adequately managed to ensure TAM success.

5. This study also identified some *improvement strategies* that the organisations need to adopt not only to improve TAM implementation process but most importantly to ensure TAM projects are successful.

6. *Organisational Input*

Finally, this study has confirmed that the success of any TAM project does not depend on the TAM manager and the management team alone, but on the organisation. For TAM projects to be successful, the organisation needs to have a TAM philosophy in place. Long range TAM plans and having a standard TAM management procedure are also needed for a TAM to be successful.

7. *The TAM framework*

The TAM framework developed and validated is all encompassing and includes all the structures and procedure which if adopted and implemented will improve TAM project implementation in the following areas:

- improved TAM implementation effectiveness
- improved TAM management efficiency; and
- most importantly ensuring TAM implementation success.

10.7 RECOMMENDATIONS

Considering the broad nature of the TAM best practice framework developed and validated in this research, the framework and its components parts are recommended to different parties who can influence or are affected by TAM projects. These parties include:

1. *Client Organisation*

The significance and conclusions drawn from this study as outlined in Section 10.6 showed the importance of this study to all organisations operating engineering facilities (the client organisation). In addition the following are also identified:

- The appropriate attributes, skills/knowledge established for TAM management should help reduce mismatching of skills and the job
- The framework should be used to organise training programmes for TAM project management team especially in organisations where the maintenance manager has the dual role of managing TAM project in addition to their functional role.
- The criteria outlined for the selection of a contractor is also of great importance since contractors are needed in all TAM projects.
- The framework as confirmed (during its validation) is not restricted for major outages but can be used for any short, partial or rolling plant shutdowns. It is also very suitable for varied sized TAM projects irrespective of the complexity of the operations and equipment.

2. *Contract Organisations*

The criteria for TAM contractor selection as established by the framework will assist contract organisations to understand what is expected of them to be successful in their bid for a TAM project work. This will assist them in contract negotiations with the client organisation. The TAM project success measurement criteria will also assist the contract organisations towards ensuring the successful completion of their jobs to the client's satisfaction.

Contract organisations that manage TAM projects for the client organisation will find the TAM framework a best practice guide towards a successful TAM project implementation.

3. *Maintenance Engineering Consultants*

Maintenance engineering consultants will find the TAM framework very useful in dealing with the client organisation as well as the contractors. With the knowledge of the critical success factors and how they impart on the TAM event, the management methodologies, including management skills/knowledge and the criteria of contractor selection, the consultants will be able to play their role more effectively and efficiently in TAM projects.

4. *TAM Managers*

This framework is highly recommended to TAM managers. The following keys areas are critical for TAM managers:

- The relevant attributes, management skills/knowledge should be of immense values to individual managers as it could help advance career prospects and lead to job satisfaction
- The knowledge of the critical success factors of TAM projects (especially the managerial factors) which are established by this study will assist the manager to handle them adequately.
- The TAM management methodologies established should help the manager in managing TAM projects effectively, efficiently and successfully.
- The post TAM implementation will also be highly helpful to the TAM manager especially in the evaluation of the TAM project outcome. The resultant benefits of the project which can now be evaluated at *hand-over* helps to exonerate the manager should there be failures of equipment due to mal-operation or wrong maintenance work during the plants operational campaign.

5. *Aspiring TAM professionals.*

With the TAM management skills and knowledge established in this study, aspiring TAM management professionals should seek ways towards acquiring and developing these skills and knowledge areas. The simplified and robust nature of the framework (as confirmed during the validation) should also be very helpful for the upcoming TAM professionals in TAM project management.

6. *Training Organisations*

Training organisations in maintenance management will find the framework developed in this study very useful in developing appropriate TAM management courses to the various TAM project stakeholders: Top management, TAM managers, TAM management team members TAM supervisory team and even contractors involved in TAM project implementation.

The management skills/knowledge areas needed for TAM project as established by this study should also be used by these organisations to develop courses/programmes for TAM managers and other aspiring TAM professionals.

7. *Government Bodies*

Considering the negative impacts of TAM project failures such as high cost of products, poor quality products, inflation and in some cases product scarcity, this framework can be used as a starting point for legislative proceedings on the improvement of manufacturing processes. The government can also initiate training programmes/courses for industry inspectors (using this best practice framework) to assist the manufacturing sector.

8. *Tertiary Institutions*

Universities and other tertiary institutions that run courses in maintenance management will find this framework of immense significance. The framework and its components parts should be incorporated in their curriculum since study has shown that TAM (which constitutes about 40% of the maintenance budget) is an important and common maintenance strategy in the manufacturing industries.

10.8 LIMITATIONS OF THE RESEARCH

Some limitations identified that are applicable to this research are as follows:

- The study is restricted to continuous process plants in the UK

- There is very large number of organisations operating continuous process industries in the UK. The organisations approached for this study during the case studies and the questionnaire surveys form just a representative sample

- The 160 organisations that participated in this research are world class multinational companies. The framework was developed based on the assumption that the TAM leadership are familiar with PMBOK of PMI. In some organisations, however, the maintenance manager duals as the TAM manager and in most cases are not knowledgeable of the PMI project management methodologies.

10.9 APPLICABILITY OF THE FRAMEWORK

Although this research is confined to continuous process plants, the framework developed can be applied to other engineering facilities. The research was concentrated on these types of industries because TAM is a major concern here as the entire plant operations are usually put to a halt, consequently TAM management strategies and techniques are mostly developed in continuous process plants because of the failure consequences.

As stated in section 6.3 (chapter 6), all engineering facilities and equipment/machineries are shutdown at one time or the other for a TAM project. The framework so developed can be adopted and adapted to any shutdown maintenance including:

- I&Ts (Inspection & Testing)
- Shutdowns
- Planned outages
- Overhaul
- Debottlenecking projects; and

- Revamps

where an operating engineering facility (or equipment/machinery) must be shut down until the work is completed and then re-started.

This research is also based on *world class multinational organisations* in the UK. This implies that their TAM management strategies are not confined to UK but has international influences. In addition some of the key staff interviewed during the case studies and all the framework verifiers have all had substantial working experiences in TAM projects outside the UK. In addition to the above, considering the position of UK as one of the world leaders in technology, the TAM framework developed and validated in this research can be adopted and adapted by any engineering facility anywhere in the world!

10.10 SUGGESTIONS FOR FURTHER RESEARCH

Following the research findings further studies on TAM project implementation are necessary to further support the TAM projects framework. The key areas identified for further research includes:

1. The implementation of the full logic of TAMPI framework may require a systematic approach which may entail extensive training and high level company support to embed in an organisation. More research is needed to identify the training needs and how best the approaches can be implemented in the various industry groups.
2. In this era of information technology, there is need to develop a best practice IT based management system for successful TAM project implementation.

3. A study to identify the optimum timeline for the TAM phases on the understanding of the man-hour size of the TAM and the consequential effect that this might have on the preparation/planning and resourcing.

4. Although the TAM framework broadly identified some KPIs to assist organisations in TAM project implementation, there is need for a research to identify all the KPIs across all the TAM phases. This will enhance adequate TAM implementation across the phases.

5. Further research is also needed to identify the factors that affect the sustainability of TAM projects. The knowledge of these factors and their effects on the gains of a TAM will help organisations to increase the shutdown intervals and reduce emergent work scope items during TAM execution.

10.11 SUMMARY OF THE CHAPTER

This chapter concludes the thesis. It started with the summary of the research process. This identified four the four main areas of enquiry as well as the three main sources of data for the research. The analyses of the data from these sources (literature review, questionnaire survey and case studies) provide the research findings in details at each phase, which formed the basis for the framework development. This section is followed by the summary of preliminary findings. These findings provided the need for the TAMPI framework that has been developed. The main findings section followed. This section summed up the research findings. It showed the fulfilment of the research aims and objectives. The main conclusions explained the novelty of this research, contributions this research makes to the body of knowledge, and its benefits to organisations to their implementation of TAM projects. The limitations of this research and their applicability were highlighted. Finally, the chapter is concluded with the identification of some areas for further research work.

REFERENCES

Amaratunga, D. & Baldry, D 2001. Case Study Methodology as a means of Theory Building: Performance Measurement in Facilities Management Organisations. *Work-Study Journal,* 50(3), pp.95-105.

Amaratunga, D., Baldry, D. & Newton, R 2002. Quantitative and Qualitative Research in the Built Environment: Application of "Mixed" Research approach. *Work Study,* 51(1), pp. 17-31.

Anderson, S.A 2002. Applying and implementing risk-based inspection programs. *Hydrocarbon Processing.* Jan. 2002 issue pp. 43-46 Gulf Publishing.

Archambault, S 2002. One-Way ANOVA. Psychology Department, Wellesley College. Available at: http://www.wellesley.edu/Psychology/Psych205/anova.html [Accessed 15 February 2010]

Arunraj, N.S & Maiti, J 2006. Risk-based maintenance - Techniques and applications. *Journal of Hazardous Materia*l Vol. 142, pp. 653-661.

Ashley, D.B, Lurie, C.S & Jaselskis, E.J 1987. Determinants of Construction Project Success. *Project Management Journal*, 18(2). Project Management Institute.

Association for Project Management, APM 2005. Project Management Body of Knowledge, Association of Project Management 5th Edition. UK

Atkinson, R 1999. Project Management: cost, time and quality, two best guesses and a phenomenon, its time to accept other success criteria. *International Journal of Project Management,* 17(6), pp. 337-342. Elsevier Science Ltd.

Avots, I 1969. Why does project management fail? California Management Review Vol. 12, pp. 77-82

Baer, E.D 1979. Philosophy provides the rationale for nursing's multiple approach direction. Image: *Journal of Nursing Scholarship* Vol. 11, pp 72-74

Baker, B.N Murphy, D C & Fisher, D 1983. *Factors affecting project success*. In D.I. Cleland & WR. King (Eds.), Project management handbook (pp. 669-685) Van Nostrand Reinhold Co. New York.

Bamber, C. J., Sharp, J.M & Hides, M.T 1999. Factors affecting successful implementation of Total Productive Maintenance: A UK manufacturing case study perspective. *Journal of Quality in Maintenance Engineering*, 5(3), pp. 162-181. MCB University Press

Barry T.R 2008. Top 10 Qualities of a Project Manager. Project Smart, 2000-2008 Available at: http://www.projectsmart.co.uk/top_10_qualities_project_manager.html [Accessed 16 June 2008]

Belassi, W & Tukel, O.I 1996. A new framework for determining critical success/failure factors in Projects. *International Journal of Project Management,* 14(3), pp. 141-151. Elsevier

Bijvank, M 2004. *Shutdown Scheduling; A practical approach to handle shutdowns at refineries.* Master thesis in Business Mathematics and Informatics, Vrije Universiteit

Blanchard, B.S 1997. An enhanced approach for implementing total productive maintenance in the manufacturing environment. *Journal of Quality in Maintenance Engineering.* 3(2), pp. 69-80 MCB University Press.

Blaxter, L., Hughes, C. & Tight, M 2003. *How to research.* 2nd Edition Open University Press. Maidenhead, Philadelphia

Bourne, L. & Walker, D.H.T 2004. Advancing project management in learning organisations. *Learn Organisation* Vol. 11 No. 3 pp 226-243

Boynton, P.M. & Greenhalgh, T 2004. Selecting, designing, and developing your questionnaire. BMJ 2004; 328: 1312-1315
Available at: http://www.bmj.com/cgi/reprint/328/7451/1312.pdf
[Accessed 06 June 2008]

Briggs, S.R & Cheek, J.M 1986. The role of factor analysis in the development and evaluation of personality scales. *Journal of Personality,* 54, 106 -148.

British Standards Institution, 1993. *BS 3811: Glossary of Terms in Terotechnology.* London: BSI.

Brown, B. V 2004. *Audel; Managing Shutdowns, Turnarounds and Outages.* Wiley Publishing Inc. Indiana.

Bryman, A, & Cramer, D 2005. *Quantitative Data Analysis with SPSS 12 and 13: A Guide for Social Scientists.* Routledge, London.

Bryman, A 1998. *Quantity and Quality in Social Research.* Unwin Hyman, London

Bryman, A 2008. *Social Research Methods.* 3rd Edition. Oxford University Press.

Burns, R.B 2000. *Introduction to Research methods*. 4th Edition, Sage Publications, London.

Buckner, E 2005. Optimize turnaround projects - Effective planning can eliminate surprises during shutdown and construction. *Hydrocarbon Processing* Sept 2005, pp 55-58

Burke, R 2003. *Project management: planning and control techniques.* 4th edition Chichester: Wiley. Available at:
http://media.wiley.com/product_data/excerpt/44/04708512/0470851244.pdf
[Accessed 15 December 2009]

Bushman, M 2007. The Responsibilities of a Project Manager. Associated Content Inc. Available at:
http://www.associatedcontent.com/article/131998/the_responsibilities_of_aproject_manager.html
[Accessed 05 August 2007]

CAM, 2003. Turnaround and Maintenance: Support services. CAM Environment Services' article, Vol.3 Issue 3. Available at:
http://www.cam-enviro.com/Downloads/Articles/Turnaround-and-Safety.pdf
[Accessed 26 April 2007]

Cassel, C. & Symon, G 1994. *Qualitative Methods in Organisational Research: A Practical guide*. Sage Publications, London.

Chan A.P.C & Chan, A.P.L., 2004. Key Performance indicators for measuring Construction Success Benchmarking. *An international Journal*, 11(2), pp. 203-221.

Cholasuke, C. Bhardwa, R. & Antony, F 2004. The status of maintenance management in UK manufacturing organisations: results from a pilot survey. *Journal of Quality in Maintenance Engineering.* 10(1) pp. 5-15 Emerald Group.

Clark, D.K & Hayes, P.R 2003. Turnaround Performance Optimisation. *Journal of Petrochemicals and Gas Processing*, pg 133-139, PQ Autumn. Available at:
http://www.fluor.com/papers/downloads/Turnaround%20Performance%20Optimisation.pdf
[Accessed 8 May 2007]

Clarke, A 1999. A practical use of key success factors to improve the effectiveness of project management. *International Journal of Project Management,* 17(3), pp. 139-145

Clifton R. H 1974. *Principles of Planned Maintenance*. Edward Arnold, London

Cleland, I. & King, W. R 1983. *Systems Analysis and Project Management*. McGraw Hill, New York.

Construction Industry Council, CIC, 2002. Construction Project Management Skills. Construction Industry Council, London ISBN: 1898671249

Cook T. D. & Reichardt C. S 1979. *Qualitative and Quantitative Methods in Evaluation Research.* Beverly Hills, CA Sage Publications Inc.

Cooke, F.L. 2003. Plant maintenance strategy: evidence from four British manufacturing firms. *Journal of Quality in Maintenance Engineering,* 9(3), pp.239-249 MCB UP

Cookie-Davies, T 2002. The "real" success factors on projects. *International Journal of Project Management,* 20(3), pp.185-190.

Cooper, R.G. & Kleinschmidt, E J 1995. Benchmarking the firm's critical success factors in product development. *Journal of Production Innovation Management* Vol.12, pp. 374-391.

Corder A 1976. *Maintenance Management Techniques*. McGraw-Hill Book Company, UK

Cross, M 1988. Raising the value of maintenance in the corporate environment. *Management Research News*, 11 (3), pp. 8-11. Emerald Backfiles. Available at: http://www.emeraldinsight.com/Insight/viewContentItem.do?contentType=Article&contentId=1647421 [Accessed 11 November 2009]

Dekker, R 1996. Applications of maintenance optimization models: a review and analysis. *Reliability Engineering and System Safety.* Vol. 51 pp. 229-240. Elsevier Science.

Denzin, N.K. & Lincoln, Y.S 2000. *Handbook of Qualitative Research.* 2nd Edition Sage Publications Inc.

Department for Business Enterprise & Regulatory Reform, BERR, 2002. The Governments Manufacturing Strategy
Available at: www.berr.gov.uk/files/file25266.pdf
[Accessed 06 June, 2009]

Department for Business Enterprise & Regulatory Reform, BERR, 2008. Manufacturing: New Challenges, New Opportunities.
Available at: www.berr.gov.uk/files/file47660.pdf
[Accessed 06 June, 2009]

De Vaus, D 2007. *Analyzing Social Science Data: 50 Key Problems in Data Analysis.* Sage Publications Ltd, London.

DiCicco-Bloom, & Crabtree B.F., 2006. The Qualitative Research Interview *Medical Education,* 40, pp. 314-321

Duffuaa S. & Daya, A.B 2004. Turnaround maintenance in Petrochemical industry: practices and suggested improvements. *Journal of Quality in maintenance Engineering* 10(3), pp. 184-190. ISSN 1355-2511.

Duncan W.R., 2004. Defining and Measuring Project success. Project Management Partners. Available at:
http://www.pmpartners.com/resources/defmeas_success.html
[Accessed 06 May, 2007]

Dunn, R 1987. Advanced maintenance technologies. *Plant Engineering*, 40 (12), pp. 80-93

Dvir, D., Lipovetsky, S., Shenhar, A. & Tishler, A 1998. In search of project classification: a Non-universal approach to project success factors. *Research Policy* Vol. 27, pp, 915-935.

Edwards, D. J.; Holt, G.D & Harris, F.C 1998. Predictive maintenance techniques and their relevance to construction plant. *Journal of Quality in Maintenance Engineering,* 4(1), pp. 25-37.

Edwards, J 1998. Outage Management Improvements in Nuclear Electricity. IEE conference Publication, Issue 452, pp 167-171.

Egbu, C.O 1999. Skills, knowledge and competences for managing construction refurbishment works. *Construction Management and Economics,* 17(1), pp. 29-43.

El-Sabaa, S 1999. The skills and career path of an effective project Manager. *International Journal of Project Management.* Vol. 19, pp. 1-7 Elsevier Science Ltd.

Engineering Employers Federation, EEF, 2009. Manufacturing Performance 2008/2009. The annual Manufacturing Performance report. Available at: www.eef.org.uk/UK/.../policy/.../Manufacturing_Performance_2008-9.htm [Accessed 06 February 2010]

Ertl, B 2005. Applying PMBOK to Shutdowns, Turnarounds and Outages Inter Plan Systems Inc. Republished with permission (Plant Maintenance Resource Centre) Revised. Available at: http://www.plant-maintenance.com/articles/ApplyingPMBOKtoShutdowns.shtml [Accessed 28 April 2007]

Eti, M.C; Ogaji, S.O.T & Probert, S.D 2006. Reducing the cost of Preventive maintenance (PM) through adopting a proactive reliability-focused culture. *Applied Energy.* 83. pp. 1235-1248

Fellows, R., Langford, D., Newcomb, R.A., & Urry, S., 2002. *Construction Management Practice.* Blackwell Science Ltd, Oxford 2nd Edition.

Flyvbjerg, B 2006. Five Misunderstandings about Case-Study Research. *Qualitative Inquiry* 12 (2), pp 219 - 245. Sage Publication.

Foy, R 1999. Structured approach to Shutdown. New Zealand Engineering Publications. 54(2), pp. 22-26

Frese, R. & Sauter, V 2003. Project Success and Failure: What is success, what is failure and How can you improve your odds for success? Available at: http://www.umsl.edu/~sauter/analysis/6840_f03_papers/frese/ [Accessed 23 April 2008]

Glaser, B.G. & Strauss, A.L 1967. *The discovery of grounded Theory: Strategies for Qualitative Research.* Chicago, IL: Aldine

Gomes, C.P.; Smith, D. & Westfold, S 1997. A transformational Approach Applied to Outage Management of Nuclear Power Plants. *Proceedings of the thirtieth Hawaii Int. Conference*, Vol.5 Iss.7-10 pp. 658-667. Available at:

Griffith, A. & Watson, P 2004. *Construction Management: Principles and Practice,* Macmillan, Basingstoke.

Gupta, S K & Paise, J E 1997. Reduce Turnaround costs: Maintenance and Retrofitting *Hydrocarbon Processing* 1997, Vol. 76 pp 67-74

Gurumeta, E. M 2007. Reliability Centred Maintenance. *Electric Power Quality and Utilisation 9th Conference* October, 2007, Barcelona, Spain. Available at: http://www.leonardo-energy.org/files/root/EPQU/2007conference/p298.pdf [Accessed 10 November 2009]

Gummesson, E 2000. *Qualitative Methods in Management Research.* 2nd Edition, Sage Publications, London.

Haber, S.B; Barriere, M.T. & Roberts K.H 1992. Outage Management: A case study. Human factors and Power Plants: *Conference record for 1992 IEEE fifth Conference.* Monterey CA, USA. pp 134-137.

Hamburg, M 1970. *Statistical Analysis for Decision Making.* Harcourt, Brace & World, Inc. USA.

Hamel, J., Dufour, S., & Fortin, D 1993. *Case study methods.* Newbury Park, CA: Sage Publications

Haughey, D 2007. The four Levels of Project success, The Project Management Maturity Matrix. Project Smart 2000-2007
Available at: http://www.projectsmart.co.uk/four_levels_of_project_success.html
[Accessed 23 September 2008]

Helfand, N. B 1985. Outage Planning: Basics are the key to success. Transactions of American Nuclear Society. San Francisco Nov 1985 PT 50. pp. 399.

Heisler, S. I., 1990. Project quality and the project manager. *International Journal of Project Management*, 8 (3), pp. 13-137. Butterworth-Heinemann Ltd

Hesse-Biber, S.N. & Leavy P 2006. *The Practice of Qualitative Research.* Sage Publications. London.

Husband, T. M 1982. Maintenance Management and Terotechnology. Gower England

International Atomic Energy Agency, IAEA 2002. Nuclear Power plant outage optimisation strategy. IAEA, Vienna Austria 2002 IAEA-TECDOC-1315

International Atomic Energy Agency, IAEA 2006. Management Strategies for Nuclear Power Plant Outages. Technical Report series No. 449, Vienna Austria.

Institute of International Studies (IIS), 2001. Institute of International Studies' Online Dissertation Proposal Workshop (2001): The Research Process. © 2001 Regents of the University of California.
Available at: http://globetrotter.berkeley.edu/DissPropWorkshop/nuts&bolts/question.pdf
[Accessed: 05 May 2008]

Ismail, M 2005. Quantitative Research Methodology. Pasut Pengajian Ilmu Pendidikan Kolokium Pelajar Pengajian Siswazah PPIP 2005. Input session IV
Available at: http://www.scribd.com/doc/98295/Quantitative-Research-Methodology
[Accessed 2 May 2009]

Jick, T.D 1979. Mixing Qualitative and Quantitative Methods: Triangulation in action. *Administrative Science Quarterly,* 24(4), pp. 602-611

Johnson, J., Karen, D. Boucher K. C & Robinson, J 2001. Collaborating on Project success. Software magazine February/March 2001

Kelly, A 1984. *Maintenance Planning and Control.* Butterworth Heinemann, London.

Kelly, A 1997. *Maintenance Strategy: Business-centred maintenance.* Butterworth Heinemann, Oxford.

Kerlinger, F.N 1970. *Foundation of Behavioural Research.* Rinehart and Winston, NY

Kerzner, H 1992. *Project Management - A system Approach to planning, scheduling and Controlling.* Van Nostrand Reinhold NY

Khan, F.I. & Haddara, M 2004. Risk-Based Maintenance (RBM): A New Approach for Process Plant Inspection and Maintenance. *Process Safety Progress* 23 (4), pp. 252-265

Khan, R. & Cannell, C 1957. *The dynamics of Interviewing.* New York: John Wiley

Kintzel, V.; Laubner, O. & Wallhauuser, S 2001. Shutdown Planning and realisation: Optimisation through partnership with a general contractor. *Oil and Gas European Magazine.* Vol. 27, No. 3 pp. 41-43..

Kloppenborg, T. & Petrick J 1999. Leadership in Project life cycle and Team character development. *Project Management Journal* Vo. 30 Issue2 pp 8-13

Kometa S, Olomolaye P.O & Haris F.C 1995. An Evaluation of Clients' needs and Responsibilities in the Construction Process. Engineering, Construction and Architectural Management, March 1995, 2(1). pp 45-56

Kopyscianski, P.P., 1982. Plant Outage Planning Cycle. *Transactions of American Nuclear Society* LA, USA June 1986 Vol. 4 pp 546.

Krings, D 2001. Proactive Approach to shutdowns Reduces Potlatch Maintenance costs. A maintenance planning and scheduling article focusing on management of shutdowns. Available at: http://www.idcon.com/article-approach.htm
[Accessed 31 March 2007]

Kumar, U. & Parida, A 2008. *Maintenance Performance Measurement System.* Complex system maintenance handbook; DE; Spring Verlag.

Kutucuoglu, K.Y.; Hamali, J.; Irani, Z. & Sharp, J.M 2001. A framework for managing maintenance using performance measurement systems. *International Journal of Operations & Production Management,* 21(1/2), pp. 173-174.

Kvale, S., 1996. *Interviews an introduction to Qualitative Research Interviewing.* Sage Publications.

Lasser R 2006. Cost Effective Turnaround Practices. ACS BIC editorial Vol. 3 2006. ACS Industries, Inc.

Leedy, P.D 1996. *Practical Research: Planning & Design*. Merrill Prentice Hall. Available at: http://www.geocities.com/Athens/3238/page3-15.htm. [Accessed 18 November 2008]

Leedy, P.D & Ormrod, J.E., 2005. *Practical Research; Planning and Design.* 9th Edition. Pearson Education Inc. NJ.

Leger, J.B., Neunreuther, E, Iung, B, & Morel, G 1998. Integration of the predictive maintenance in manufacturing system. *Third European Robotics, Intelligent Systems and Control Conference,* 1998, pp. 133–143.

Lenahan, T 1999. *Turnaround Management,* Butterworth-Heinemann, Oxford.

Lenahan, T 2006. *Turnaround, Shutdown and Outage Management: Effective Planning and step-by-step Execution of Planned Maintenance Operations.* Butterworth-Heinemann, London.

Levitt, J 2004. *Managing Maintenance Shutdowns and Outages.* Industrial Press Inc.

Lim, C.S & Mohamed, M.Z., 1999. Criteria of Project success: an exploratory re-examination. *International Journal of Project Management*, Vol. 17 No. 4, pp 243-248.

Lipovetsky, S.; Tishler A.; Dvir, D. & Shenhar, A 1997. The relative importance of project success dimensions. *R&D Management* 27(2), Blackwell Publishers Ltd, UK.

Liu, A.M.M. & Walker, A 1998. Evaluation of Project Outcomes. *Construction Management and Economics* 1998 16, 209-219.

Locke, D 1984. *Project management*. New York: St. Martins Press.

Lowell R 2002. Five Shut Down strategies Cement Americas Penton Media, Inc Available at:
http://cementamericas.com/mag/cement_five_successful_shutdown/index.html
[Accessed 8 June 2008]

Lovell R. J 1993. Power and the Project Manager. *International Journal of Project Management.* Vol.11, No. 2. Butterworth-Heinemann Ltd.

Mann, L 1976. *Maintenance Management*. D.C Heath and Company, Canada.

Marshall C. & Rossman G.B 1999. *Designing Qualitative research.* 3rd Edition. Sage Publication, London

Martin C. C 1976. *Project Management* AMACO New York

Matthews, D 2004. Taking the pain out of Turnarounds (Plant shutdown time minimisation using Turnaround Management; *Engineering Management Journal*; Year 2004, Vol. 14, Iss.6, pp 41-42.

McLay, J.A 2003. *Practical Management for Plant Turnarounds.* Available at: www.reliabilityweb.com/art04/plant_turnarounds.htm Accessed26 March 2007]

McQuillan, K.W, McGeachie, K & Richards, D 2003. A Shutdown Story. *ERTC Petrochemical Conference*, Paris, France. Pg 1- 24. Available at: http://www02.abb.com/GLOBAL/SEITP/SEITP161.NSF/viewunid/D27B4054D7C4670C80256D0B00488AB8/$file/A5+Huntsman+and+Eutech.pdf [Accessed 10 April 2007]

Miles, M.B. & Huberman, A.M 1994. *Qualitative Data Analysis.* 2nd Edition Thousand Oaks, CA: Sage.

Mirghani, M.A 2001. A framework for costing planned maintenance. *Journal of Quality in Maintenance Engineering,* 7(3), pp.170-182.

Mobley, R.K 1990. *An Introduction to Predictive Maintenance*. Van Nostrand Reinhold, NY

Morris, P W G & Hugh, G. H 1986. Preconditions of success and failure of Major Projects. Templeton College, the Oxford Centre for Management Studies, Kinnnington Oxford, Technical paper No. 3 1986.

Morris, P. W. G.; & Hugh, G. H 1987. *The Anatomy of Major projects*. John Wiley and Sons; New York.

Motylenski, R. J 2003. Proven Turnaround practices. *Maintenance & Reliability/Hydrocarbon Conference*, 2003, Vol. 82 pp 37-41

Moubray, J 1997. *Reliability-Centred Maintenance.* 2nd Edition. Butterworth Heinemann, London

Murthy, D.N.P; Atrens, A, & Eccleston, J.A 2002. Strategic maintenance management. *Journal of Quality in Maintenance Engineering.* 8 (4) pp, 287-305., MCB University Press

Myers, S.T & Haase, J.E 1989. Guidelines for integration of qualitative and quantitative approaches. *Nursing Research,* Vol.38, pp. 294-298.

Nachmias, C.F. & Nachmias, D 1996. *Research Methods in the Social Sciences.* 5th Edition. Arnold, London.

Nachmias, C.F. & Nachmias, D 2000. *Research Methods in the Social Sciences.* 6th Edition.Worth Publishers, New York.

Nakajima, S 1988. TPM: *Introduction to Total Productive Maintenance*. Productivity Press Inc. Cambridge, MA

Naoum, S.G 1998. *Dissertation Research and Writing for Construction Students*, Butterworth Heinemann, Oxford London

Naoum, S.G 2002. *Dissertation Research and Writing for Construction Students*, Butterworth Heinemann, Oxford London

Naughton, E 2004. Measuring for Project Success. *Systems Management: August 27 2004.* Techcentral.ie Available at: http://www.techcentral.ie/article.aspx?id=6954.
[Accessed 25 September 2007]

Nunnally, J. O 1978. *Psychometric theory.* New York: McGraw-Hill

Office of Government Commerce, OGC, 2005. Common Causes of Project Failure. Office of Government Commerce.
Available at: http://www.ogc.gov.uk/documents/cp0015.pdf
[Accessed 28 July 2007]

Oliver, R 2001. Organising the Plan for Turnarounds. *Petroleum technology.*
Available at:
http://www.meridiumeurope.com/news_events/articles/pdf_files/Organising_the_Plan_for_Turnarounds.pdf
[Accessed 15 March 2007]

Oliver, R 2002. *Complete Planning for Maintenance Turnarounds will ensure success. Oil & Gas Journal*, Meridium, Inc. Available at:
http://www.meridium.com/news_events/articles/pdf_files/Planning_Maintenance_Turnarounds.pdf
[Accessed 15 March 2007]

Oliver, R 2003. Turnarounds, an integral Component of Asset Performance Management Maintenance & Operation- Turnaround Planning; Meridium Inc. Available at:
http://www.meridium.com/news_events/articles/pdf_files/planning_the_turnaround.pdf.
[Accessed 15 March 2007]

Oredi, R.G; Petras, D.S; Prokopovich, S.R. & Oft, R. R 1992. Outage Optimization versus Shutdown Risk.Westinghouse Electric Corporation. *Human factors and Power Plants: Conference record for 1992. IEEE fifth Conference*. Monterey CA, USA. pp 138-142.

Pallant, J 2007. *SPSS Survival Manual: A Step by Step Guide to Data Analysis using SPSS for Windows.* 3rd. McGraw-Hill, Open University Press. Berkshire, England.

Pant, I. & Baroudi, B 2007. Project Management education: The human skill imperative *International Journal of Project Management* doi:10.1016/j.ijproman.2007.05.010
Available at: http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=00283421&tag=1
[Accessed 12 August 2007]

Patton, J. D 1994. *Maintainability and Maintenance Management*. 3rd edition revised and enlarged. Instrument Society of America.

Pettersen, N 1991. Selecting Project Managers: An Integrated List of Predictors. *Project Management Journal,* 22(2), pp. 21-26.

Pinto, J K & Kharbanda, Om P 1995. Lessons for an accidental Profession *Business Horizons*, 38(2), pp41-50.

Pinto J.K & Slevin, D.P 1987. Critical factors in successful project implementations *IEEE Transactions on Engineering Management,* 34 (11), pp. 22-27.

Pinto, J.K & Prescott, J.E 1990.Planning and Tactical factors in the Project Implementation Process. *Journal of Management studies.* 27:3 0022-2380.

Pobst, D.S. & Hicks, F 1999. Appling Shutdown Risk Strategies to Outage Planning to Minimize Risk during Shutdown Outage activities. *Transactions of American Nuclear Society.* Chicago USA 15-20 Nov. Vol. 66 pp. 437.

Pokharel, S. & Jiao, J.R 2008. Turn-around maintenance management in a processing industry: A case study. *Journal of Quality in Maintenance Engineering,* 14 (2), pp. 109-122. Emerald Group

Poon, J., Potts, K. & Cooper, P 2001. Identification of success factors in the construction process. In: Construction and Building Research (COBRA) Conference, Glasgow Caledonian University, Glasgow, 5-7 September 2001. pp. 423-433.

Priel, V. Z 1974. *Systematic Maintenance Organisation.* Macdonald & Evans, London

Project Management Institute, PMI, 1996. A guide to the Project Management Body of Knowledge, PMI Standard Committee PMI Publishing Division, Maryland, USA.

Punch, K.F 1998. *Introduction to Social Research - Quantitative and Qualitative Approaches,* Sage Publication London.

Punch, K.F 2003. *Survey Research: the basics.* Sage Publications, London.

Raiche, H. A 1997. Pre-Turnaround Planning: A key to profitability National Petroleum Refiners Association: Refinery and Petrochemical Plant Maintenance Conference paper no. MC-97-73 pp59-62

Randles, W.J & Bryson, R.D 1983. Outage Management Plan. *Transactions of American Nuclear Society.* San Francisco USA 30/10 Vol. 45 pp 531

Ritchie, J. & Lewis, J 2003. *Qualitative Research Practice. A guide for Social Science Students and Researchers* Sage Publications, London

Riege, A.M 2003. Validity and reliability tests in case study research: a literature review with "hands-on" applications for each research phase. *Qualitative Market Research: An International Journal.* 6(2). pp 75-86

Robson, C 2002. *Real World Research.* 2nd Edition, Blackwell Publishers.

Ruben, I.M. & Seeling, W 1967. Experience as a factor in the selection and performance of Project managers. *IEEE Trans Eng. Management* 14(3) pp.131-134

Santos, J. R. A 1999. Cronbach's Alpha: A Tool for Assessing the Reliability of Scales. *Journal of Extension,* 37(2), pp. 1-4. Available at:
http://www.joe.org/joe/1999april/tt3.php.
[Accessed 01 May 2009]

Sarantakos, S 2001. *Social Research.* SAGE publication, London

Sarantakos, S 2005. *Social Research.* Basingstoke: Palgrave Macmillan, 3rd Edition, London

Schegloff, E 2008. Transcription Conventions *American Sociological Association, Social Psychology Quarterly.* Available at:
http://www.asanet.org/cs/root/leftnav/publications/journals/social_psychology_quarterly/transcript_conventions.
[Accessed 20 September 2008]

Schmidt, W.C 1997. World-Wide Web Survey Research: Benefits, Potential Problems and Solutions. *Behaviour Research Methods, Instruments & Computers,* 29(2), pp. 274 - 279. Available at: http://fhs.mcmaster.ca/ceb/community_medicine_page/docs/wwwsurveys.pdf
[Accessed 23 September 2009]

Schultz, R.L; Slevin, D.P & Pinto, J.K 1987.Strategy and Tactics in Process Model of Project Implementation Interfaces 17: 3 May-June 1987 pp. 34-46. The Institute of Management sciences.

Shenhar A. J., Dvir, D., Levy, O. & Maltz A. C 2001. Project Success: A multidimensional Strategic Concept. *Long Range Planning,* 34, pp. 699-725

Shenhar A. J, Levy, & Ofer, 1997. Mapping the dimensions of Project success. *Project Management Journal, June 1997,* 28 (2), p5.

Shih, F.J 1998. Triangulation in nursing research: issues of conceptual clarity and purpose. *Journal of Advanced Nursing,* 28(3), pp.631-641

Shuttleworth, M 2008. Pilot Study. Experiment Resources
Available at: http://www.experiment-resources.com/pilot-study.html
[Accessed 28 October 2009]

Silverman, D 1998. *Qualitative Research: theory, method and practice.* Sage Publications London.

Silverman, D 2000. *Doing Qualitative Research: a practical handbook.* Sage Publications London.

Silverman, D 2001. *Interpreting Qualitative data: Method of Analysing Talk, Text and interaction.* 2nd edition Sage Publication London

Simon, H., 2009. *Case Study Research in Practice.* Sage Publications London.

Sommer, D 2003. Avoiding Project Failure. Business Technology Research Center
Available at:
http://www.executivebusinessadvisers.com/Articles/How_To_Avoid_Project_Failure.pdf
[Accessed 5 September 2007]

Soy, S.K 1997. The case study as a research method. Unpublished paper, University of Texas at Austin.
Available at: http://www.ischool.utexas.edu/~ssoy/usesusers/l391d1b.htm
[Accessed 6 May 2009]

Snow, N 2007. EIA: Refinery outages usually don't affect prices
Oil and Gas Journal Online. Available at;
http://www.ogj.com/articles/print_screen.cfm?ARTICLE_ID=288910
[Accessed 12 May 2007]

Srivastava, P.K 2009. Maintenance Philosophy, Policy and Strategy. Core International USAID/INDIA Best Practices in Distribution Systems Operation and Maintenance. pp, 1-8
Available at:
www.drumindia.org/.../OM%206-4Maintenance%20Philosophy,%20Policy%20and%20Strategy.doc
[Accessed 23 August 2008]

Stake, R.E 1995. *The Art of Case Study Research* Sage Publications London

Sayles, L.R. & Chandler, M. K 1971. *Managing Large systems.* Harper and Row, New York

Steckler, A., McLeroy, K. R., Goodman, R. M., Bird, S. T., & McCormick, L 1992. Towards Integrating Qualitative and Quantitative Methods: An Introduction. *Health education Behaviour Quarterly.* 19(1), pp. 1-8.

Swanson, L 2001. Linking maintenance strategies to performance. *International Journal of Production Economics*. 70. pp. 237-244. Available at:
http://www.emeraldinsight.com.lcproxy.shu.ac.uk/Insight/viewPDF.jsp?contentType=Article&Filename=html/Output/Published/EmeraldFullTextArticle/Pdf/1540050301.pdf
[Accessed 09 November 2009]

Tellis, W 1997. Application of a Case Study Methodology. *The Qualitative Report*, 3(3).
Available at: http://www.nova.edu/ssss/QR/QR3-3/tellis2.html
[Accessed 10 February 2008].

Thorstensen, T.A 2006. Turnaround Optimization- experiences from RAPID
MARINTEK Review No 1 - April - 2006
Available at: http://www.sintef.no/content/page111557.aspx
[Accessed 29 September 2007]

Tiernan, T 1987. The art of successful shutdown planning. *Works Management* June 1987 Vol. 40, pp. 25-26

Torp, O; Austeng, K. & Mengesha, W. J 2004. Critical success factors for Project Performance: A study from front-end assessments of large public projects in Norway. Concept Research Programme 2004. Available at: http://www.concept.ntnu.no/Publikasjoner/Dokumenter/Critical%20succes%20factors%20for%20project%20performance_Torp.pdf [Accessed 10 July 2007]

Tukel, O.I. & Rom, W.O 2001. An empirical investigation of project evaluation criteria. *International Journal of Operations & Production Management*, 21(3), pp. 400-416. MCB University Press, 0144-3577.

Turner, J.R 1999. *The Handbook of Project-based Management: Improving the Processes for Achieving Strategic Objectives*, McGraw-Hill London

Upstream CIO Report, 2005. Integrating Applications Speeds Turnaround Projects. Upstream CIO pp.16-19. Zeus Development Corporation.

US Dept of Commerce, 2004. Manufacturing in America: A comprehensive Strategy to Address the Challenges to US Manufacturers. Available at: http://www.ita.doc.gov/media/Publications/pdf/manuam0104final.pdf [Accessed 12 December 2009]

Van-Teijlingen, E.R. & Hundley,V 2001. The Importance of Pilot studies. Social Research Update, Department of Sociology university of Surrey, UK Issue. 35 Available at: http://sru.soc.surrey.ac.uk/SRU35.html [Accessed 23 November 2009]

Venkatesh, J 2007. An Introduction to Total Productive Maintenance. Available at: http://www.plant-maintenance.com/articles/tpm_intro.pdf [Accessed 24 November 2009]

Vichichi, B 2008. New Best Practice to Deliver Predictably Competitive Turnaround Results. Asset Performance Networks. Available at: http://www.ap-networks.com/white-papers/view-category/Page-1.html [Accessed 9 December 2009]

Waddington, H 2000. Types of survey questions. In B. Hoffman (Ed.), Encyclopaedia of Educational Technology. Available at: http://coe.sdsu.edu/eet/Articles/surveyquest/start.htm [Accessed 27 October 2009]

Walker, D.H.T 1997. Choosing an appropriate research methodology. C*onstruction Management and Economics,* 15 pp 149-159.

Walton, H 1984. The Project Manager - a capite ad calcem. *International Journal of Project Management*. Vol. 2 No. 1 Butterworth & Co (Publishers) Ltd

Westhuizen, D. & Fitzgerald E.P 2005. Defining and measuring Project Success. Available at:
http://eprints.usq.edu.au/archive/00000346/01/DependentVariableArticleV8.pdf
[Accessed 14 June 2007]

Wilemon, D L & Cicero J. P 1970. The Project Manager- Anomalies and Ambiguities. *Academy of Management Journal.* Vol. 13 pp 269-282

Williams, J.P 2004. "*Worldwide trends in RAM improvement". Plant Maintenance Journal.* PTQ Spring 2004. Available at:
http://www.kbcat.com/pdfs/tech/PTQ%20Spring%202004%20P_Williams%20
[Accessed 12 August 2007]

Whittaker, J 1992. Managing a Shutdown: A longitudinal Study. IEEE/ Engineering Conference, Eaton Town NJ USA, 25- 28 Oct. 1992, pp 332-334

Witt, P 2006. Project Success Factors. 1998-2007 Information Technology Toolbox Available at: http://blogs.ittoolbox.com/pm/witt/archives/project-success-factors-8932
[Accessed 8 September 2007]

Wohlin C. & Andrews, A.A 2001. Assessing Project Success using subjective evaluation factors. *Software Quality Journal,* 9, 43-70 2001. Kluwer Academic Publishers Netherland.

Woken, D. M., 2009. Advantages of a Pilot Study. Centre for teaching and Learning, University of Illinois, USA.
Available at: http://www.uis.edu/ctl/writing/documents/ctlths7.pdf .
[Accessed 28 October 2009]

Woodhouse, J 2002. Optimization program: Shutdown what, why and when. *Journal of Chemical Engineering* ISSN 0009-2460, vol. 109, pp. 71-73(4ref).

Yin, R.K 1994. *Case Study Research: Design and Methods*. 2nd Edition Applied Social Research Methods Series Vol. 5. Sage Publications.

Yin, R.K 2003. *Case Study Research: Design and Methods*. 3rd Edition Applied Social Research Methods Series Vol. 5. Sage Publications.

Yin, R.K 2009. *Case Study Research: Design and Methods*. 4th Edition Applied Social Research Methods Series Vol. 5. Sage Publications.

Zhao, Y.; Volovoi, V.; Waters, M. & Mavris, D 2006. A profit-based Approach for gas Turbine Power Plant Outage Planning. *Journal of Engineering for Gas Turbines and Power*. Transactions of the ASME Vol. 128. pp. 806-814

Zwikael, O & Globerson, S 2006. From Critical Success factors to Critical Processes. *International Journal of Production Research*, Vol. 44, No. 17, 1 September 2006, 3433-3449. Taylor and Francis.

APPENDIX A

Sheffield Hallam University

QUESTIONNAIRE

Preamble: ***Turnaround Maintenance (TAM) Project*** *is intended to encompass all types of industrial projects for existing engineering facilities including: I&Ts (Inspection &Testing), Shutdowns, Planned outages, Debottlenecking projects, Revamp where an operating plant must be shut down until the work is completed and then re-started, thus "turning around" the plant - (Ertl, 2005)*

PART I

(Please tick as appropriate)

1 Your current position in your organisation

Kindly specify ....

2. Your firm employs:

( ) Less than 20

( ) Between 21 - 50

( ) Between 51 - 249

( ) Above 251

3. Years of Experience in Maintenance/Operations /Plant Management

( ) Less than 5years

( ) Between 6 - 10years

( ) Between 11 - 15years

( ) Above 15years

4. Years of Experience in Engineering/Project Management

( ) Less than 5years

( ) Between 6 - 10years

( ) Between 11 - 15years

( ) Above 15years

5. How many years have you been involved in TAM projects or Major Plant Overhauls?

As:

A TAM Management Team member:

( ) Less than 5years

( ) Between 6 - 10years

( ) Above 10years

a. A TAM Manager

( ) Less than 5years

( ) Between 6 - 10years

( ) Above 10

b. A Consultant/Contractor

( ) Less than 5years

( ) Between 6 - 10years

( ) Above 10years

d. A Client/Top Management Team

( ) 0 - 5 years

( ) Between 6 - 10years

( ) Above 10 years

6. How many years of these TAM projects were carried out in;

a. United Kingdom

( ) Less than 5years

( ) Between 6 - 10years

( ) Above 10years

b. Abroad

( ) Less than 5years

( ) Between 6 - 10years

( ) Above 10years

7. What are the major drivers of the TAM projects you have been involved in:

(Tick as many as possible).

( ) Statutory Requirements

( ) Equipment Manufacturers Specification

( ) Anticipated Failure

( ) Poor Equipment Performance

( ) Others (Please specify)

....

....

....

8. We may be contacting you in future for further enquiries on this research: (Kindly indicate your interest).

( ) Yes

( ) No

9. If your answer to (8) is yes, please let us have your contact details;

Your Name: ....

Address: ....

Tel. No. ....

Email Address ....

PART II

Please indicate your opinion the propositions about TAM project implementation by circling the number that match closest to your opinion on the scale of 1 - 5 [**1 = Strongly disagree (SDA)**; 2 = Disagree; 3 = Possibly agree; 4 = agree; **5 = Strongly agree (SA)].**

SECTION 1 - TAM Project Evaluation

1.1 Management success Evaluation

a. <u>*The following are true of **Cost** in evaluating TAM projects outcome*</u>

	<u>*SDA*</u>				<u>*SA*</u>
a. Total cost should be within budget	1	2	3	4	5
b. Emergent scope cost should be part of contingencies	1	2	3	4	5
c. Anticipated scope cost should be part of the budget	1	2	3	4	5

b. <u>*The following are true of **Time** in evaluating TAM projects outcome*</u>

	<u>*SDA*</u>				<u>*SA*</u>
a. Total time should be within budget	1	2	3	4	5
b. Emergent scope duration should be part of contingency.	1	2	3	4	5
c. Anticipated scope duration should be part of the budget	1	2	3	4	5

c. *The following are significant in evaluating* ***Quality***

		SDA				SA
a.	Level of rework	1	2	3	4	5
b.	Adherence to technical specifications	1	2	3	4	5
c.	Start-up incidents	1	2	3	4	5
d.	Commissioning incidents	1	2	3	4	5

d. *The following are suitable in measuring* ***Functionality***

		SDA				SA
a.	Plant/Equipment Performance expectation	1	2	3	4	5
b.	Quality expectation of output	1	2	3	4	5
c.	Quantity of output per unit time	1	2	3	4	5

e. ***Safety*** *can be evaluated by considering the following:*

		SDA				SA
a.	Personnel Safety incidents	1	2	3	4	5
b.	Plant equipment safety incidents	1	2	3	4	5
c.	Lost time due to safety incidents	1	2	3	4	5
d.	Legal issues due to safety incidents.	1	2	3	4	5
e.	Exposure to hazards (radiation, chemicals etc)	1	2	3	4	5

f. ***Environmental Performance*** *can be measured by carrying out Environmental Impact Assessment in the following areas*

		SDA				SA
a.	Gas emissions level	1	2	3	4	5
b.	Liquid contaminations	1	2	3	4	5
c.	Solid waste	1	2	3	4	5

1.2 Perception of Stakeholders:

1. ***Client/Top management*** *considers TAM a success when:*

		SDA				SA
a.	TAM management is successful.	1	2	3	4	5
b.	The Resultant Benefits are achieved.	1	2	3	4	5

2. Participants Satisfaction

a. *The following are Significant to the* ***Contractors*** *perception of TAM evaluation;*

		SDA				SA
a.	Relationship with client	1	2	3	4	5
b.	Profit margin	1	2	3	4	5
c.	Delivery of their jobs as per the contractual agreement	1	2	3	4	5
d.	Satisfaction of Client expectation	1	2	3	4	5

b. *The following are suitable for* ***TAM management team*** *evaluation*

		SDA				SA
a.	Management success	1	2	3	4	5
b.	Satisfaction of Top Management expectation	1	2	3	4	5
c.	Satisfaction of user's expectation	1	2	3	4	5

c. Plant Users - *Plant Operators*

consider the following when evaluating TAM projects;

		SDA				SA
a.	Plant Operational performance	1	2	3	4	5
b.	Meeting functional requirements	1	2	3	4	5
c.	Plant being safe to operate	1	2	3	4	5

d. Plant Users- *Maintenance Team*

consider the following when evaluating TAM projects;

		SDA				SA
a.	Reduction in routine maintenance	1	2	3	4	5
b.	Reduction in Breakdown maintenance	1	2	3	4	5

1.3 Evaluation of Resultant Benefits

a. *The following are adequate to assess the* ***Resultant Benefits*** *of TAM project*

		SDA				SA
a.	Bringing the plant to their original health	1	2	3	4	5
b.	Making the plant machines safe to operate.	1	2	3	4	5
c.	Improvement on efficiency and throughput of plant by suitable modification.	1	2	3	4	5
d.	Reduction of routine maintenance costs.	1	2	3	4	5
e.	Increasing the reliability/availability of equipment during operation.	1	2	3	4	5

f.	Upgrading technology by introducing modern equipment and techniques.	1	2	3	4	5

b. ***At handover the following can be used to evaluate the Benefits of TAM Project (2.3)***

		SDA				***SA***
a.	Safety of the units.	1	2	3	4	5
b.	Management success	1	2	3	4	5
c.	Operational performance of the system.	1	2	3	4	5
d.	Quality of end product of the system.	1	2	3	4	5
e.	Output performance.	1	2	3	4	5

SECTION 2 - TAM Manager Selection

2.1 *The following are important* ***Personal Attitude, Attributes and Traits*** *towards managing TAM projects successfully*

		SDA				***SA***
1.	Shared vision	1	2	3	4	5
2.	Good communicator	1	2	3	4	5
3.	Integrity	1	2	3	4	5
4.	Honesty	1	2	3	4	5
5.	Enthusiasm	1	2	3	4	5
6.	Empathy	1	2	3	4	5
7.	Competence	1	2	3	4	5
8.	Ability to delegate tasks and responsibilities	1	2	3	4	5
9.	Cool under Pressure	1	2	3	4	5
10.	Team building ability	1	2	3	4	5
11.	Problem solving abilities	1	2	3	4	5
12.	Open minded	1	2	3	4	5
13.	Tolerance to Ambiguity	1	2	3	4	5
14.	Supportive	1	2	3	4	5
15.	Patient	1	2	3	4	5
16.	Determination	1	2	3	4	5
17.	Interest in the job	1	2	3	4	5
18.	Need to achieve and proactive	1	2	3	4	5

2.2. *The following* ***Management Skills*** *are essential in managing TAM Projects successfully*

		SDA				***SA***
1.	Leadership	1	2	3	4	5

2.	Managing Conflicts and crisis	1	2	3	4	5
3.	Planning and control	1	2	3	4	5
4.	Organisational	1	2	3	4	5
5.	Time Management	1	2	3	4	5
6.	Negotiation : Contractors	1	2	3	4	5
7.	Negotiation : Suppliers and Vendors	1	2	3	4	5
8.	Negotiation : Equipment Manufacturers	1	2	3	4	5
9.	Negotiation : Govt Agencies/Regulatory Bodies	1	2	3	4	5
10.	Negotiation : Inspection Agencies	1	2	3	4	5
11.	Negotiation : Trade Unions	1	2	3	4	5
12.	Forecasting	1	2	3	4	5
13.	Motivation	1	2	3	4	5
14.	Management support building	1	2	3	4	5
15.	Resource Allocation	1	2	3	4	5
16.	Communication/Presentation	1	2	3	4	5
17.	Decision Making	1	2	3	4	5
18.	Health, Safety & Environment	1	2	3	4	5
19.	Use of Computer	1	2	3	4	5
20.	Technical	1	2	3	4	5
21.	Control	1	2	3	4	5
22.	Quality management	1	2	3	4	5
23.	Risk Management	1	2	3	4	5
24.	Administrative	1	2	3	4	5
25.	Human Resource Management	1	2	3	4	5
26.	budgeting and budgetary control	1	2	3	4	5
27.	Cost Management	1	2	3	4	5
28.	Supervision of others	1	2	3	4	5

2.3 *These Knowledge and Awareness are important to the TAM Manager towards ensuring TAM project success*

		SDA				SA
1.	Technical Knowledge	1	2	3	4	5
2.	Contractual	1	2	3	4	5
3.	Regulatory Processes	1	2	3	4	5
4.	Tendering Strategies	1	2	3	4	5
5.	Health and Safety regulations	1	2	3	4	5
6.	Project Management techniques	1	2	3	4	5
7.	Site security	1	2	3	4	5
8.	Setting objectives and goals	1	2	3	4	5
9.	Organisation of communication systems	1	2	3	4	5

SECTION 3 - TAM Project Critical Success Factors

3A. ORGANISATIONAL FACTORS

1. *The **TAM Philosophy** should;*

		SDA				SA
1.	Be integrated into the Corporate Business plan	1	2	3	4	5
2.	Be clear and concise with a descriptor of both plant turnaround management and plant shutdown.	1	2	3	4	5
3.	Develop TAM management process procedure.	1	2	3	4	5
4.	Be an Integral component of Asset Performance Management.	1	2	3	4	5
5.	Establish long-range plans for TAM.	1	2	3	4	5

2. *These are important of **Top Management support***

		SDA				SA
1.	Sharing responsibility with the TAM management team.	1	2	3	4	5
2.	Providing adequate funds. and other resources	1	2	3	4	5
3.	Granting the necessary authority and support decision concerning the project	1	2	3	4	5
4.	Supporting Management team on request for additional resources due to scope changes.	1	2	3	4	5
5.	Empowering of the TAM manager with necessary authority.	1	2	3	4	5

3. ***TAM goals and Objectives** should;*

		SDA				SA
1.	Be established early	1	2	3	4	5
2.	Be in be line with general goals of the organisation	1	2	3	4	5
3.	Be clear to the TAM management team.	1	2	3	4	5
4.	Address the key elements to achieve the goals of the project.	1	2	3	4	5
5.	Be concise and measurable.	1	2	3	4	5

4. *The organisation should ensure that the **TAM manager;***

		SDA				SA
1.	Need to be appointed at the end of the current TAM	1	2	3	4	5
2.	Should be experienced in TAM projects.	1	2	3	4	5
3.	Should have adequate skills and knowledge for TAM	1	2	3	4	5
4.	Should have adequate personal attributes	1	2	3	4	5
5.	Has adequate Project Management knowledge	1	2	3	4	5

6. Has adequate Maintenance Management Knowledge	1	2	3	4	5

3B. MANAGEMENT FACTORS

1. ***Organisation/Organisational Structure*** *should;*

	SDA				*SA*
1. Define TAM specific organisational structure for TAM	1	2	3	4	5
2. Identify the management team	1	2	3	4	5
3. Identify the entire crew to carryout the work	1	2	3	4	5
4. Ensure all functions are covered	1	2	3	4	5
5. Ensure minimal duplication of functions	1	2	3	4	5
6. Be hierarchic	1	2	3	4	5
7. Ensure one person must be in overall control	1	2	3	4	5
8. Ensure that single point responsibility is exercised at every stage.	1	2	3	4	5
9. Ensure roles and responsibilities are defined and communicated clearly.	1	2	3	4	5
10. Support coordination, communication and quick decision making.	1	2	3	4	5
11. Be flexible and can respond to new conditions particularly during the execution.	1	2	3	4	5

2. *The following are important of* ***TAM Management Team***

	SDA				*SA*
1. Should be a well motivated and competent team	1	2	3	4	5
2. Members should represent all areas of responsibility.	1	2	3	4	5
3. Each member must have the relevant skill set.	1	2	3	4	5
4. Members should have the ability to work as a team.	1	2	3	4	5
5. Roles and responsibility of each should be defined to avoid conflict.	1	2	3	4	5
6. Roles and relationships should be defined and communicated clearly.	1	2	3	4	5
7. Contractors' representatives should be members.	1	2	3	4	5

3. *Please indicate your opinion about the following of TAM Project* ***Plans/Schedules***

3a. ***Planning***

	SDA				*SA*
1. Unique milestone plan - identifying all key TAM planning activities needed prior to execution.	1	2	3	4	5

2.	Detailed plans of time, safety concerns, human & material resource, regulatory & technical requirements, cost and communication.	1	2	3	4	5
3.	The shutdown start-up logic.	1	2	3	4	5
4.	The shutdown network.	1	2	3	4	5
5.	The start-up network	1	2	3	4	5
6.	The critical path program.	1	2	3	4	5
7.	Contingency plans for emergent work.	1	2	3	4	5
8.	Integrated plan to incorporate the entire TAM activities.	1	2	3	4	5
9.	Additional work approval plan.	1	2	3	4	5
10.	Integrated execution plan	1	2	3	4	5

3b. ***Work scheduling.***

1.	Plan for executing all tasks in a logical sequence.	1	2	3	4	5
2.	Cost profile	1	2	3	4	5
3.	Duration within the available time scale	1	2	3	4	5
4.	Human resource-needs profile	1	2	3	4	5
5.	Economical and sustainable work patterns.	1	2	3	4	5

4. *Indicate your opinion about* ***Communications in TAM projects***

		SDA				SA
1.	Adequate communication reduces delay	1	2	3	4	5
2.	Effective Communication reduces Safety incidents	1	2	3	4	5
3.	Status and progress should be communicated to the relevant personnel.	1	2	3	4	5
4.	Contractors need to be informed of TAM progress.	1	2	3	4	5
5.	Adequate intra-departmental communication.	1	2	3	4	5
6.	Adequate inter-departmental communication.	1	2	3	4	5
7.	Adequate external communication.	1	2	3	4	5

5. ***Technical Tasks.***

		SDA				SA
1.	Tasks are highly specialised	1	2	3	4	5
2.	Special tools and equipment are required	1	2	3	4	5
3.	Scarce highly skilled manpower resources	1	2	3	4	5
4.	High level dependant on Equipment manufacturers' staff	1	2	3	4	5

6. ***The following are important in Personnel Recruitment***

		SDA				SA
1.	Need for competent and experienced TAM Manager	1	2	3	4	5
2.	Competent and motivated TAM team.	1	2	3	4	5
3.	Personnel need to be arranged at the earliest possible date.	1	2	3	4	5
4.	Ensure personnel qualifications and competence in the specific task required.	1	2	3	4	5
5.	Adequate skilled or trained manpower.	1	2	3	4	5

7. ***The following are significant on Contract Strategy***

		SDA				SA
1.	Work scope and how it is packaged	1	2	3	4	5
2.	Strategy depends on the nature of jobs.	1	2	3	4	5
3.	In-house personnel availability.	1	2	3	4	5
4.	Design of the TAM organisation.	1	2	3	4	5
5.	Availability and competence of contractors	1	2	3	4	5
6.	Amount of risk the organisation wants to assume.	1	2	3	4	5

8. ***Logistics***

		SDA				SA
1.	Need for a plot plan to ensure the safety, availability and effective mobilization of every item on site.	1	2	3	4	5
2.	Need to ensure materials, equipment/tools, crane/transportation, utilities and accommodation and facilities are in place.	1	2	3	4	5
3.	Adequate mode of receiving items on site	1	2	3	4	5
4.	Proper mode accommodating or storing of objects	1	2	3	4	5
5.	Disposing of hired equipment and services should be effective.	1	2	3	4	5

9. ***Scope***

		SDA				SA
1.	There is large level of scope functions	1	2	3	4	5
2.	There is multiple sources of work (Capital projects, process needs, inspection requirements, and maintenance)	1	2	3	4	5
3.	Scope is flexible as some activities can be postponed	1	2	3	4	5
4.	Most of the jobs are unrelated	1	2	3	4	5
5.	No end point, there is always jobs to be done.	1	2	3	4	5

10. *Environment, Health and Safety*

		SDA				SA
1.	Safety policy need to be put in place	1	2	3	4	5
2.	Establishing safety communication networks	1	2	3	4	5
3.	Establishing safety working routine.	1	2	3	4	5
4.	Safety awareness and training	1	2	3	4	5
5.	Exposure to hazardous chemicals/radiation needs to be monitored.	1	2	3	4	5
6.	Industrial hygiene monitoring	1	2	3	4	5
7.	Environmental monitoring for pollution.	1	2	3	4	5

11. *Adequate Technology in TAM Project brings about;*

		SDA				SA
1.	On time completion	1	2	3	4	5
2.	Increased productivity	1	2	3	4	5
3.	Correct alignment of tasks	1	2	3	4	5
4.	Improved communication	1	2	3	4	5
5.	Professional reports	1	2	3	4	5
6.	Reduction in cost, man-power and duration	1	2	3	4	5
7.	Reduction in work load.	1	2	3	4	5

12. *Monitoring and feedback*

		SDA				SA
1.	Adequate control mechanisms need to be set up	1	2	3	4	5
2.	Milestone, checkpoints need to be established to ease monitoring, evaluation and feedback	1	2	3	4	5
3.	Helps in carrying out corrective measures	1	2	3	4	5
4.	Ensures that the project is in the right direction.	1	2	3	4	5
5.	Ensures that TAM project is implemented efficiently and economically ensuring the achievement of its objectives.	1	2	3	4	5

13. *Adequate Resource Allocation*

		SDA				SA
1.	Proper resource planning/scheduling	1	2	3	4	5
2.	The right number of personnel are allocated	1	2	3	4	5
3.	Availability of tools and equipment for the tasks.	1	2	3	4	5
4.	Adequate materials and money are allocated	1	2	3	4	5
5.	Approval of additional resources if and when the need arises.	1	2	3	4	5

14. ***Troubleshooting.***

		SDA				SA
1.	Arrangement should be made to handle deviations to plan	1	2	3	4	5
2.	Crisis should be expected.	1	2	3	4	5
3.	Due to scope changes, adequate procedure to handle them should be put in place.	1	2	3	4	5

15. ***Regulatory Bodies***

		SDA				SA
1.	Regulatory requirements should be established early.	1	2	3	4	5
2.	The requirements should be properly interpreted.	1	2	3	4	5
3.	Clear agreement about the work scope should established	1	2	3	4	5
4.	Details of the restart permission process should be agreed with the regulatory body.	1	2	3	4	5
5.	Inspection Agents should agree on the schedules related to inspection.	1	2	3	4	5

SECTION 4 - TAM Management Methodology

4.1 Scope Management - scope of work should be:

		SDA				SA
1.	From different departments.	1	2	3	4	5
2.	Verified to avoid work duplication	1	2	3	4	5
3.	Validate to ensure only shutdown related jobs are approved.	1	2	3	4	5
4.	Outside maintenance professionals can be used to review the scope.	1	2	3	4	5
5.	Management process for scope changes should established.	1	2	3	4	5

4.2 *The following are significant in **Time Management***

		SDA				SA
1.	Activities must be clearly defined and should be measurable	1	2	3	4	5
2.	Activities must be defined every time there is a break or change in work content and/or changes in the work crew.	1	2	3	4	5
3.	Activities should be properly sequenced to enhance the optimum utilisation of resources.	1	2	3	4	5
4.	Estimates for activity duration and the required resources should be realistic.	1	2	3	4	5
5.	Contingency for activity that has been missed but is very critical for the turnaround.	1	2	3	4	5

6.	Establishing Schedule development using CPM, GERT or PERT.	1	2	3	4	5
7.	Establishing schedule change control system to handle schedule changes.	1	2	3	4	5

4.3 ***The following are important in Cost Management.***

		SDA				*SA*
1.	Determination of the resources (people, equipment, materials) needed to perform the known scope items of TAM project.	1	2	3	4	5
2.	Determination of the quantities of these materials.	1	2	3	4	5
3.	Developing a cost estimate of the resources needed to complete the TAM.	1	2	3	4	5
4.	Budgeting for anticipated scope items.	1	2	3	4	5
5.	Budgeting for contingencies.	1	2	3	4	5
6.	Allocating the overall cost estimate to individual work items.	1	2	3	4	5
7.	Developing control measures to changes to the TAM project budget.	1	2	3	4	5
8.	Emergent works should be treated separately.	1	2	3	4	5

4.4 ***The following are important in Quality Management***

		SDA				*SA*
1.	The specification of materials and spares should be clearly stated.	1	2	3	4	5
2.	The requirements of every task must be correctly specified.	1	2	3	4	5
3.	Standard procedure of carrying out the tasks should be specified and adhered to.	1	2	3	4	5
4.	Quality assurance system should be put in place to ensure each tasks conforms to specification.	1	2	3	4	5
5.	Monitoring the specific results to ensure the elimination of deviations to standards.	1	2	3	4	5

4.5 ***The following are necessary in Human Resource Management***

		SDA				*SA*
1.	Roles, responsibilities and reporting relationships should be identified.	1	2	3	4	5
2.	Skills and knowledge required for the roles need to be established.	1	2	3	4	5

3.	An organisational structure need to be established for TAM.	1	2	3	4	5
4.	The Acquisition of human resources needed for TAM.	1	2	3	4	5
5.	Enhancement of the stakeholders to function as a team.	1	2	3	4	5
6.	Integrate the project team into the TAM team to form a single organisation.	1	2	3	4	5
7.	Motivational schemes for the stakeholders.	1	2	3	4	5

4.6 *Communications Management can be managed adequately by considering the following;*

		SDA				SA
1.	Communications plan should include					
i.	Executive Management (summary schedule, progress)	1	2	3	4	5
ii.	TAM management (scope, schedule, progress, manpower).	1	2	3	4	5
iii.	Planning/Scheduling (scope, schedule, progress)	1	2	3	4	5
iv.	Inspection (schedule, progress)	1	2	3	4	5
v.	Operations (scope, schedule, progress)	1	2	3	4	5
vi.	Safety (scope, schedule, [permit requirements])	1	2	3	4	5
vii.	Warehouse (scope, schedule).	1	2	3	4	5
2.	Information dissemination with the supervisors at the end of each shift.	1	2	3	4	5
3.	Standard report formats to stakeholders should be adhered to.	1	2	3	4	5
4.	Performance information reporting of status, progress and forecasting formats should be established.	1	2	3	4	5
5.	Performance reports should include; scope, schedule, cost, quality, risks and procurement issues.	1	2	3	4	5

4.7 *The following are significant in* ***Risk Management***

		SDA				SA
1.	Developing a checklist of risk elements.	1	2	3	4	5
2.	Interviewing other stakeholders to identify risks.	1	2	3	4	5
3.	Deciding on the probability of the risk and its relative impact to TAM.	1	2	3	4	5
4.	Identifying and establish ways of responding to the risk.	1	2	3	4	5
5.	Organising the team to be risk vigilant in order to respond to risk treats.	1	2	3	4	5
6.	Ensuring the Security of the plant, workers, equipment and spares.	1	2	3	4	5

4.8 ***Health, Safety and Environmental Management can be adequately managed through;***

		SDA				SA
1.	Safety trainings and awareness programme for workers.	1	2	3	4	5
2.	Safety policy statement, safety communication networks and safety working routine must be established.	1	2	3	4	5
3.	Environmental monitoring to assess level of environmental pollution.	1	2	3	4	5
4.	Establishing Safe work permit for all activities and ensuring strict adherence to them.	1	2	3	4	5
5.	Identifying all hazards and establishing ways to protect the workers.	1	2	3	4	5
6.	Establishing the procedure to handle any incident	1	2	3	4	5
7.	Every safety or Environmental incident should be investigated and reported.	1	2	3	4	5
8.	The use of PPE should not be compromised.	1	2	3	4	5
9.	'Job Safety Hazard Analysis' should be carried out for all jobs.	1	2	3	4	5

4.9 *The following are important in **Materials Management***

		SDA				SA
1.	Ensure that an experienced personnel is assigned as a materials coordinator.	1	2	3	4	5
2.	Regular communication established between the TAM team and Materials function.	1	2	3	4	5
3.	Analyzing the work list at the earliest to identify materials needed for the TAM.	1	2	3	4	5
4.	Identify long delivery, specialty, and unique items and delivery needs.	1	2	3	4	5
5.	Plant- versus Contractor-supplied materials needs to be defined.	1	2	3	4	5
6.	Material to be procured must be correctly specified.	1	2	3	4	5
7.	Quality of materials received must conform to specifications.	1	2	3	4	5
8.	Material tracking procedure should be put in place	1	2	3	4	5

4.10 *The following are important in **Contract Management***

		SDA				SA
1.	Ensuring that the work scope of each contractor is well defined.	1	2	3	4	5

2.	Thorough assessment of contractor's capability (in terms of manpower, skills etc).	1	2	3	4	5
3.	Reduction of interfaces between contractors and plant personnel.	1	2	3	4	5
4.	Payment schedule for the contractors to be properly defined and adhered to.	1	2	3	4	5
5.	Proper assessment in terms quality control and assurance of contractors supplied materials and jobs.	1	2	3	4	5

APPENDIX B

CASE STUDIES GUIDE QUESTIONS

A. GENERAL

1. What are the main drivers of the TAM projects you have been involved in?
2. Are there ways of avoiding TAM projects? Please explain.
3. What are the problems and barriers that you face currently in managing TAM projects?
4. How do you cope with these? And in what ways do you feel these problems can be best addressed.

B. TAM PROJECT SUCCESS EVALUATION

1. Do you evaluate the outcome of your TAM projects?
2. What elements do you use in measuring the outcome of the TAM projects?
3. How do you currently evaluate the success/failure of the following elements of TAM projects?
   a. Cost (and cost associated with emergent jobs).
   b. Time (and time associated with emergent jobs)
   c. Quality
   d. Safety/Environmental impact.
   e. Functionality of the system.
4. How do you assess the satisfaction (meeting the expectation) of these Project Stakeholders;
   a. The Contractors.
   b. Client/Top management
   c. TAM Management Team
   d. Plant Users.
5. At handover, how best do you think the benefits of the TAM Project can be measured to know if the objective of the project is achieved?

C. TAM MANAGER & TAM MANAGEMENT SKILLS/KNOWLEDGE

Results from Questionnaire

Attributes, Attitude & Traits	% Score (Mean)	Management Skills	% Score (Mean)
Good Communicator	92.3	Health, Safety and Environment	94.7
Competence	92	Planning and control	93.7
Team building ability	90.2	Leadership	93.4
Enthusiasm	86.7	Motivation	92.8
Honesty	86.7	Cost Management	92.2
Determination	86.7	Budgetary Control	91.7
Ability to delegate tasks and responsibilities	85.8	Decision making	91.3
Supportive	85.4	Quality Management	91.3
Cool under pressure	84.8	Time management	91
Integrity	83	Communication/Presentation	90.8
Problem solving abilities	82	Risk Management	89.1
Interest in the job	80	Managing conflicts and crisis	89
Open minded	79.8	Control	87
Need to achieve and proactive	78.8	Forecasting	86.6
Shared vision	78.6	Technical	85.7
Patient	74.6	Management support building	84.2
Tolerance to ambiguity	72	Resource Allocation	83.6
Empathy	68	Negotiation: Contractors	83.4
		Negotiation: Inspection Agencies	83.3
		Negotiation: Govt. Agencies and Regulatory Bodies	83.3
		Human Resource Management	79.5
		Negotiation: Eqt. manufacturers	79.1
		Supervision of others	78.9
		Organisation	78.2
		Administrative	74.9
		Negotiation: Suppliers and vendors	74.3
		Use of Computer	70.9
		Negotiation: Trade Unions.	66

Knowledge and Awareness	% Score (Mean)
Health and safety regulations	93.7
Project Management techniques	90
Organisation of communication systems	88.8
Setting objectives and goals	87.7
Technical Knowledge	86.4
Regulatory processes	86
Contractual Knowledge	78
Tendering Strategies	70.5
Site security	70

Table 2

1) Kindly comment on the personal attributes/traits of TAM Managers towards the successful managing of TAM projects as shown in the Table 1.
2) In your opinion, which one do you consider to be very critical, and which ones do you consider a TAM manager must possess to be successful. Please explain.
3) Kindly comment on the Management skills, knowledge and awareness needed to achieve TAM success as shown in the Tables 1 & 2.
4) Which of these skills are very crucial for TAM to be successful?
5) It may not be possible for the TAM Manager to possess all these skills/knowledge, which of the skills/knowledge do you consider the TAM Manager must possess and why?
6) In your current organisation, do you think your TAM Manager possess these critical personal traits/attribute and management Skills?

D. **TAM CRITICAL SUCCESS FACTORS & MANAGEMENT STRATEGIES.**

1) **TAM Philosophy**
   a. Do you have any philosophy in place that guides your TAM projects?
   b. Do you agree that a having/not having TAM philosophy in place can affect the TAM Project successor failure? Please explain.
   c. What in your opinion should constitute this philosophy?

2) Top Management Support

- **a.** In what ways would you expect the Top Management to support the project to achieve success?
- **b.** How do they respond to issues concerning scope changes in you shutdown projects?

3) Goals & Objectives

- **a.** Does your organisation define the goals and objectives of your shutdown projects?
- **b.** Are these goals and objectives very clearly defined and made known to the TAM Management team and are they measurable?
- **c.** How in your opinion do you feel the goals and objectives should be defined?

4) Selection of TAM Manager

- **a.** In your opinion, when do you consider it best to appoint a TAM manager for the next project, (how long before the project)? Why?
- b. Who is more effective in delivering TAM projects; an in-house TAM Manager of a Contract TAM manager? Why?

5) Organisation/Organisational Structure

- **a.** Do you have an organisational structure for your TAM projects? Why?
- b. How do you organise your shutdowns currently?
- **c.** What areas do you think needs improvement?

6) TAM Management Team

- a. Do you constitute any management team for your shutdowns? Why?
- b. Are the skills of the members considered before their appointment?
- c. Are contractors' representatives members of this team? Why?

7) Project Plans/Schedules

- a. Do you plan for anticipated and emergent jobs? How do you do this?
- b. In most TAM projects, there are other engineering projects to be carried out; do you have an *integrated plan* for all the activities? Why?
- c. What software do you use in planning and scheduling your TAM projects? And how has it improved on the TAM project implementation?

d. In what ways do you think planning for this project can be improved?

8) Communication/Communication Management

a. Adequate communication reduces delay and safety incidents, do you agree? Why and How?
b. What communication modes do you have in place for your TAM projects?
c. Are these very adequate? In what ways in your opinion can these be improved?

9) Contract Strategy/Management

a. Do you use contractors in your shutdown? Why?
b. What types of contract strategy do you use currently? Why?
c. In selecting contractors, what are the criteria you use to make your choice?
d. In what ways do you consider improving contract management strategies to ensure more effective and successful TAM?

10) Human Resources Management

a. How do you ensure that personnel arranged for the jobs have the relevant skills and competence?
b. Considering the diversity in the workers, do you ensure the entire team works as a team? How?
c. Duration of TAM projects need to be as short as possible, what shift patterns do you adopt, and which one do you feel is more effective towards ensuring TAM success? Please explain.
d. Do you have any motivational schemes for TAM workers? Why? What are these schemes?

11) Scope/Scope Management

a. One of the major differences between TAM and other engineering projects is TAM scope fluctuations, how do you manage your shutdown scope of work?
b. Do you carry out scope verification and validation for your TAM projects? Why and how do you do this?

c. In your opinion do you feel the maintenance approach in a plant can affect the level of scope changes during the shutdown project? Why? And How?

d. What type of Maintenance approach (es) does your organisation adopt currently? And Why?

12) Environment, Health & Safety

a. How do you currently manage HSE in your TAM projects?

b. In what ways, in your opinion can this be improved?

13) Quality/Quality Management

a. Quality is very critical to TAM project success, how do you manage it in your current TAM projects?

b. Do you have quality control and quality assurance in place? How do you do this?

c. How do you assure that a job is done to the right specification?

d. What areas need improvement and how?

14) Risk Management

a. What are the risks apparent in your TAM projects?

b. How do you currently manage these risks?

c. In your opinion, what are the ways to improve on managing these risks?

15) Material/ Logistics Management

a. How do you manage materials associated with TAM projects?

b. How do you handle materials (spares/equipment) to be used in emergent jobs?

c. Quality of materials procured affects the project success, how do you ensure the quality is within standard expected?

16) Time Management

a. 'Time overrun is to be avoided as much as possible in TAM projects'. Do you agree with this? Why?

b. What are the issues that can cause time overrun in TAM projects? And how do you manage them to ensure TAM success?

17) Cost Management

a. How do you carry out cost budgeting in your TAM projects?

b. How do you handle issue concerning emergent jobs?

APPENDIX C

ABSTRACT OF PAPER PRESENTED AT THE ARCOM WORKSHOP, at Sheffield Hallam University, June 1, 2007.

TITLE: OPTIMIZATION OF TURNAROUND MAINTENANCE PROJECT IMPLEMENTATION

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Due to age, operating/environmental conditions, statutory requirements, etc there comes a time when the entire facility of Process industries had to be shutdown for necessary repairs, maintenance and project works. Shutdown maintenance (also known as Turnaround maintenance; TAM) projects have been experiencing failures due mainly to the assumption by organisations that TAM projects are same as Engineering, Procurement and Construction (EPC) projects. This research aims at determining the factors responsible for the failures of TAM implementation projects and to create a framework to guide against them. It will also establish the key management skills required to ensure TAM project success. Field surveys, questionnaires and case studies approaches are planned to evaluate and validate the above research aims. It is envisaged that the research when completed will solve the problem of TAM failures in Process industries.

Keywords: project implementation, shutdown maintenance, turnaround maintenance

APPENDIX D

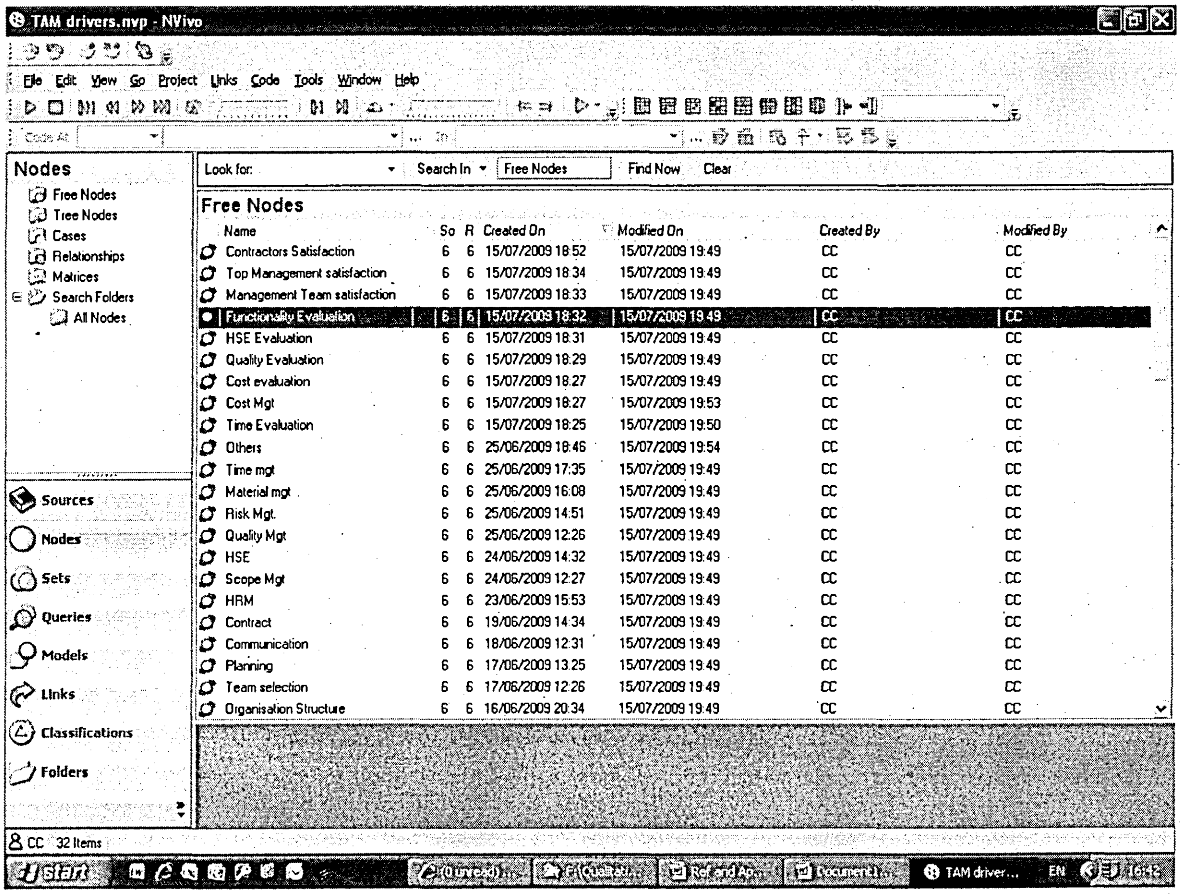

Figure I: Screen display of the Primary nodes Used for the case studies data