The impact of scope changes on turnaround schedule and cost in the Oil Refinery Industry

by

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DECLARATION

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ABSTRACT

The number of deviations submitted to the turnaround team after the scope freeze dates and during turnaround caused a great concern to Engen Refinery, as it has a potential to put stress to the already committed resources, delays schedule and increase in turnaround overall cost. This study examined the turnaround processes on the change in the scope of work and their contributing factors on turnaround schedule and cost in the oil refinery industry. Furthermore, the research investigated the possible factors that could be considered to address the change in scope during turnaround, thus limiting the number of deviations during turnaround.

To achieve these factors, the qualitative and exploratory research approach was employed to the Engen Refinery case study. The targeted population of the study included seventeen participants from Engen Refinery who were purposively selected to take part in the interview session. The sample included nine participants which included the professionals from different sub-departments in the Maintenance and Turnaround Department. The sample had two managers and seven Senior Personnel's, mostly Engineers and one Lead Supervisor. In-depth, semi-structured interviews were done telephonically, where each participant consent first for being recorded and the recordings were transcribed into word document. The transcribed data was analysed using the Thematic Analysis which utilises the six-phase process of data analysis. There were twelve themes which were created and were utilised to analyse the data received from the interview. The theory underpinning this study is the "Theory of Triple Constrains" which relates to the project success or failure. The theory defines the need to satisfy the customer requirements at an agreed schedule and estimated cost. However, this theory does not give guidance on project success or failure when the customer initiated the change in scope which is the main weakness in theory. Therefore, this study assumes the customer requirements are fixed irrespective who request the change.

The research study results are tested against the theory of constrains. The research study results indicated that the change in scope after the freeze dates and during turnaround delayed the schedule and increased the overall cost of the turnaround. The contributing factors included the mismanagement of the deviations process, the "known unknowns" and the diversified work culture displayed during turnaround. The "known unknown" were found to be the leading cause of schedule delays and increase in turnaround cost and are contributed by not doing required inspections, and lack of skills and experience of personnel conducting the scope. Not able to clearly define the scope was the cause of change in scope which could be as a result of

competency in scope definition. The behaviours, attitude and mindset displayed towards turnaround and during turnaround have a potential to increase cost and delays schedule if not managed properly.

The study was limited to Maintenance and Turnaround Department at Engen Refinery which only included the most experienced individuals in the department, focused on changes in turnaround work scope on schedule and cost, and therefore does not represent the overall view of people working in the Oil Refinery and those researching the Turnaround strategies in Oil and Gas sector, therefore the results cannot be generalised.

The research outcome may assist turnaround project teams on the impact of changing the turnaround scope of work on the schedule and cost. Those who develop turnaround strategies, scholars, future researchers will find great value of this study on the impact of changing the turnaround scope during or towards the start of the turnaround.

Key words:

Turnaround, deviations, scope creep, scope change, anticipated scope, “known unknowns”

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CHAPTER 1 – INTRODUCTION AND BACKGROUND TO THE STUDY

1.1. Introduction

The Engen Refinery site located in Durban has undergone the temporary controlled shutdown, as from the 27th of March 2020, where controlled activities were performed, which Engen assures the customers that will not impact on the company's ability to supply commercial customers and motorists with the main petroleum products in the middle of the national lockdown (Slater, 2020). Engen Refinery was safe to shut down during COVID-19 lockdown, as they have high product inventory which will not affect the customers as the demand is low. According to Engen Petroleum Limited Managing Director, and Chief Executive Officer (CEO) Mr Yusa Hassan, to meet the demand requirement for the inland, the company needs to continue their operations to support and maximise their offtake from inland refineries (Slater, 2020).

Jakubowski and Karlsson (2010) states that there are thousand components such as pipes, heat exchangers, catalysts, pumps, motors, cooling towers etc. within a refinery which are subjected to different kinds of maintenance which includes preventative and predictive maintenance (Jakubowski & Karlsson, 2010). There are demands from authorities, insurance companies including the nature of operations which requires the refinery and other petrochemical industries to unconditionally shutdown their plant for revision, inspection and schedule maintenance which is normally done every four to six years (Jakubowski & Karlsson, 2010). Jakubowski and Karlsson (2010) further states that the planning procedures for these turnarounds are extensive and commonly handled by permanent employees of each refinery which are complimented by external consultants while the refinery takes total responsibility of the turnaround (Jakubowski & Karlsson, 2010).

Bevilacqua, Ciarapica, Giacchetta and Marchetti (2012) states that the planned turnarounds have a varying frequency depending on the type of unit to be shutdown and takes a year or two to plan and prepare sometimes longer when major equipment are replaced (Bevilacqua, et al., 2012). Turnarounds normally affects production of finished products in a refinery and pose as a safety concern since it runs high pressure and temperature equipment and contains hydrocarbons which are explosive in nature (Bevilacqua, et al., 2012).

Considering the above, this study investigated the changing scope impact on schedule and cost, and the contributing factors to change scope during turnaround. The study highlighted the importance of education and skill management in preparation for a turnaround.

Komal, Janjua, Anwar, Madni, Cheema, Malik and Shahid (2020) introduced scope creep as one of the common causes of project failure and leads to compromise in quality, delay schedule, increase cost and decrease satisfaction of a customer (Komal, et al., 2020).

Komal et al (2020) further states that scope changes are accompanied by schedule and cost overruns, and one of their respondent during the interview stated that " any changes in a dimension of iron triangle (cost, schedule and quality) are as a results of change in market condition that could lead to scope changes" (Komal, et al., 2020).

Bevilacqua et al. (2012) described the scope challenge session as a managing tool for the shutdown and optimisation of the activities that needs to be done during turnaround (Bevilacqua, et al., 2012).

Bevilacqua et al. (2012) defined the scope of work as a document containing the list of activities which needs to be done during the turnaround and is the basis of all other schedule aspects such as quality, duration, resources, materials and equipment (Bevilacqua, et al., 2012).

The chapter thus proceeds with the study motivation, followed by the study focus, the problem statement, the main purpose of the study, the objectives of the research and the structure of the dissertation.

1.2. The motivation of the study

Althiyabi and Qureshi (2021) states that in project management, the scope of work is the bases of the project planning where the cost estimate, schedule, and crating a work breakdown structure. Project scope with poor definitions directly affects the cost and schedule of a project (Althiyabi & Qureshi, 2021). Althiyabi and Qureshi (2021) further suggest that the failure of a project could be as a result of unrealistic scope definition and any change in project scope has a negative and positive impact on the success of the project (Althiyabi & Qureshi, 2021).

Hassan and Asghar (2021) stated that failures in a project are often caused by an inadequate scope definition which leads to causes of delays, changes or rework, and cost and schedule overruns (Hassan & Asghar, 2021). This study is motivated by several late applications for turnaround work scope deviation, where several departments request the job to be added,

removed, or update the work scope. Another aspect that motivated the study was the fact that during plant start-up, the plant does not start at the scheduled dates, thus raising questions about the causes of these delays.

1.3. Problem statement

The turnaround department usually sends turnaround communication way before the turnaround start. However, most of the time, towards the start of the turnaround when the scope submission dates are frozen, numerous scope deviations requests are submitted for approval. Some of these deviations could impact the critical path, while others do not, but the concern is that this has become a norm. According to Althiyabi and Qureshi (2021) the changes in a project are immanent to occur, therefore changes in a project scope have a negative and positive impact on the overall project status, therefore these changes may lead to a project failure (Althiyabi & Qureshi, 2021).

Some activities are done during the turnaround without being registered on the turnaround worklist using turnaround resources, thus straining the turnaround planned activities at Engen Refinery. This has been ongoing for all the turnarounds and raised concerns among management, as some activities compromise the critical path, while no one knows about these activities. These issues of adding activities in a turnaround worklist have compromised the starting of the refinery, thus contributing to the increase in total turnaround cost. This study utilises the principles outlines in the project management body on knowledge (PMBOK) to reflect on how project scope of work is created and aligned with the turnaround.

The turnaround management studies in the oil and gas industries have not properly investigated the changes in the scope of work during turnaround, however there were few studies relating to change in scope in software project scopes. There have been numerous studies done before which includes the study by Mhlanga, Munapo & Mavetera (2016) which investigated the amount of escalation in cost and the delays in the execution of a turnaround activity. Althiyabi and Qureshi (2021) investigated the potential scope changes to ensure the project scope is on track and identified weaknesses in scope definition at the early stages of a project (Althiyabi & Qureshi, 2021). Obiajunwa (2020) discussed the factors that are critical which affect the turnaround management implementation on projects and determining the best ways of implementing the turnaround management projects (Obiajunwa, 2010). Mhlanga et al. (2016) suggested for future studies, one should focus on the entire project management aspects within

the refinery. The study intends to lay bare, the major factors contributing to the turnaround work scope deviation requests. Section 2.1.1 further display the studies that were done which are similar to the study focused on this report.

1.4. The focus of the study

Investigating the impact of changing the scope of work on schedule and cost in the Oil Refinery Industry is the main focus of this study. The intention of this research is to outline the components that contributes to the continuous addition of scope after the freeze dates at Engen Refinery. The study focuses on the value of the scope of work, as well as the impact of the deviations on the start and during the execution of the turnaround and seeks to find the contributing factors to the turnaround scope deviations.

1.5. The aim of the study

Examining the turnaround processes in relation to change in the scope of work and the contributing factors on turnaround schedule and cost in the oil refinery industry. The study seeks to understand the project management processes that are guiding the maintenance department at Engen Refinery to determine the factors contributing to the change in work scope during turnaround.

1.5.1. The research objectives

In relation to the aims of this research study, the study aims to fulfil the below objectives:

- To examine the impact of change in scope on turnaround schedule in the Oil Refinery Industry.
- To examine the impact of change in scope on turnaround cost in the Oil Refinery Industry.
- To get the deep understanding of the contributing factors on the change in scope, after the scope freeze dates and during turnaround in the Oil Refinery Industry.

1.5.2. The research questions of the study

In accordance with the presented objectives in the above subsection, the study needs to give answers to the research questions which are presented below:

- How does the change in scope impact the turnaround schedule in the Oil Refinery Industry?
- How does the change in scope impact the turnaround cost in the Oil Refinery industry?
- What are the contributing factors on the change in scope after the scope freeze dates and during turnaround in Oil Refinery Industry?

1.6. Significance of the study

The research is oriented to Engen Refinery, however its value on assessing the turnaround work scope may benefit other petrochemical refineries and any organisation that undergoes the outage, turnaround, and shutdown.

Change in scope during turnaround is regarded as a major contributor to the increase in cost and extension of the turnaround duration in the petrochemical industry. However, effect of change in scope have not yet been implemented at Engen Refinery. This study is significant to the turnaround team as it highlights the impact caused by changing the turnaround scope on the turnaround schedule and cost. The study is also significant to scholars and for future researcher of the turnaround strategies or in project management on the refinery sector. The findings could assist in developing turnaround strategies, lessons learned and education of the team on how to approach the scope change. The maintenance team would benefit from the study at the issues related to freeze dates will be explored which will allow the team to be aware of their actions of continuous addition to the scope during turnaround.

1.7. Structure of the dissertation

This dissertation consists of six chapters and this section outlines a brief description of each chapter:

Chapter 1 is the introductory section which introduces the chapter and presents study motivation, the problem statement, the main area of focus of the study, the main aims which includes the research objectives and questions, how significant the overall study, and outlining the summary of the chapter.

Chapter 2 represents the literature review which outlines the project management theoretical aspects. The chapter reflected on the theory which guides this research study and outlines the major drawbacks of the theory. The impact of changing the turnaround scope during the turnaround and it impact in turnaround schedule and cost was outlined in the literature review.

This chapter details the how the change in scope contributes to the increase in turnaround cost and compromises it has on the turnaround schedule.

Chapter 3 outlines the methodology used for the research, which presents the research philosophy, research design and the methods used to conduct the study. This chapter presented the targeted population, sampling methods, the method of how data was collected, and the method used to analyse the data. The data analysis method – thematic analysis is also described, which enables the collected data to be analysed using repetition to create themes. There were twelve themes that were discovered and explained in great details.

Chapter 4 outlines the analysis and the presentation of results and focuses on the research questions against the respondents' feedback and presents them in a tabular form. The summary of the views of each respondent was presented in a tabular form.

Chapter 5 outlines the discussion of the study which relates to the findings of the research against the research study objectives, thus answering the research questions while aligning them with the existing literature. The discussion was where the triple constraints theory was used to test the findings.

Chapter 6 presents the conclusions and recommendations section which outlines the conclusions and recommendations of the entire thesis which are based on the findings of the research. The study limitations and the areas of further studies were presented in this section.

1.8. Chapter summary

This section summarises the chapter and details the rationale for this study, how the issue of changing work scope during the turnaround has impacted on cost and schedule. The chapter started with the introduction and the study motivation. The study focused was outlined which presented the impact of changing scope on cost and schedule in the Oil Refinery Industry. It also reflected on the problem statement, the objectives, and the significance of the study. The chapter also presented the research layout for each chapter. Chapter 2 lays the research theoretical aspects, which will be used to formulate the research questions.

CHAPTER 2 - LITERATURE REVIEW

2.1 Introduction

The impact of changing the scope of work on schedule and cost of the turnaround in the Oil Refinery Industry is presented in this section. Using the case study of Engen refinery, the literature review on project management principles delves into the contributing factors of scope change during turnaround. In this view, the chapter proceeds and discusses the turnaround concept, turnaround scope of work management, detailing the challenges of creating a turnaround scope of work, the factors affecting the turnaround scope, schedule management and the turnaround cost management.

Nikmatul, Yudoko and Firman (2023) states that the turnaround which is sometimes called the shutdown is the maintenance management strategy which is common to the Oil and Gas Processing plants to improve the plant availability and reliability (Nikmatul, et al., 2023).

2.1.1. Previous studies on turnaround

Previously Nikmatul, et al. (2023) evaluated the turnaround maintenance project execution plan in the Central Processing Plant (Nikmatul, et al., 2023). The study conducted by Nikmatul, et al. (2023) provided an alternative solution and gave recommendations to optimise the total utilization time for the third turnaround execution through long term specific contracting strategy (Nikmatul, et al., 2023).

Mazumder and Mubashar (2016) previously examined the initiation process of plant shutdown including document involved and their effects on time and cost (Mazumder & Mubashar, 2016). Their paper outlines the impact of late receival of the documentation which could lead to time delays and influence the project cost (Mazumder & Mubashar, 2016).

Fabic, Pavletic and Valic (2020) presented a paper where they defined and tested the factors in turnaround refinery project management process, and the quality factors in the turnaround refinery projects (FABIĆ, et al., 2020). Their presentation identified scientifically the factors in the turnaround project management process, which has a potential to have a greater effect in performance of projects and a level of relevance in the scientific field of managing complex maintenance projects (FABIĆ, et al., 2020). Their objectives were to list the factors of the management process and to determine their contribution to the process of managing the turnaround projects (FABIĆ, et al., 2020).

Althiyabi and Qureshi (2021) previously investigated the causes of poorly defined scope and further proposed the solution to overcome, and they categorised the scope changes as planned and unplanned which is also called scope creep (Althiyabi & Qureshi, 2021). In their study, it focused on providing procedures of discovering and dealing with scope changes that may occur on the project.

Adiza, Ghazali and Isha (2014) previously investigated the balance between turnaround maintenance managers and their experiences in the petrochemical companies and explored the way turnaround managers manage their communication in diversified workforce teams (Adiza, et al., 2018).

2.1.2. Unpacking the "Turnaround" concept

PMBOK (2017) defined the project as "*a temporary endeavour undertaken to create a unique product or service, where temporary endeavour means that every project has a definite beginning and end, and unique products means that the product or service is different in some distinguishing way from all similar products or services*"(PMBOK,2017:44).

Sasol (2020) defined turnaround as a periodic, planned and scheduled event where multiple production units are taken out of service temporarily to conduct all necessary operational, maintenance and improvements to ensure the equipment is reliable and safe to use at the desired performance for the next operating cycle (Sasol, 2020). Sahoo (2013) agreed with the Sasol (2020) and defined a turnaround as a well organised, temporary shutdown of the refinery's processing unit or the entire plant to carryout services such as maintenance, inspection and repair of the equipment that have been broken or worn-out to ensure that the refinery is operating safely and efficiently. Obiajunwa (2010) also defined turnaround as 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*" (Obiajunwa, 2010:39).

Mazumder and Mubashar (2016) stated that a shutdown which is planned is known as a turnaround where most refineries go through every three to five years (Mazumder & Mubashar, 2016).

Lawrence (2012) states that industries which run on continuous production such as oil refineries must every few years, shut down operations to enable access to the production

facilities to conduct critical maintenance, inspections and modifications which could not be done while the units are online (Lawrence, 2012).

Based on the above turnaround definitions, this study defines a turnaround as periodic, planned maintenance of the plant or section of the plant or unit where multiple projects or activities are done at once and are scheduled to align with the turnaround critical path.

Turnaround management is defined as the process which provides a structured approach to improve continuously the effectiveness and efficiency of turnaround and its main objectives is to complete turnaround in a shortest possible time, lowest cost, best quality of workmanship and no safety incidents (Sasol, 2020). According to Kelly (2006), the main objective of a turnaround for any industry is to complete the agreed maintenance services within the agreed turnaround times, using minimum budged as possible, while meeting all relevant safety standards (Kelly, 2006). Sahoo (2013), gave a list of activities that could be performed during shutdown, turnaround, or outage:

- Routine's inspections which include inspecting corrosion, deposit formation, condition of electrical and piping systems, and equipment integrity (Sahoo, 2013).
- Inspections that require specialists' interventions such as those arising from failures of rotating equipment, major vessels or any rotating equipment (Sahoo, 2013)
- Equipment upgrades for which includes the pumps, instrumentation or electrical worn out.

Improvements activities during turnaround could include the following (Sahoo, 2013):

- Upgrades for improving refinery processing units or installation of modern technologies.
- Minor or Major capital project which includes the new installations or altering of the refinery process and product output.

Sahoo (2013) list of activities to be done during turnaround are supported by Lawrence (2012) which states that the scope of the turnaround includes statutory inspections which are governed by the government rules, pipework corrosion inspections both internal and external inspections, cleaning, repair and maintenance of equipment (Lawrence, 2012). Tie-in for capital projects, modifications and minor upgrades are included as turnaround activities and controlled using management of change (Lawrence, 2012).

Honeywell (2019) stated that there may be significant planning in all phases of the turnaround, but unexpected risks may take place, which may include the use of new tools, people coming on site may not be familiar with the site, Health, Safety and Environment (HSE) rules, projects operating simultaneously (Honeywell , 2019). According to Obiajunwa (2010), there are three types of turnarounds of work scopes which includes the known scope, anticipated and emergent scope, where all turnaround managers agree to be happening and are listed below:

i. **Known scope of work -** are those scopes that are well defined, budgeted, planned for, and included in a turnaround worklist.
ii. **Anticipated work scopes –** are the scopes that are not well defined, which are as the results of inspection estimates, maintenance reports and other means of collection the work scope such as visual inspection and equipment history.
iii. **Emergent work scope –** are those scopes that emerges because of inspections and dismantling of equipment's, these can be caused by underestimated scope of work which emerges due to poor scope definitions.

Table 2.1: Turnaround project management plan

Event Size	**Timing (months)**					
Small	**12**	**6**	**4**	**3**	**2**	**0.5**
Large	**18**	**15**	**12**	**6**	**3**	**1**
Phase	**1: Conceptual**	**2: Work Dev**	**3: Detailed planning**		**4: Pre TA execution**	
SCOPE						
Work list preparation	Initial worklist from inspection/ maintenance records Set or amend scope challenge criteria	Develop work packages	Create WBS challenge and validate tasks	Finalize work list. Final scope challenge	Freeze work list.	Do required pre-turnaround work
Projects/modes	Initial project list from engineering		Integrate into plan			
Major tasks	Identify major tasks from above		Issue work package to planning			
TIME						
Planning	Milestone schedule. Initial plan template from previous TA model.	Define and categorize activities	Detailed planning on CPM model	Level resources and optimize model		Ensure completion of all pre-turnaround work
Scheduling	Duration from previous TA Model	Build turnaround model		Finalize scheduling within agreed TA duration.	Finalize task method sheets. Freeze date and baseline	
COST						
Costing	Cost from previous TA model escalated for budget approval	Improve cost estimate. Preliminary cost for approval		Firm up budget. Final cost for approval		Test cost management system

Source: Adopted from Hey (2019)

Table 2.1 represents the most significant constraints in project management which includes the scope of work, schedule and cost of the project and measure them against the turnaround project

management plant process which will guide the literature of this paper while following the project management body of knowledge (PMBOK) principles of scope management. Hey (2019) states that the scope of work needs to be early defined in the process and all procedures related to scope management need to be reviewed.

2.1.3. The "Theory of triple constrains"

Oberlender (2000), states that a project has three components which includes the scope, cost and a schedule. For a project to start, the triple constrains needs to be clearly defined and the balance between them is necessary. Figure 2.1 represents the core project management triple constraints which are used to measure the success of the project.

Figure 2.1: Triple constraints (Scope, Budget, and Schedule)

Source: (Oberlender, 2000)

In contrary to the statement given by Oberlender (2000), which relates to the triple constraints, Sasol (2020) states that the turnaround process provides a structured approach which continually improves the effectiveness and efficiency of the turnaround process.

Sasol (2020) states that the process in Fig. 2.2 focuses on delivering key objectives which include completing the turnaround on the agreed schedule, at the lowest possible cost, with a great quality of workmanship, and with no safety incidents or impact on the environment (Sasol, 2020).

Cuellar (2010) referenced the list of authors who supported that the triple constrains are the measure of project success where the project manager needs to consider the scope, cost and agreed schedule for the project so as the project will be successful (Cuellar, 2010). Cuellar (2010) argued that project success and failure are relative terms as failure is a condition or fact of not achieving the required results and success is achieving the desired outcomes (Cuellar, 2010).

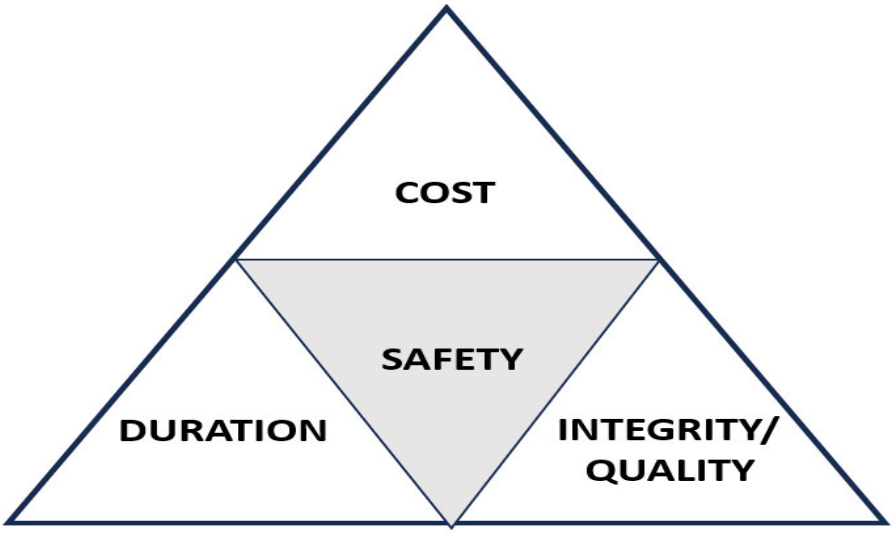

Figure 2.2: Focus of turnaround management process

Source: (Sasol, 2020)

Oberlender (2000) stated that project failures are because of the failure to define the project scope and it should be the first task which must be done considering cost of the project and its schedule. The success of the turnaround is related to an effective work scope, and it relates to performance, then reducing the cost, schedule parameters will see the success of the turnaround, while ensuring the plan is reliable (Hansen & Schroeder, 2016). They further stated that about forty percent of turnarounds experience a cost overrun and schedule delay, the causes of these aspects are defined below (Hansen & Schroeder, 2016):

- Poor scope control before the start of the shutdown
- High-cost rates of added scope or discovery work during execution
- Poor planning and preparation
- Unrealistic cost and schedule targets

Ebbesen and Hope (2013) stated that the triple constraints may not necessarily mean the project is successful as that would be defined by the customer (Ebbesen & Hope, 2013). Ebbesen and

Hope (2013) suggested that the quality shall be represented instead of scope as it covers all the gaps related to the scope and referred to the three elements as iron constraints.

Rugenyi (2016) defined the triple constraints as the triangle formulated by the agreed schedule, within budget and the requirements and guidelines on how the project shall be achieved (Rugenyi, 2016). In regard to triple constrains, the driver is the variable which that the project requirements shall meet for success or failure (Rugenyi, 2016). The constrains that are regarded as weak are those that are flexible and presents the opportunity to modify in order to ensure the driving variable does not fail (Rugenyi, 2016).

Different authors defined the triple constraints as meeting the required schedule, within budget and meeting the customer requirements and these definitions all agrees with each other. The theory states that the customer requirements define the project success, however the theory does not give details on project success when the customer initiates the change in scope in which the project durations increase or increase in project cost or both. The theory suggests that the customer requirements guide the project success however there is no mention of implication in project success when the customer initiates the change with will change the critical path, therefore there is a gap in theory which needs to be investigated.

Based on the literature of triple constrains, this study will refer to the scope of work as all the requirements agreed with the customer or stakeholders which includes the quality of workmanship, project safety aspects, quality of the output, detailed guidelines on how to complete the activity etc. In line with the project scope definition, the triple constrains refers to meeting the scope of work definition, within the required schedule and agreed scope. The scope of work is the driving variable which when increased will possible increase one or both of the weak variables thus regarding the project failure or success (Rugenyi, 2016). Therefore, this study, assumes that the customer requirements are fixed to ensure that any change in scope will result in project success or failure.

This literature review discusses the value of the turnaround work scope and how it contributes to turnaround failures and successes, and further discusses the impact of work scope deviation in the planning phase and during execution, as well as how it affects the turnaround objectives (maintaining schedule with less cost) and what are their contributing factors.

2.2. Turnaround Work Scope Management

The project scope is defined by PMBOK (2017) as the activities which must be done to create a unique product, service or results with clearly defined features and functions, while project scope management is the process needed to ensure a project accommodates all the required work activities to successfully complete the project (PMBOK, 2017). Turnaround work scope is defined by (Bloch & Geitner, 2006) as the process of identifying mechanical and projects that are required to be carried out during turnaround.

Sahoo (2013) stated that a work scope is a foundation of the turnaround where all aspects are defined, and influence in considering the final cost, while the scope statement is a baseline of the turnaround and is defined as a document that defines the turnaround goals, deliveries, and requirements so they can be used for execution decisions. Sahoo (2013) further stated that should there be a need for changes or questions arise, the scope statement could be used to direct any change or questions. The objectives of the process of project scoping are defined by Sasol (2020) to develop a consolidated worklist, minimise the impact of additional work commitments after the scope freeze date, and agree on the approved work list that needs to be planned, scheduled and executed during turnaround (Sasol, 2020). Based on the definitions of turnaround work scope, all the authors suggest that the turnaround work scope are all the activities that needs to be done during turnaround which are budgeted and scheduled against the turnaround critical path.

Sasol (2020) stated that there are five key activities that need to be done, as well as three decisions that need to be made, which complements the below statement presented by PMBOK. PMBOK (2017) outlines that project scope management process consists of six elements which includes the plan scope management, collect requirements, defining the scope, creating a work breakdown structure (WBS), validating the scope and control the scope and are defined below:

2.2.1. Plan Scope Management

PMBOK (2017) defines the plan scope management process as the process which outline and document different ways of determining the activities of the scope of the product, and how to validate and control the product. The plan scope management gives a direction on how the end product should appear, or what needs to be done, and outline the ways on managing the scope throughout the project lifecycle (PMBOK, 2017). As stated by PMBOK (2017), the project

management plan and the project charter form part of the plan scope management inputs and are described below:

Project charter stipulates the purpose of the project, and describes a project with the high-level definition, it outlines the constrains, assumptions and project satisfactory requirements at an elevated level (PMBOK, 2017).

Project management plan has two components which are outlines in the PMBOK (2017) as are as given below:

i. Quality management plan: Organisational quality policy, methodologies and standards influence the project and products scope management (PMBOK, 2017)
ii. Project life cycle description: It determines the series of phases which a project goes through from the beginning to the end of the project.

Pevehouse (2015) described how to develop a turnaround work scope and defined the scope development process as the process of outlining the turnaround deliverables and tabling all the jobs that needs to be done to complete the turnaround deliverables. Pevehouse (2015) further states that all the mentioned scope activities shall have at least one connection that is direct to the business objectives of the turnaround (Pevehouse, 2015).

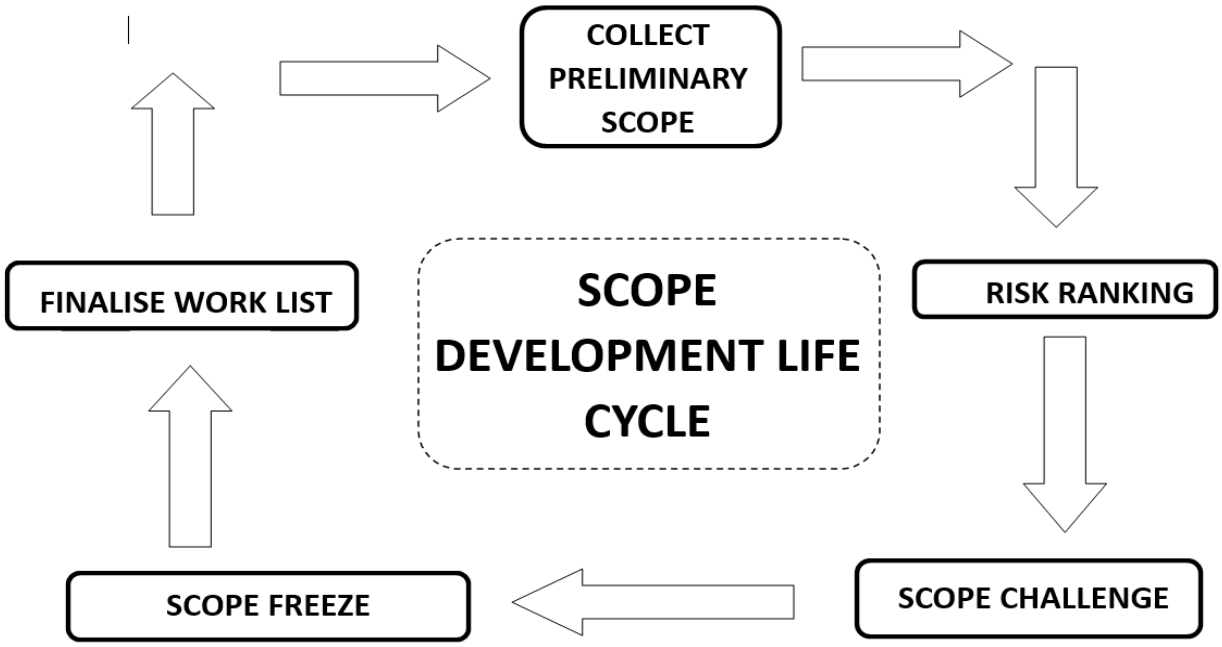

Figure 2.3: Scope Development Life Cycle

Source: (Pevehouse, 2015)

Parker, Collier, Rudisel, Rutan, & Pyle (1996) states that the planning stage is the foundation of the entire turnaround as the teams defines the work scope requirements and develops strategies for tasks accomplishment and assigns roles and responsibilities to team members (Parker, et al., 1996). The better the planning process, delays and mistakes will be reduced during execution phase, which leads to improved job flows, as these results into less downtime and lower costs (Parker, et al., 1996). Pevehouse (2015) uses the definition of project life cycle description and relates it to work scope and defined it as scope development life cycle, which is represented in Fig. 2.3:

Using the Pevehouse (2015) strategy of developing a turnaround scope life cycle and detailing each aspect of the life cycle, it is defined as shown below:

2.2.1.1. Collect preliminary turnaround worklist

A list from different parts of the organisation may be consolidated for the initial stage of the scope development life cycle (Pevehouse, 2015). Consolidating the preliminary work list collected from different departments into the turnaround worklist and the scope should be manageable and contain appropriate information (Pevehouse, 2015). Sasol (2020) states that the scope shall be distributed amongst various disciplines, considering the existing work on the software known as the Systems, Applications, and Products in Data Processing known as SAP including task listed under statutory and contingency work. The scope template shall be distributed to ensure consistency and uniformity between all departments compiling the turnaround work scope.

The turnaround work scope is generated from statutory or risk-based inspection (RBI) requirements which include requests from different disciplines that they send after identifying defects that cannot be done during normal running of the plant (Benaya, 2007). The turnaround team shall be responsible for collecting the data required to prepare for the turnaround work scope, and preparation meetings associated with turnaround objectives must be organised and chaired by the responsible manager (Kelly, 2006). Most of the turnaround worklist consists of the inspection work and the team must be put in place to forecast work which is critical for the turnaround (Sahoo, 2013). Sahoo stated that expects may be hired if required, to support the turnaround team to conduct maintenance, where the health status data of the equipment and detailed analysis of the collected shall back up the inspection work to be done during turnaround (Sahoo, 2013).

2.2.1.2. Risk ranking the turnaround worklist

According to Pevehouse (2015), risk matrixes are used to develop a turnaround work scope using probability and consequences of doing or not doing the job. This risk matrix involves the 5 x 5 matrix scale with probability presented by the horizontal axis and the consequences are presented on the vertical axis (Pevehouse, 2015). Sasol (2020) states that all disciplines shall be given an equal opportunity to identify their scope for considerations, consider previous turnaround work, and only work that cannot be done outside turnaround to be considered, and that can be done outside turnaround to be taken out of the turnaround worklist (Sasol, 2020).

Risk analysis is conducted of all the activities and obtaining the likelihood, the exposure, and the consequences of all the failures, where the probability of failures occurring is associated with likelihood, where exposure is time factor for impact, and where the impact of failure in terms of amount and HSEQ is consequences (Pokharel & Jiao, 2008). They also stated that if the risk factor obtained from the risk analysis has a low HSEQ impact, then the components will be removed from the list and if they have a higher risk included.

PETRONAS HSE Risk Matrix (adapted for Engen Refinery)

		SEVERITY	1 Insignificant	2 Minor	3 Moderate	4 Major	5 Catastrophic
CONSEQUENCES		PEOPLE	Slight Injury	Minor Injury	Major Injury or Health Effects	Single Fatality or total disability	Multiple Fatalities or permanent total disability
		ENVIRONMENT	Slight Impact	Minor Impact	Major Impact	Major Impact	Massive Impact
		ASSET	Slight Damage	Minor Damage	Major Damage	Major Damage	Extensive Damage
		REPUTATION	Slight Impact	Limited Impact	Considerable Impact	Major National Impact	Major International Impact
LIKELIHOOD	E Almost certain	Incident has occurred several times per year in Engen Refinery	E1	E2	E3	E4	E5
	D Likely	Incident has occurred in Engen Refinery; or more than once per year in PETRONAS/Engen	D1	D2	D3	D4	D5
	C Possible	Incident has occurred in PETRONAS/Engen; or more than once per year in industry worldwide	C1	C2	C3	C4	C5
	B Unlikely	Incident has occurred in industry, worldwide	B1	B2	B3	B4	B5
	A Remotely Likely to happen	Never heard of in industry worldwide but could occur	A1	A2	A3	A4	A5

Figure 2.4: Risk Based Work Selection

Source: (SP96, 2016)

Figure 2.4 represents a risk-based work selection which provides basis for an organization to make decisions on whether a particular scope item should be included in the turnaround's work scope and this process will assist in eliminating an unnecessary work scope from the turnaround. This could assist in reducing the overall budget and duration of the turnaround (Pevehouse, 2015). Asquini (2017) suggested that the turnaround team shall start by minimising the risks with the highest impact and they will be added to or subtracted from the list based on the identification of new risks, mitigation of existing risks and the changing conditions (Asquini, 2017).

2.2.1.3. Challenging the turnaround work scope

The scope challenge session is the process of assessing each preliminary work list items to determine whether they meet the requirement to be in a turnaround, where each item must meet at least one turnaround objective (Pevehouse, 2015). Bevilacqua et al. (2012) stated that the session to challenge the scope is a tool for managing the turnaround and enhance the activities that needs to be completed (Bevilacqua, et al., 2012). Sasol (2020) states that the turnaround project leader shall challenge recommended scope of work to ensure the tasks in the worklist are part of the finalised work which needs to be done on the turnaround (Sasol, 2020).

Lenahan (2006) presented a turnaround worklist challenge routine presented in Fig. 2.5, which could be used to challenge any scope of work during the turnaround. This would also assist the organisations to only do the necessary work during the turnaround. During the scope challenge session, the preliminary scope identification would have been completed and this session assists in the improvement of scope, defining the operative system and needs, developing initial plans and cost estimates, defining material needs and items with long waiting list, compiling strategies and analysing the risk (Bevilacqua, et al., 2012).

Work order number……Plant Location:……. Job description……		
PURPOSE		
The purpose of this document is to ensure unnecessary work is eliminated from the work list. Answer the following questions as indicated – for Yes / No questions tick the appropriate response.		
1. What type of benefit will be gained from doing this job?	Hazard reduction Reliability Life extension Improvement Compliance	
2. What is the estimated man-hour cost of this task?		
3. What is the estimated cost of this task?		
4. Is the job a duplicate of some other job on the work list?	**YES**	**NO**
5. Could this job be eliminated from the work list without compromising safety or production?	**YES**	**NO**
6. Can this job be done at some other time?	**YES**	**NO**
7. Is there any other job or project work that could be eliminate the need for this job?	**YES**	**NO**
8. Can this job be simplified?	**YES**	**NO**
9. Can this job be combined with any other job to save time or expense?	**YES**	**NO**
10. Can a new technique or technology be used to save time or expense on this job?	**YES**	**NO**
11. Can the need for this job be designed out of the system?	**YES**	**NO**
12. Is there any other information available that would influence the need or ability to do this job?	**YES**	**NO**
Comments (if the answer to any of the questions 4 to 12 is Yes)		
This job is to be included or eliminated from the work list (delete as appropriate). Authorized by: Name……Signature……Date……		

Figure 2.5: Turnaround worklist challenge routine

Source: (Lenahan, 2006)

Benaya (2007) and Sahoo (2013) both stated that the process of identifying turnaround work scope should be scrutinised to ensure that the short-listed scope is relevant and aligns with the turnaround ideology should be included as it costs more money to do work during the turnaround than in normal operation as the rates are higher (Benaya, 2007).

2.2.1.4. Turnaround scope freeze

Scope freeze is the process of locking the scope to allow for sufficient time to plan, schedule and budget for the project, which is normally done early during the turnaround and the process initiates change management process (Pevehouse, 2015). Sahoo (2013) stated that the scope freeze begins after the cut-off date where activities that are submitted after these dates shall be

sent to the steering committee which will look into the justifications, urgency and the impact an activity has on the turnaround schedule and be able to approve if it meet the set minimum requirements (Sahoo, 2013). Sasol (2020) indicated that scope freeze shall be initiated to ensure approved final scope of work is required before the detailed planning and implementation can start. Sahoo further suggested that any additions shall be managed by the additional work approval process to ensure minimal disturbance on the turnaround and all risks are managed.

The worklist must be finalised within 3 to 6 months before the turnaround and only minor changes on the scope shall be permitted until the scope dates are frozen (Hey, 1999). Any scope addition after the scope freeze dates shall be closely control and limited only to obvious oversights from the list, any new addition shall undergo rigorous review and obtain higher approval (Hey, 1999). The scope freeze dates are the dates at which the submission of new scope for the turnaround are due, and a model baseline is set, this could be done weeks before the turnaround, where the baseline is measured against progress (Hey, 2019). Kelly (2006) stated that the frozen worklist will be the basis of the turnaround and will be used to generate the key measurements such as duration, cost and resources (Kelly, 2006). Should the dates work list be not frozen, it will not be possible to accurately calculate the turnaround indicators, therefore as Sahoo (2013) and Hey (1999) suggested, any work requested after the scope freeze dates shall be handled by the late work committee after the turnaround team has been set up (Kelly, 2006).

2.2.1.5. Finalise turnaround worklist

The owners of the work scope are responsible for endorsing the final turnaround work list and must take ownership, this is done to segregate the work responsibilities as it has been noted that planners in some projects are made to justify and own the worklist (Bloch & Geitner, 2006). The minimum work required to achieve business objectives shall be included on the finalised turnaround worklist (Bloch & Geitner, 2006).

The review team shall be established for cross functional work scope, to be a focal point for assigning responsibilities and in approving the turnaround work requests that needs to be included in the final work scope (Benaya, 2007). The review team shall represent all the departments and should use the objective approach in approving the final turnaround worklist (Benaya, 2007). Each job shall be analysed in detail after the team identified and approved the

turnaround worklist, should one not be familiar with the job details then the maintenance personnel responsible for the job shall be asked to assist (Sahoo, 2013).

Kelly (2006) agreed with Sahoo (2013) and both mention that the work list produced by the departments will be the raw data containing elements of unnecessary and duplication work, incorrectly specified and errors in specification etc. Some of these jobs must be eliminated from the work list and others corrected (Kelly, 2006). The turnaround preparation team shall ensure the scope of work is validated and all necessary requirements are defined by analysing every major, minor, and bulk work request on the worklist to ensure it meets all the necessary requirements (Kelly, 2006).

2.2.2. Collect Requirements

PMBOK (2017) defines the collect requirements as the process of documenting, managing the needs of stakeholders, determining the requirements to meet the project objectives and it provides the basis for evaluating the product and project scope (PMBOK, 2017). Schwalbe (2011) stated that collect requirements is where the features and function of the product produced during the project are defined and documented, this includes the processes used to create them. Schwalbe (2011) further states that the project team creates requirements for stakeholders, for management plan and for traceability matrix as outputs or the requirements collection process (Schwalbe, 2011). In order to improve the turnaround planning and scheduling, collecting and using reliable information shall be used to plan for the turnaround and that information could be obtained from SAP where one could obtain historic data from previous turnaround, maintenance records and from inspections (Sahoo, 2013). The information that can be obtained from SAP includes master equipment list, work scope and prioritisation, tools and equipment, materials, time, labour, safety, quality, and cost (Sahoo, 2013).

2.2.3. Defining Scope Management

Defining scope management as a process of developing a detailed description of the project activities and product, it defines the product, service or results boundaries and acceptance criteria (PMBOK, 2017). Schwalbe (2011) stated that defining scope involves reviewing the project charter, requirements and documents, organisational process assets to create a scope

statement, add more information as requirements are developed and change requests are approved (Schwalbe, 2011).

Parker et al. (1996) states that the turnaround processes are mostly affected by the planning stage, as it's where the turnaround teams define the work scope requirements and develop strategies on how to complete the work list. They further stated that the probability of delays and mistakes are reduced if the planning phase is done properly. Planning improves job flow and translates to reduced downtime and lower costs, and it requires coordination of turnaround with business needs (Parker, et al., 1996). Sasol (2020) gave the objectives of define phase as the clarification and alignment of inputs from long term maintenance plan (eight-year plan) to prepare for the upcoming turnarounds. Sasol (2020) further states that the defining phase intent is to develop and approve the turnaround milestone plan (Sasol, 2020). It also serves to identify the project leaders as well as ensure team members are committed to the plan of executing the turnaround (Sasol, 2020). Parker et al. (1996) agrees with Sasol (2020) and acknowledge that planning requires coordination of the turnaround with business needs and other activities to ensure that required personnel and resources will be available, and these stages includes the following steps (Parker, et al., 1996):

- Establish the turnaround work team if it does not exist.
- Meetings to review past turnaround, unit performance and training requirements.
- Defining the scope of work and work list
- Developing strategies for turnaround implementation

2.2.2.1.Turnaround team

Turnaround team establishment is based on defining a planning framework of the turnaround which should be done way before the turnaround. The team may consist of the core members which may be the permanent staff, service representatives which may be contracted during planning phase and execution, depending on what needs to be done, and these representatives may include the original equipment manufacturers (OEM), site contractors and safety coordinators (Parker, et al., 1996).

2.2.2.2.Planning meetings

Planning meetings are the meetings which are held for numerous reasons which may include reviewing the past turnarounds, evaluating the machinery performance, determining the turnaround scope of work and check the training requirements for the team.

The planning meetings shall address the requirements of new laws, environmental restrictions, and risks of the defined scope of work (Parker, et al., 1996).

2.2.2.3.Past turnaround and unit performance

Past turnaround and unit performance entails the reviewing of past turnaround and observe how the job was done before, this is done to give good indication of how the new turnaround could be, and it will assist in knowing which OEM would be required during turnaround execution.

2.2.2.4.Training requirement

Training requirements vary with size of the turnaround and the type of skills required during turnaround, which could give guide on what training is required for the team (Parker, et al., 1996).

2.2.2.5.Work scope

A well-written work scope provides basis from which all the turnaround team members can work with, and every member will understand and agree to the given objectives.

2.2.2.6.Worklist

This outlines the specific tasks required to be done during turnaround, and what type of jobs required.

2.2.4. Creating a work breakdown structure (WBS)

PMBOK (2017) describes creating work breakdown structure (WBS) as the process of subdividing the project deliverables to manageable components. This structure provides a framework of what must be delivered in a project (PMBOK, 2017). Sahoo (2013) and Lenahan (2006) both agree with PMBOK (2017) in relation to defining the WBS as a tool for breaking turnaround work scope into smaller components which are more manageable, where all the items are planned against the agreed timelines. Schwalbe (2011) defines the WBS as the deliverable combined work involved in a project that relates to the total scope of the project (Schwalbe, 2011). The WBS is used to develop a project or turnaround schedule and cost breakdown. Therefore, the project team first develops a WBS, which is defined by Watt (2014) as the description of arranged in a layer of details. Watt (2014) acknowledges that work scope

is the first document that needs to be constructed to develop a WBS, as the WBS incorporates all project deliverables and reflect any information that clarifies the project deliverables.

2.2.4.1. Objectives of a work breakdown structure

The work breakdown structure objective is to reduce the work elements into manageable, clearly defined activities that can easily be budgeted, scheduled, and controlled (Hallgren & Maaninen-Olsson, 2009). According to (Sahoo, 2013), the project manager has a responsibility to structure the worklist into manageable small elements that are manageable and be assigned to relevant teams. Most projects start off with project definitions, then a work breakdown technique is used to break the entire turnaround into smaller and more manageable tasks, which are then scheduled on a timeline and then broken down into individual tasks (Lenahan, 2006). Hallgren and Maaninen-Olsson (2009) stated that breaking down the project tasks into work parkages could assist in assigning management and task responsibilities while helps in developing the time and cost estimates.

2.2.4.2. Approaches to creating a work breakdown structure

Sahoo (2019) provides two different approaches used during the planning session to create a work breakdown structure: which includes the top-down, as well as the team approaches, while (Schwalbe, 2011) highlights several approaches to develop a WBS which includes the use of guidelines, the analogy approach, top-down approach, bottom-up approach and using mind-mapping approach.

i. **Using Guidelines –** it is an approach that encourages project managers or leaders to use available guidelines when developing a WBS, as they will give the organisational requirements when creating a scope of work.
ii. **The analogy approach –** This approach uses similar project WBS's as a starting point in developing a new project and providing cost estimates.
iii. **Top-down approach –** it is stated by (Sahoo, 2013) as an approach which begins with a goal and successively partitions work down to lower levels of definition until the participants are satisfied that the work has been successfully defined. Schwalbe (2011) explained that this approach starts with largest items of the project and break them down into their subordinates' items, it involves refining work into grater level of details (Schwalbe, 2011).

iv. **Bottom-up approach –** It assists team members to identify as many specific tasks that relates to projects as possible, and then combines the specific tasks and organise them into summary activities or higher levels in the WBS (Schwalbe, 2011).

v. **The mind-mapping approach -** It is a manner of approach which uses branches radiating out from a core idea to structure thoughts and ideas, it allows people to write or even draw pictures of ideas in a nonlinear format.

vi. **Team Approach –** is defined by (Sahoo, 2013) as the one that is used at the planning stage where planning teams are used to create a WBS. The following steps are used to create a WBS using team approach:

- The planning team agrees on the approach to build the first level of the WBS.
- The planning team creates the Level 1 activities.
- A subject matter expert leads the team in further decomposition of the WBS for his or her area of expertise.
- The team suggests decomposition ideas for the expert until each activity within the Level 1 activities meets the WBS completion criteria.

2.2.5. Validating turnaround scope of work

Scope validation is the formalising process of accepting the project deliverables; where benefits to the project are because of increasing the probability of final product, service or being accepted by validating each deliverable (PMBOK, 2017). When validating the turnaround scope of work, the duplications are removed, non-essential work is removed, and ensuring the remaining scope has clear objectives as this may results in lower project prices because there will be few unknowns (Sahoo, 2013). Sahoo (2013) proceeded and mention that once the scope of work is concluded, the worklist will be frozen on the agreed date where any other unauthorized work shall go through the highest executive authority if available where the new scope shall be justified.

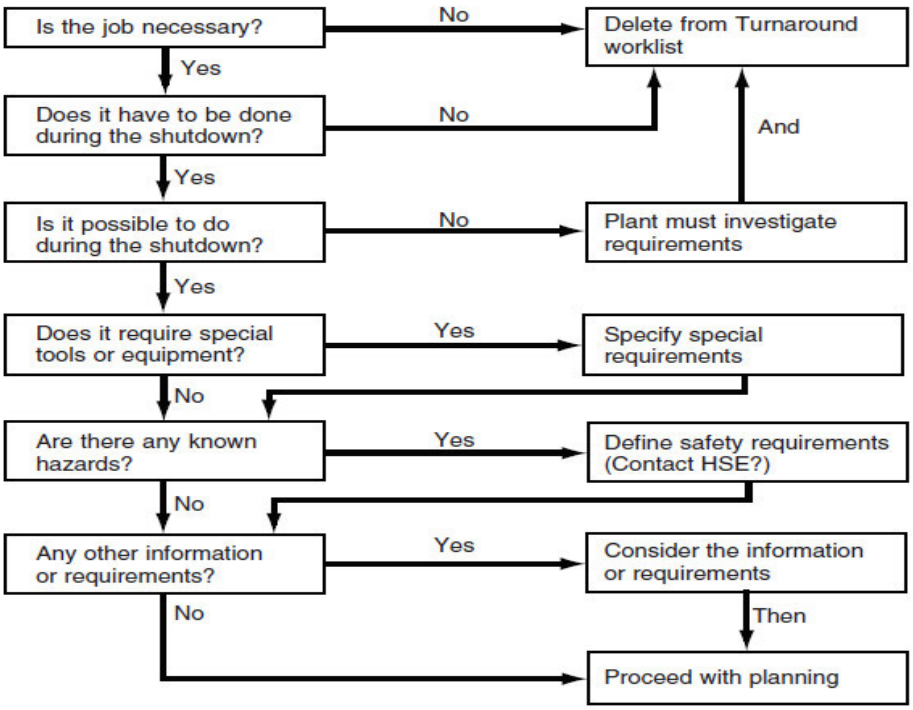

Figure 2.6: Turnaround scope of work validation process

Source: (Lenahan, 2006)

Figure 2.6 represents an example of a turnaround work scope validation process which is required to ensure that approved scope contains only the necessary scope needed to restore, maintain or increase the performance of the plant and to ensure the task prepared for turnaround cannot be done when the plant is online (Lenahan, 2006).

2.2.6. Turnaround control scope

PMBOK (2017) described the scope control as a process of monitoring the status of the project, product scope and managing change in the scope baseline, where the scope baseline does not change during the process. The main objective of scope control is to influence the factors that contribute to scope changes, assure changes are processed according to procedures developed as part of the integrated change control, and manage change when it occurs (Schwalbe, 2011). Watt (2014) stated that whenever there are problems in a project scope or execution, one cannot just change, as that change can be costly, therefore there should be a controlled way of making a change which assesses the impact of the change to the triple constraints (cost, schedule, and scope). Watt (2014) defined the change control as a set of procedures that let one make changes in an organised manner. Whenever one needs to make a change in their scope, they first need to fill in a change request which will be documented (Watt, 2014).

2.3. Challenges of creating turnaround work scope

When creating an effective work scope strategy, the turnaround team faces many challenges which includes issues related to discovery work during inspection (AMACS, 2017). The key to having an effective work scope strategy is having scenarios of unplanned work and able to have plan for them, and the following are common issues that impact the shortfall of the work scope strategy(AMACS, 2017):

- Exclusion of necessary aspects in the scope of work.
- Unplanned addition of new work scope
- Continuous task addition on the scope of work after scope freeze dates
- Lack of taking effective decision making on time regarding included tasks in the scope of work
- Limited number of materials and equipment during the turnaround
- Lack of effective strategy resulting to non-conformance to the turnaround objectives

One of the main challenges the turnaround management team encounters is poor work scope management (Hey, 2019). Departments are responsible for giving leadership and development of turnaround work scope; therefore, they should establish contacts within each other (Hey, 2019). Scope of work inefficiencies as signs of poorly planned scope which risks the turnaround results, and these inefficiencies ranges from conflicting documentation to scheduling plans which could be between company's employees and service providers (AMACS, 2017).

Muller (2015) defined risk management as an attempt to identify, evaluate, measure, mitigate and monitor risks and their consequences. During turnaround, there are many people who need to be managed, of which some or most of them are not familiar with the site. Therefore, managers need to take extra precautions to address the risk related to the safety of the service providers, due to the volume of work that needs to be completed within schedule (Muller, 2015). According to Muller (2015), a major part of the turnaround scope is mandatory, it cannot be done anytime, therefore, one of the risks facing the turnaround team is scope that never reaches its freezing point (Muller, 2015). Cultural issues where management is not enforcing the scope freeze practice which allows the late addition of major jobs (Muller, 2015). In all aspects, failing to restrict the number of tasks that need to be in the turnaround is risk which should be avoided.

2.4. Components of an effective turnaround work scope

AMACS (2017) states that prioritisation of the scope of work during the planning phase assists in achieving best outcomes for the turnaround (AMACS, 2017). Allocation of roles and responsibilities must be developed in the initial stages and each department commits to the completions of their turnaround tasks indicated in the turnaround list (AMACS, 2017). AMACS (2017) gave few examples of how companies can create an effective work scope and they are given below:

- Departments must put forward their ideas on how to complete a turnaround in the most effective way.
- Work scope should include contingencies to allow for change in scope and any unlikely setbacks.
- Clear roles designated to service provides.
- Commitment from each department to work according to given schedule.
- The turnaround objectives shall align with the scope of work management.

Experienced service providers must be contracted during the planning phase of the turnaround, to ensure the turnaround team gets enough support (AMACS, 2017). Once an equipment has been identified, which needs to be added to the work scope, a defined criteria must be used to evaluate the scope (Asquini, 2017). O'Brien and Amarra (2016) stated the ways in which the availability and economics of a refinery can be enhanced through the introduction of a robust strategy:

- Reduce turnaround work scope:
    - Disciplined control for work scope and scope growth
    - Rescheduling work that does not consist of the turnaround objectives, either to other shutdown or when the plant is online.
    - Assessing the possibility of moving other units out of the turnaround
- Reduce turnaround duration, below can be used to achieve this:
    - Proper planning and scheduling including critical path analysis.
    - Adopting an appropriate work pattern for critical work
    - Integrate capital projects into the overall turnaround plan or schedule.

According to O'Brien and Amarra (2016), turnaround work scope optimisation increases asset availability through reduced downtime, it reduces maintenance activities through risk-based work selection.

2.5. Factors affecting turnaround work scope management

Ertl (2015) mentioned that it is common for turnaround scope to continuously change up until the project is executed and gave the contributing factors such as:

- Market conditions that vary all the times can cause a change for a company to consider their budget which may cause the budget adjustment.
- Given window of operations where management may decide to squeeze or increasing the turnaround period to execute the projects.
- The start dates may change from the original schedule which may affect the decisions on what scope can be included, the ability to plan for the jobs or material availability.
- Operations, maintenance, inspections, safety, and other departments gives the inputs to the turnaround planning and depending on the plant needs the plant operations may give the turnaround scope within last minutes of the turnaround.

This section describes a few aspects that affects the turnaround work scope management which includes change in scope.

2.5.1. Turnaround scope change management

Hussain (2012) defined change in scope as an official decision made by the project manager and the client to change some features within the project to expand or reduce its functionality (Hussain, 2012).

Poor turnaround scope identifications and validation on the preparation phases have a potential to create additional and emerging work scope which creeps up during the execution of the turnaround which can cause a lot of constrains on the available resources which may result into the schedule slippage and the escalation of the cost (Bevilacqua, et al., 2012).

Obiajunwa (2010) stated that a major part of the scope of work is discovered during the beginning of the turnaround, this is as of the result that work scope changes as the equipment is dismantled. The changes in scope might not be prevented in projects and could be as the results of inspections when the equipment's are opened and cleaned. However, the change in

scope should be closely managed and controlled, as it could evolve to major cost and delay of the project (Mhlanga, et al., 2016). Hussain (2012) agreed with Mhlanga, et al. (2016), noting that changes in scope impacts on the cost and other features of the project or the timeline.

2.5.2. Scope growth during turnaround

Turnaround scope growth is an addition of new scope or the extension of the authorised work scope which deviates from the approved turnaround worklist (Sahoo, 2013). An example of this category is 'replacing six trays in a vessel' then the actual work becomes 'replacing nine trays', as this scope was included in a turnaround worklist, while the other form is adding a totally new scope within a turnaround worklist which increases the planned turnaround worklist (Sahoo, 2013). According to Sasol (2020), additional work is work added or cancelled after the scope freeze dates (Sasol, 2020). Sasol (2020) states that additional work has a potential of introducing a new risk on the objectives of the turnaround, which includes safety and quality impacts, schedule delays, cost implications, integrity risks, etc (Sasol, 2020). Figure 2.7 represents an example of the late work authorisation form.

Sasol (2020) gave meaning to numerous terms which will be used in this report describing scope growth and are discussed below:

i. Late work: work which was known prior to scope freeze, such as the activities that the originator could have "foreseen" and failed to submit before the scope freeze meetings (Sasol, 2020).
ii. Extra work: an activity that was discovered after the scope freeze such as a legitimate work planned and malfunctioned after the scope freeze (Sasol, 2020)
iii. Cancellation: an activity which was planned, resources committed and not executed during turnaround.
iv. Discovery work: an activity which comes during execution of the turnaround, where an equipment is opened for different purposes and discovered that there is another activity which must be included (Sasol, 2020).

The people requesting this late addition to the work list must submit it personally to the plant manager	
Order number.	Plant area
1. What is the nature of the work being requested?	
2. What is the estimated cost of the work?	
Manpower:	Cost of materials and service:
3. Why was this job not on the original work list?	
4. What would be the consequences of not doing this job?	
I approve/reject this late work request (delete as appropriate) Plant manager's signature…… Date……	

Figure 2.7: Late work authorisation form

Source: (Lenahan, 2006)

Benaya (2007) states that in the case where project managers poorly identify and validate the scope of work in the planning phase, the probability of having additional jobs and emergent work coming up during execution will be high, which will stress the available resources, cause the increase in cost and threaten the existing schedule (Benaya, 2007). Sasol (2020) indicates that late and extra work overloads the employees which inherently incur a cost premium and safety implications and should therefore be fast-tracked when they are introduced (Sasol, 2020).

Obiajunwa (2010) stated that establishing a procedure to control additional work could add more value in the management of emergent work and it should be to require an approval before the change is done, that must be on a procedure which will reduce the time frame to approve the emergent work (Obiajunwa, 2010). Kelly (2006) stated that equipment inspection during turnaround normally reveals issues that were never accounted for, e.g., faults, which results in extra work not planned for (Kelly, 2006). Kelly (2006) further suggests that such issues shall have designated personnel that assess their urgency, assess the implication and risks, estimate the cost, and submit for approval to the turnaround manager (Kelly, 2006). The approved work

shall be registered as extra work and be added into the works register (Kelly, 2006). Kelly (2006) agrees with Sasol (2020) in defining extra work as an activity which was not considered or overlooked by the planning team before scope freeze and introduced after scope freeze dates, which will be recorded in a separate worklist (Kelly, 2006). Should these kinds of work be deemed important, they should be investigated on why they were not included in the first place, on the turnaround worklist. Sahoo (2013) differs, arguing that additional work emerges unexpectedly and is never accurate, even if it is planned. Sahoo thus suggested that maintenance should use their experience and include all the suspicious equipment's on the worklist (Sahoo, 2013).

2.5.3. Removing scope from turnaround worklist

Obiajunwa (2010) referenced a RAPID project which helped in explaining the removal of scope during turnaround. The acronym of RAPID is defined by Obiajunwa (2010) as Remove Activities, Prolong Intervals and Decrease the duration, which is done through the improvement campaign that focuses on production increase and maintenance reduction (Obiajunwa, 2010). Sahoo (2013) stated that procedures must be developed to manage the addition and removal of work scope, and the brainstorming technique could be used to review the work scope and removing unnecessary scope of work from the turnaround worklist (Sahoo, 2013). The RAPID acronym is explained below:

i. Remove Activities

Reducing the scope of the turnaround can be achieved by removing some activities from the turnaround worklist and that may give rise to a possibility of a shorter turnaround. Some of the activities done as follows:

a. **Work scope challenge:** an approach of challenging the scope of work using a systematic way.
b. **Utilization of unplanned production breakdowns:** when there are plant breakdowns, one could use that opportunity to do maintenance work that could be planned for the shutdown.
c. **Improved inspection methods:** use of online monitoring systems that could detect abnormal conditions of equipment without having to open it (Oberlender, 2000).

d. **Methods of "Hot work" implementation improved:** surveying 'hot work' technology (Oberlender, 2000).

ii. Prolonged Intervals

Obiajunwa (2010) states that prolonged intervals on temporary repair shall be implemented for minor faults on an equipment to properly plan them for the next turnaround.

iii. Decrease the duration

Critical jobs or critical path normally determine the duration of the turnaround; therefore, the turnaround duration maybe decreased using the following:

- Methodology to challenge critical jobs – restructuring the tasks and improve maintainability could be done to reduce the turnaround duration.
- Mapping of cleaning in Place – maintaining most of the equipment online, such as cleaning pressure vessels without bringing them down could assist in reducing the turnaround duration.

Sasol (2020) defines RAPID differently to Obiajunwa (2010), noting that it stands for Recommend, Agree, Perform, Input and Decide, which is an organisational design tool assisting in differentiating peoples' roles in decision making (Sasol, 2020). The main focus of the RAPID framework presented by Sasol (2020) is to put more emphasis on critical decision, which in-turn assists in reducing turnaround cost, reducing labour costs through time saving, focused management behaviour and eliminating all the activities that are duplicated (Sasol, 2020).

2.5.4. Scope creep during turnaround

PMBOK (2017) defined scope creep as a process of expanding the project scope without any control or relevant authorisations which may result in change in time, cost and in resources. Goff, Wilday and Holroyd (2015) define creeping change as the accumulation of small changes which often goes unnoticed which have the potential to make up a significant change in a project (Goff, et al., 2015). These changes often go unnoticed, not planned and difficulty to monitor, they cover ranges of changes such as equipment integrity, production conditions, human intervention and organisational culture (Goff, et al., 2015).

Althiyabi and Qureshi (2021) stated that scope creep is known as a leading contributor of delays within a project and causes cost overrun and may lead to overall project failure. Althiyabi and Qureshi (2021), Komal et al. (2020) defined scope creep as the change or growth within a project scope or pressure to deliver more than what was approved, which might be small changes, formal or informal changes to be implemented without proper approval may affect the project baseline. Hussain (2012) gave two definitions of scope creep and defined them as follows:

- An event where the original scope slowly grows beyond the boundaries its original defined scope of work without authorised approval (Hussain, 2012).
- The manner at which a project may extend beyond its initial boundaries (Hussain, 2012)

The main causes of scope creep are defined by (Hussain, 2012) as given below:

- Key stakeholders' ignorance of the scope until the project has commence.
- Execution of projects without reviewing the study and scope definition after they were completed years prior to the execution date.
- Allowing people with limited knowledge or skills to conduct the scope definitions.
- Unrealistic targets regarding the outcomes of the project
- Use of insufficient information to conduct the scope of work.
- Mismanagement of the changes within the project and the lack of scope management and control systems
- Focus on major scope changes and ignore minor changes that could impact the turnaround objectives.

Komal et al. (2020) states that the scope creep management is known as the process of controlling or preventing scope creep from happening in any project. Hussain's (2012) survey results indicated that most participants suggested that ignorance from key stakeholders, the delays in the execution of the scope and the scope definitions created by people with limited knowledge and skills are the main three causes for scope creep (Hussain, 2012). Hussain (2012) suggested that to avoid scope creep during project execution, a number of things needs to change, this includes the following:

- Relevant stakeholders must be involved during project planning.
- Project scope must be defined by people with knowledge and experience on the subject matter.

- Gathering of relevant information before finalising the scope statement.
- Effective control system for scope change and proper communication.

2.5.5. Cultural dynamics during turnaround

Ghazali, Halib and Shamim (2014) highlighted the importance of work culture as work activities during turnaround are performed by individuals from different companies with different work ethics. Work culture becomes important to foster teamwork as it comprises of ideas, patterns, attitude, experiences, beliefs and values of individuals who are involved in the turnaround (Ghazali, et al., 2014).

Ghazali and Shamim (2014) states that focusing on technology and technical systems alone will not ensure that the turnaround is successful since there are other events such as work culture of the individuals who will be doing all the turnaround activities (Ghazali & Shamim, 2014). Work culture is one of the social dimensions that needs to be given special attention as this will management to understand peoples' values and their work ethics even though the turnaround is temporary (Ghazali & Shamim, 2014).

Management needs to understand the compatibility of the organisation work culture and with service providers to ensure there is a common understanding between the organisation and the service providers (Ghazali & Shamim, 2014). Ghazali et al. (2014) mentioned that the turnaround maintenance leaders need to understand the work force behaviours and their social relationships and for all the teams involved in the turnaround.

Alhassan, Ghazali and Isha (2018) stated managers requires to understand different work cultures as it impacts on work ethics and the way of managing different service providers since the activities are performed simultaneously. There is a difference between work culture and organisational culture, as the work culture represents the beliefs and attitudes of the workforce while the organisational culture is how the organisation stipulates how things shall be done and what the organisation believe (Alhassan, et al., 2018). Adiza et al. (2018) defined work culture as rules, regulations, policies, values, and beliefs of an organisation.

2.6. Schedule management

Sasol (2020) states the objectives of scheduling is to determine and optimise the critical path to align the turnaround schedule with production start-up schedule, to integrate production units, applying scheduling principles to create optimal levelling of resources, develop and

approve a fully integrated final bar chart, and identifying all possible risks which could have negative impact on the turnaround, this includes conducting a potential deviation analysis (Sasol, 2020).

The turnaround project team analyses the turnaround work scope, contracts, and relevant information which enables them to define the turnaround objectives. This information includes the projects that impact on the critical path to develop a turnaround schedule (Watt, 2014). Schedule milestones establish key dates throughout the life of a project that must be satisfied to complete a turnaround on time (Watt, 2014). Watts states that key dates are often used to meet contractual obligations or establish intervals that will reflect the progress of the turnaround (Watt, 2014). Turnaround project durations are dynamic in nature and are a measure of how long it took to complete a turnaround and very difficult to estimate since scope changes during the turnaround are more likely to happen (Obiajunwa, 2010). Strategies are set up to approximate and quantify the scope, where there are unknowns that may occur, especially if the new scope may impact on the critical path, the duration may depend on how this new scope may affect the turnaround, which may result in the scope to be moved forward, causing time over-runs, implying turnaround project failure and turnaround duration is a measure of its success (Obiajunwa, 2010).

There is a need to control the schedule during turnaround, as a changing schedule is counterproductive when it comes to creating a resource levelling which includes manpower requirements (Ertl, 2015). Watt (2014) stated that project manager's experiences schedule conflicts during the implementation phase as it uses most time and resources. Project managers normally put more resources on the critical path activities to complete these activities quickly, this brings to an activity called schedule crashing. Schedule crashing is a process of adding more resources or move around some resources to bring the project schedule within line (Watt, 2014). This process costs more money, and it should be noted that there are times where it does not work, for instance, adding more manpower in a project where more people would stand and do nothing, that is one example of adding more resources in a project.

The literature above suggest that project crashing will assist in catching up with the critical path schedule, however the literate was not able to provide the quality issues related to using the same resources of extended hours which may affect the quality of workmanship. During turnaround, all activities align with the turnaround critical path, therefore when crashing the

turnaround schedule means adding more hours which may lead to exhaustion for those specialised service providers, which may lead to quality issues which may be discovered during turnaround start-up, thus increasing the turnaround duration.

During scheduling of a turnaround, Sasol (2020) provides five key activities and two key decisions which need to be taken during turnaround and are listed below:

2.6.1. Five key scheduling activities

a. Develop a critical path and synchronisation of overhead schedule

Sasol (2020) indicates that the key activity includes developing and aligning a critical path to turnaround schedule, with a planning and optimisation budget, and overhead schedule to optimise the integration between production units (Sasol, 2020). The overhead schedule indicates unit specific dates and needs to be approved, the turnaround duration and production budget needs to align and emphasise the need to reduce the duration of a turnaround (Sasol, 2020).

b. Conduct integration and scheduling

Sasol (2020) states that the main schedule needs to be integrated with other detailed departmental project schedules to have a holistic view and ensuring effective coordination (Sasol, 2020). Developing detailed initial schedules by grouping all work and optimise the duration of the outage and utilisation of resources (Sasol, 2020).

c. Validate, refine and approve the final activities

Sasol (2020) states that the initial schedule shall be reviewed to identify opportunities of refinement and the final schedule shall be reviewed to ensure detailed activities are scheduled in a logical and effective manner and further approved for execution (Sasol, 2020).

d. Conduct a potential deviation analysis

Sasol (2020) states that the potential deviation analysis shall be done by identifying all possible deviations and develop a mitigation plan to ensure effective execution and completion of a turnaround (Sasol, 2020).

e. Manage logistics and mobilise activities

Sasol (2020) states that the purchase orders for service and materials shall be prioritised to ensure availability and on-time delivery to ensure all work is accounted for on time. Turnaround work packs shall be audited to ensure all purchase requisitions are placed before

the commencement of the turnaround and oversee the mobilisation plan and follow up to ensure on time site establishment (Sasol, 2020).

2.6.2. Two key scheduling decisions

a. Approval of the overhead schedule

Identification of a critical path enables the alignment of the turnaround schedule with planning and optimisation budget and overhead schedule, to optimise integration between the production units (Sasol, 2020). The duration of the turnaround shall be aligned with production budget and reduce the duration of the turnaround by optimising the plan to indicate unit specific dates to ensure detailed scheduling is done (Sasol, 2020).

b. Approval of the final schedule

Sasol (2020) states that the detailed activities shall be scheduled in a logical manner and approved for execution (Sasol, 2020).

2.7. Turnaround Cost Management

One of the turnaround success measures is cost, which is defined as an extent to which the turnaround is completed within budget (Obiajunwa, 2010). Lawrence (2012) states that in the refineries and other petrochemical facilities, turnaround are major events which have a potential to cost a significant amount of operational and capital expenditure in order to execute (Lawrence, 2012). During the turnaround, the company incur production losses during the time the facility is on shutdown and during start-up they could be significant disruption due to leaks and other production trips if the process was poorly executed and managed (Lawrence, 2012).

Obiajunwa (2010) further states that the nature of a scope is dynamic, where an increase in scope may increase the cost of the project. However, cost may increase the budget because of extra resources which may include hiring of equipment or costs of contract adjustments to withstand the emergent scope which was not part of the original scope (Obiajunwa, 2010). Obiajunwa (2010) further notes that most turnaround managers plan for unknown scope using estimations of about 10-15% contingency, which includes the allocation of anticipated scope which could assist in avoiding turnaround cost over-run which narrows down emergent activities (Obiajunwa, 2010). Turnaround cost estimates are usually evaluated using past turnaround estimates, incomplete planned scopes with a large contingency as a result. When the turnaround work scopes and cost estimates are concluded, they are challenged in the

steering meetings, depending on if the estimates are less or greater than the allocated budget the decisions could be made (Lenahan, 2006). Lenehan (2006) states that scope should be quantified to ensure the cost is withing budget, should the cost estimate measured is greater than the allocated budget, and below are ways to keep the cost of the turnaround within budget:

- Reduce the turnaround worklist or their complexity.
- Most some of the tasks to later dates of the turnaround or include them on another planned turnaround.
- Challenge the unit value of the resources.

Lenahan (2006) gave an alternative of the above, as to request the budget increase from the steering meeting where the turnaround manager motivates the importance of the worklist, should the above cannot be done, since in the same meeting the budget will be approved.

Lawrence (2012) emphasised that the cost estimation in the turnaround is currently not accurate due to allowances of “known unknowns” and contingency of “unknown unknowns”. The elements of “known unknown” and “unknown unknown” are described by Lawrence (2012) as uncertainties that shall be allocated when creating a cost estimate of a turnaround (Lawrence, 2012).

Lawrence (2012) states that the “known unknown” are emerging work and discovery work which are defined below as:

i. Emerging work are activities to repair items that failed or broken when turnaround cost estimate is completed and towards the start of the turnaround.
ii. Discovery work as repairs which are discovered during the turnaround once an equipment is opened for detailed inspection.

Lawrence (2012) states “unknown unknown” are quantities that were underestimated or complete overlooked when creating a cost estimate. To cater for “unknown unknowns” the estimator shall include a contingency on the cost to ensure they cater for items that may arise during turnaround (Lawrence, 2012).

2.8. Chapter Summary

This section discussed the literature related to the topic’s objectives and was aligned to the PMBOK ways of doing projects. This section highlighted the theory behind project

management and used contrasting views from various sources to understand the impact of scope change on schedule and cost during turnaround and what are the contributing factors.

The authors stated that the turnaround scope document contains the turnaround work breakdown structure with contains all the turnaround activities including the cost and durations of each activity. Proper scope challenge session assists the project team with quantifying the amount of scope within the turnaround. Risk assessment is one of the activities that are used to assess the risk of inclusion and exclusion on the turnaround. Poor scope planning contributes to project failure.

The literature described schedule as one of the measures of the project success. The authors stated that scheduling is to optimise the critical path of the project and ensure all activities aligns with the project critical path. Schedule is dependant of the number of activities in the turnaround scope of work. All the risks shall be discovered which may interfere with the critical path such as the unauthorised scope. The schedule milestones are established in the beginning of the turnaround.

The literature describes cost as one of the main measures of the turnaround success, where if above the estimated values indicates the project failure. The project scope was described as dynamic which may increase or decrease, which could make the project cost increase of decrease. The uncertainties elements of “known unknowns” and “unknown unknows” were discussed to be the major issues that contributes to the increase in scope of the turnaround thus increasing the overall cost of a project. The authors stated that “unknown unknown” are mitigates by the use of contingency while the “known unknowns” are mitigated using the estimation of relevant cost to the expected cost of what might happens. The authors verified the dependency of cost and scope of work.

The literature focused mostly on aspect of a project in general sense as there was limited information on impact of changing the turnaround scope of work in the oil and gas industry. The authors of turnaround strategies in oil and gas industry investigated other elements of a project on turnaround such as scope creep, schedules, work culture, safety and quality however not the scope changes in the oil and gas industries or similar. The literature which focused on the change in scope of work was on the change in software project scopes.

Chapter 3 presents the research methodology a researcher used to answer the research questions.

CHAPTER 3 - RESEARCH METHODOLOGY

3.1. Introduction

Saunders, Lewis and Thornhill (2012) defined research as a systematic way of collecting and interpreting the information with a clear purpose to investigate and obtain the information (Saunders, et al., 2012).

Obiajunwa (2010) stated that the research methodology controls and give direction to the gathering of data, formulates them into logical relationships (Obiajunwa, 2010). He further states that it allows means of refining raw data and creates an approach to provide meaning on the presented data and leads to a conclusion that allows the expansion of knowledge (Obiajunwa, 2010).

3.2. Research philosophy

Saunders et al. (2012) defined the research philosophy as a comprehensive term used to describe the development and nature of the knowledge in relation to the research (Saunders, et al., 2012). In a qualitative study researchers use their knowledge, paradigms and sets of beliefs to the research project (Creswell, 2013). Creswell (2013) outlines five philosophical assumptions which could lead a researcher to decide which qualitative method to use and they include ontology, epistemology, axiology, rhetorical and methodological assumptions (Creswell, 2013). This section describes the four assumptions that brings the researchers beliefs into the qualitative research which includes post-positivism, constructivism, advocacy, and pragmatism (Creswell, 2013).

3.2.1. Post-positivism

Post-positivism is defined by Creswell and Creswell (2018) as an assumption which reflects the deterministic philosophy relating to the research in which causes probably determine effects or outcomes (Creswell & Creswell, 2018). In this method the problems are studies post-positivists reflecting issues that needs to be identify and assess the cause that influence the outcomes including found experiments (Creswell & Creswell, 2018). Cresswell (2013) states that the system grounded on post-positivism will take a scientific approach in research (Creswell, 2013).

3.2.2. Constructivism

In constructivism, individuals seek to understand the world in which they live or work and create subjective meanings using their experiences and knowledge to direct the meaning towards certain objects (Creswell, 2013). The manner in which the participants view the presented situation drives the outcome of the purpose of the research (Creswell, 2013).

3.2.3. Advocacy

Alternative views are used by the researcher since the postpositivist impose structural laws and theories that do not fit a certain group or individuals (Creswell, 2013). The researcher shall contain an action agenda for reform that may change the lives of participants (Creswell, 2013).

3.2.4. Pragmatism

Pragmatism is defined by Creswell and Creswell (2018) as a worldview or philosophy arises out of actions, situations, and consequences instead of antecedent conditions, and there is a concern with applications and solutions to problems (Creswell & Creswell, 2018).

In this study, the constructivism design was selected as the study will be based on the researchers' study site which is Engen Refinery and participants views will be required to investigate the impact of scope changes on turnaround cost and schedule.

3.3. Research Design

Saunders et al. (2012) defined the research design as a general plan of how one will answer the research plans (Saunders, et al., 2012). The research design contains clear objectives formulated from the research questions, which gives accurate sources from where collection of data is done, analysed, and all ethical considerations and constrains one may encounter (Saunders, et al., 2012). A qualitative and exploratory method was selected to be suitable for this research since the researcher sought to uncover the insights on the impact of scope changes on turnaround schedule and cost in the oil refinery industry. On the other hand, research design is defined by Creswell and Creswell (2018) as inquires within a qualitative, quantitative, and mixed methods approach which provides specific direction for procedures in the research study (Creswell & Creswell, 2018).

Creswell (2013) states that in the qualitative study, the research process begins with the philosophical assumptions that the researchers make in deciding to undertake the study

(Creswell, 2013). The below subsections define the research philosophy and approach that are used in this study.

3.4. Research approach

Research approaches are defined by Creswell and Creswell (2018) as different types of inquiry within qualitative, quantitative, and mixed methods approaches that provide specific direction to procedures in a study. The quantitative approach is associated with deductive approach, where the focus is on using data to test theory, and it examines the relationship between variables which are measured numerically (Saunders, et al., 2012). Saunders et al. (2012) further stated that on quantitative research, data is collected in a standard manner and there is an importance in ensuring that questions are expressed in a same way and be understood in a same way by all the respondents.

In contrast, qualitative research is exploratory in nature, and researchers uses it to probe a topic when a theory and variable are unknown (Creswell & Creswell, 2018). Qualitative research is defined by Creswell (2013) as research where an observer is guided by situated activities (Creswell, 2013). Situated activities is formulated by interpretive, material practices which causes a visible world (Creswell, 2013). The philosophy related to qualitative research is interpretive and this is because researchers need to make sense of the subjective and socially constructed meanings expressed about the research study (Saunders, et al., 2012).

The researcher sought to uncover insights into the impact of changing scope, after the scope freeze dates and during the turnaround, on schedule and cost. The study also endeavoured to establish the contributing factors in changing the scope. For this reason, the qualitative approach was considered for this research.

3.5. Population

Saunders et al. (2012) defined a study population as a full set of cases from which a sample is taken (Saunders, et al., 2012). The target population for this study comprised the employees with engineering background from Engen Petroleum Ltd (Refinery, Durban) which belongs to the Maintenance and Turnaround Department. The employees from the Maintenance and Turnaround were deemed suitable for the study, as they physically manage and execute the turnaround activities. The study excludes participation from other departments not mentioned above, such as Procurement, Process, Operations, etc. The organogram excludes all the non-

permanent employees which includes those of contractual bases, apprenticeship and the engineers in training.

MAINTENANCE AND TURNAROUND DEPARTMENT						
LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5	LEVEL 6	LEVEL 7
Maintenance and Turnaround Manager	Electrical Manager	Staff Engineers X 2	Senior Engineers X 2	Engineer X 1	Supervisors X 7	Electricians X 7
	Instrumentation and Control Manager	Lead Engineer X 1	Lead Supervisor X 1		Technicians X 7	
					Supervisors X 7	Artisans X 27
	Mechanical Manager	Lead Engineers X 3		Area Engineers X 5	Technicians X 7	
					Mechanical Supervisors X 7	Mechanical Artisans X 22
					Rigging Supervisor X 1	Rigging Assistance X 5
	Rotating Equipment Manager	Lead Engineer X 1		Engineers X 2	CM Technicians X 6	
					Workshop Supervisor X 1	Fitters X 14
	Turnaround Manager			Engineers X 2		
	Reliability Manager		Senior Engineers X 1	Reliability Specialists X 3		
	Planning Manager			Lead Planner X 1	Senior Planners X 3	Planner X 3

Note: CM Technician is Condition Monitoring Technician

Figure 3.1: Maintenance and Turnaround Department Organogram for 2019

Source (Author)

Figure 3.1 presents the organogram for the year 2019 of the Maintenance and Turnaround Department. Higher in the hierarchy is level 1 which represents the position of the Maintenance and Turnaround Manager, and the reporting structure is followed by the discipline managers as presented by level 2 and the last part of the structure is represented by level 7 as indicated in Fig. 3.1.

The Maintenance and Turnaround Department has seven Sub-Departments which includes the Electrical, Mechanical, Rotating Equipment, Instrumentation and Control, Turnaround, Reliability and Planning departments. The entire turnaround structure was not presented on the organogram however it has over 30 employees which ranges from finance, planning, etc. Only the Turnaround Manager and the engineers were presented on the organogram. The approximate number of employees per discipline, excluding the reliability which has 5, is 30, which makes the approximate population for 215 employees for this study.

There are seven managers in the Maintenance and Turnaround Department which are composed by the one manager per Sub-Department indicated as Level 2 in Fig. 3.1. The staff engineer position is a technical path profession which is in the same level in terms of monitory

value as the managerial path position which focuses on the technical aspect of the plant while the manager is focusing on the management point of view. The staff engineers report directly to the discipline manager and their position is similar to the lead engineer position. There are 5 Lead engineers and 2 Staff Engineers, 3 Senior Engineers and a Lead Supervisor in the Maintenance and Turnaround Department. There are six areas at Engen Petroleum Ltd Refinery which includes Island View, North Complex, South Complex, COMBO, Blending and SAFOR, where each sub discipline, excluding the Planning, Warehouse and Reliability, has one Supervisor. There are approximately 23 Supervisors at the refinery.

3.6. Sampling strategy

According to Saunders, et al. (2012) there are two types of sampling techniques which are probability sampling (also called the representative) and non-probability sampling. Probability sampling or representative sampling is defined as a sample mostly associated with the survey research strategies, where one needs to make a conclusion using evidence and reasonings about a population to arrive at the objectives and answer a research question (Saunders, et al., 2012). Non-probability sampling, on the other hand, is defined as the sampling that employs a range of alternative techniques to select samples, and many include subjective judgement samples (Saunders, et al., 2012). Non-probability sampling which is also called a non-random sampling is defined by Saunders, et al. (2012) as a technique that is best used when there is a subjective judgement in selection of a sample. Sampling provides a valid alternative to a census when it would not be possible to survey the entire population, or when there is either time, budget or both are preventing one from surveying the entire population, therefore one needs to select a sample (Saunders, et al., 2012).

Amongst the list of methods described by Saunders, et al. (2012) is purposive sampling, where one uses their perception to select the cases that would best allow one to get response to research questions and be able to meet the main objectives. The researcher purposively selected the Maintenance and Turnaround Department at Engen Refinery. The researcher knew all the people intended to be invited for interview and the discipline managers, Lead and Staff engineers, Senior Engineers and a Lead Supervisor were consulted and invited to participate in the study.

3.6.1. Sample size

According to Saunders, et al. (2012) a sample size is dependent on the research questions and objectives, and it is recommended that one should continue with the collection of qualitative data, such as by conducting additional interviews, until data saturation is reached (Saunders, et al., 2012). As such the sampling frame for the study constitute of all the discipline Managers, Staff and Lead Engineers, Senior Engineers and a Lead Supervisor, and as such the researcher intended to interview all the seventeen employees from the Maintenance and Turnaround Department.

Figure 3.2 presents the targeted population for the study which consists of seventeen Engen Refinery employees, and the sample size consists of nine professionals in the Maintenance and Turnaround Department. The study focused on these individual due to their experience in the petrochemical industry and their technical ability to understand the concepts to handle turnaround. The interview invitation was sent to the sample indicated in Fig. 3.2 and the first person who accepted was regarded as participant P1 and the last to be interviewed was regarded as participant P9. There were thirteen people who accepted the interview invitation, however, since there were no new data obtained from participant P6, the researcher continued for three more participants and use the data saturation definition and ended up interviewing nine participants.

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4
MAINTENANCE AND TURNAROUND MANAGER	Electrical Manager	Staff Engineers X2	Senior Engineers X 2
	Instrumentation and Control Manager	Lead Engineer X 1	Lead Supervisor X 1
	Mechanical Manager	Lead Engineers X 3	
	Rotating Equipment Manager	Lead Engineer X 1	
	Turnaround Manager		
	Reliability Manager		Senior Engineers X 1

Figure 3.2: Targeted population to conduct the interviews

Source (Author)

The study followed a homogeneous sampling method which focuses on a specific subgroup where all sample members are similar, such as a particular occupation or level in the organisation, as this study focused on the Senior Technical Personnel at Engen Refinery (Saunders, et al., 2012). There were elements of heterogeneous sampling where the variation was between disciplines and levels of responsibilities in the departments. Heterogeneous sampling is outlined by Saunders, et al. (2012) as the one where the researcher uses their judgement to select relevant participants with sufficiently diverse characteristics to provide variation in data collected (Saunders, et al., 2012).

3.7. Data Collection

According to Saunders, et al. (2012) a semi-structured interview is one where a researcher has a list of themes and key questions to be covered, and may choose to omit some questions, given a specific organisational context that is encountered (Saunders, et al., 2012). The interviews were conducted by the researcher during the Covid-19 Pandemic period where the minimum regulations used minimised the risk of contracting the virus, such as using non-contact means to hold the interviews. Thus, telephonic interviews were conducted with the participants. The interviews lasted between 45 minutes to an hour. The researcher used loudspeaker and a voice recorder to capture the interviews which were then transcribed verbatim. The interview guide (Appendix 2) comprised five sections, where the first one is the Personal Detailed Questions, followed by the General Scope Management Questions and the last three are the Research Questions. Questions on Personal Detailed outlines the background of the participants, their engineering and petrochemical experience, and the knowledge of project management background. The General Scope Management questions were designed to understand the respondents' views about project management in a theoretical and practical manner, and if they saw a need for an individual to study and graduate in the Project Management field to manage projects or turnarounds better. The last three research questions were designed to align with the secondary data that was captured on Chapter 2.

3.8. Pilot Study

According to Saunders et al. (2012), the purpose of the pilot test is to refine the questionnaire in order to create a flow of questions and eliminating any issues related to the questionnaire thus ensuring that there will not be any problems for respondents when answering the questions and there would not be any problems in recording data (Saunders, et al., 2012). The pilot study provides an opportunity for the researcher to assess how long the interview would take and to

establish the content validity and provide consistency for the items and give an opportunity to improve the questionnaire (Creswell & Creswell, 2018).

The researcher opted to use a laptop and a mobile phone to conduct an interview on Microsoft Teams. The laptop was used to make a call and a mobile phone was used as a recording instrument. The researcher used the already designed interview guide to interview two people from Engen Refinery who were familiar with the topic to see if they were comfortable to answer the questions, and how long the interview would be. This was done before the persons identified on this research were invited, and the pilot study interviewees were not included as part of the research. The corrections were made, where the participants were feeling uncomfortable and those repetitive questions were improved and some removed, to improve the research instrument (Appendix 2: Interview Questions Format).

3.9. Unit of Analysis

Creswell (2013) defines the unit of analysis in a case study as a study of an event, a programme, an activity or more than one individual and it might be multiple cases or single case study within the study site. The turnaround scope management is the unit of analysis of the scope and the factors affecting cost and schedule (Creswell, 2013). The researcher intended to establish the factors that affects the schedule and cost during turnaround when identifying multiple factors within the scope.

3.10. Criteria of Trustworthiness

Trustworthiness relates to the procedures that are undertaken to assess accuracy and ensure integrity of the research findings (Creswell & Creswell, 2018 and Korstjens & Moser, 2018). In line with Chikandiwa and Mutambara (2023), the five principles of research include credibility, dependability, transferability, conformability and research ethics were observed and maintained all the time, to ensure quality of the research findings (Chikandiwa & Mutambara, 2023).

Forero, Nahidi, De Costa, Mohsin, Fitzgerald, Gibson, McCarthy and Aboagye-Sarfo (2018) stated that a criterion which includes credibility, dependability, confirmability and transferability as used in qualitative study to establish trustworthiness (Forero, et al., 2018).

3.10.1. Dependability

Moon, Brewer, Januchowski-Hartley, Adams and Blackman (2016) stated that dependability refers to the consistency and reliability of the research findings and the degree to which research procedures are documented, allowing someone outside the research to follow, audit, and critique the research process (Moon, et al., 2016). Korstjens and Moser (2018) define dependability as the stability of the findings over time and it invloves participants evaluation of the findings, interpretation and recommendations of the study such that it supports the data of the study from participants (Korstjens & Moser, 2018).

According to Forero et al. (2018) the purpose of dependability is to make sure the findings are repeatable if the study occurs within the same group of participants, coders and context (Forero, et al., 2018). The strategies used by Forero et al. (2018) includes thorough description of the study, creating audit trails and step by step data replication, which were in included in this study as the researcher prepared the format of interview questions indicated in Appendix 1 which details the questions involves in the study and the researcher asked all participants questions in the same format. The data was collected using audio recordings where consent was requested from the participant to record and transcribed to word document. The codes were turned to themes and sub-themes which were used to as findings of the study.

3.10.2. Credibility

Moon et al. (2016) refers to credibility as what research participants identifies as a truth or give meaning to what the research presents, and the findings are used to make policy recommendations (Moon, et al., 2016). Credibility is defined as the confidence that can be placed in the truth in the research findings and establishes whether the research findings presents plausible information drawn from participants original data (Korstjens & Moser, 2018 and Forero et al, 2018). Credibility establishes questions on how congruent the findings are against reality, and a method to promote credibility includes various processes of triangulation (Stahl & King, 2020). Stahl and King (2020) define triangulation as the use of multiple sources or procedures from the field to identify a repeatedly patterns, or to use multiplicity to test credibility of the research (Stahl & King, 2020). According to Nassaji (2020) in order to achieve credibility, the researcher needs to understand their participants, the context, and processes are as accurate and the interpretation are inclusive (Nassaji, 2020).

The strategies used by Forero et al. (2018) includes prolonged and varied engagement with each setting, techniques and processes of interviewing participants, establish the authority as a researcher, collection of referential adequacy materials and peer debriefing (Forero, et al., 2018). Using Forero et al. (2018) method, the researcher achieved credibility conducting a pilot study to assess the interview flow and refine the set of questioning to be able to approximate the time to conduct one interview. The researcher spent two weeks conducting interviews and spending on average about 45 minutes per participant. The researcher has worked on numerous turnarounds and know all the participants as credible sources to add value into the study. They were regular interaction with people who have worked on the turnaround.

3.10.3. Confirmability

Moon et al. (2016) suggested that a researcher should demonstrate conformability by ensuring that results are clearly linked to the conclusion such that one can follow and process. Korstjens & Moser (2018) states that confirmability is the extent to which other researchers could be able to confirm the findings of the study (Korstjens & Moser, 2018).

The purpose of confirmability according to Forero et al. (2018) extends the confidence that results could be confirmed or supported by other researchers. Chung, Biddix and Park (2020) states that confirmability describes the way the study results could be supported or achieved by others through replication. They associated confirmability as data analysis which is verifiable when researchers present details about data analysis procedures such as how data sources became codes and the codes converter to themes (Chung, et al., 2020). The approach of converting codes to themes is called audit trail by Chung et al. (2020) which provides sufficient details that other researchers could used the same steps and achieve similar results to the study. The researcher maintained confirmability through audit trails by saved all the research documentation to ensure on the same folder to allow the data to be examined when requested by other researchers.

3.10.4. Transferability

Moon et al. (2016) defined transferability as a degree to which findings described in one study are applicable to theory, practice, and future research. Korstjens and Moser (2018) defines tranferability as the extent to which the results can be transferred to other context or settings with other respondents (Korstjens & Moser, 2018). The purpose of transferability is to extend

the degree to which the results maybe generalised or transferred to other contexts or settings (Forero, et al., 2018). The strategies used by Forero et al. (2018) includes using purposeful sampling and data saturation.

The purposive sample was used for the study to select the participants that would add a great value into the research. The researcher achieved transferability by collecting data using semi structured interviews as indicated in Appendix 2, and the interviews were conducted until data saturation. The voice recordings from the interview were transcribed to a word document and analysed in tabular form for all participants per question to present the participants views.

3.11. Ethical Consideration

Ethics is defined by Wa-Mbaleka (2019) as a principle of moral duty and obligations when dealing what is bad or good (Wa-Mbaleka, 2019). Wa-Mbaleka (2019) further states that ethical consideration assists researchers conducting qualitative research to conduct their studies within moral bounds (Wa-Mbaleka, 2019). Highest ethical standards are part of the researcher's obligations to uphold when planning and executing their studies and have a duty to limit the potential risk to the possible minimum (Wa-Mbaleka, 2019).

Halai (2006) states that the survey on ethical consideration was conducted and five ethical principles were found to be common across the board which includes Informed and voluntary consent, confidentiality and information shared, anonymity of the research participants, beneficence or no harm to participants and reciprocity (Halai, 2006). Halai (2006) further states that the principles listed above are procedures which are written with great details which the researchers are expected to follow and provide as evidence to the review committee (Halai, 2006).

3.11.1. Informed and voluntary consent

Kadam (2017) states that the informed consent process was created to provide important information to potential participants and give them power to make and informed decision for taking part into the research (Kadam, 2017). Halai (2006) states that informed consent is expected to be gathered by researchers from all those who are directly or in the vicinity of the research (Halai, 2006).

3.11.2. Confidentiality, shared information and anonymity of participants

Saunders, Kitzinger and Kitzinger (2015) states that confidentiality is a term used to all information kept hidden from everyone except the primary research team and term is mostly used either interchangeably with anonymity (Saunders, et al., 2015). Saunders et al. (2015) states that confidentiality also refers to not disclosing anything that was communicated by participants, while anonymity is one of the confidentiality forms that is used to keep participants identities hidden (Halai, 2006).

Halai (2006) agrees with Saunders et al. (2015) and states that confidentiality and anonymity give great respect and protection to participants through assurance of the information shared during the interview and not revealing their identity (Saunders, et al., 2015).

3.11.3. Beneficence, no harm to participants and reciprocity

The researcher has a duty to identify all risks and benefits of participating on the research and ensure that there are minimal risks involves since all research has inherent risks and benefits (Ajuwon, 2020). Ajuwon (2020) states that beneficence requires researchers to minimise the risk and maximise the benefits of participation in the research (Ajuwon, 2020). Halai (2006) states that the principle of reciprocity requires the researcher to consider the participants time and efforts and how they could be compensated (Halai, 2006).

Having defined the principles involved in ethical considerations, researcher first obtained an approval of the Gatekeepers Acceptance Letter from Engen Refinery Management presented in Appendix 3, which stipulated that the information shall only be used for research purposes and the research be in line with the Petronas Corporate Privacy Policy which was attached as part of the Ethical Clearance application. The application for ethical consideration was done by the researcher and submitted to the University of KwaZulu Natal Research Ethics Committee which included the Informed Consent Form in Appendix 1 and the Ethical Clearance Letter from the University on Appendix 4.

The Interview Informed Consent Letter presented in Appendix 1 has two pages, with the first page detailing the purpose of the interview and the confidentiality matters, and the second page is where the participant voluntarily consents by signing the form. Before the interview, the

researcher read out the informed consent letter and explained that the purpose of the interview, emphasise that participation on the interview is voluntary and the participants may stop the interview and at anytime or request that their interview be withdrawn and there will be no consequences.

The researcher explained that there will be no monetary benefits by participating to the interview. Anonymity of participants details will be kept hidden including on what will written on the report, and confidentiality refers to keeping everything discussed on the interview hidden.

After the informed consent is read out, the researcher gave the participants the form to complete, therefore all the participants voluntarily completed the informed consent forms. All the participants agreed to have their interviews recorded and were assured that the recording will be transferred to written text for the purpose of analysing the content of the interview.

3.12. Data Analysis

Qualitative data is derived from words which may have numerous unclear meanings, where a researcher is required to explore the data with extra care as this data depends on the interaction between data collection and data analysis (Saunders, et al., 2012). It needs to be noted that qualitative interviews, audio-record is used to capture the interview and that audio is reproduced as a written account using actual words of the interview proceedings (Saunders, et al., 2012).

The researcher conducted an interview using a telephone and recorded the interviews. The researcher reproduced the audio recording by typing word by word (verbatim) of the interview. The data was analysed using thematic analysis, focusing on analysing data in a pattern format. Thematic analysis is defined by Nowell et al. (2017) as a qualitative research method that could be used to across the range of research questions which is used to identify, analyse, organise, describe and reporting of themes which are found in the research questions (Nowell, et al., 2017). Vaismoradi, et al. (2016) states that thematic analysis entails the researcher considering the latent content as themes, where coding, collecting of codes under potential themes or subthemes and comparing it to the coding clusters in relation to the entire data set (Vaismoradi, et al., 2016). Alhojailan (2012) states that thematic analysis is used to analyse and present the themes which are known as patterns that relates to the data and present it in greater detail and use interpretations (Alhojailan, 2012).

Nowell et al. (2017) state that during data analysis, the researcher becomes the analysis instrument, making judgements about the codes, themes and creating a context out of the given data (Nowell, et al., 2017). Vaismoradi, et al. (2016) state that a theme is a product of data analysis which produces great results and maybe represented with their subthemes to obtain a comprehensive view of the presented data and be able to uncover the pattern (Vaismoradi, et al., 2016).

Alhojailan (2012) states that both data analysis and collection process start at the same time, which suggests that data collection will be grounded from previously analysed data (Alhojailan, 2012). According to Vaismoradi, et al. (2016), each theme may have subthemes to obtain a comprehensive view of the data and use patterns using the information presented by the participants (Vaismoradi, et al., 2016). The researcher's effort is required to identify patterns and may include a text with multiple meanings and be able to process the analysis in terms of themes and their subdivisions as subthemes (Vaismoradi, et al., 2016).

Vaismoradi, et al. (2016) gave six-phase process of data analysis in thematic analysis, as given below:

Table 3.1: Six-phase process of data analysis

Phases	Description
Familiarising with data	Transcribing data, reading, and rereading the data, noting down initial ideas.
Generating initial codes	Coding interesting features of the data systematically across the entire data set, collating data relevant to each code.
Searching for themes	Collating codes into potential themes, gathering all data relevant to each potential theme.
Reviewing themes	Checking if the themes work in relation to the coded extracts and the entire data set, generating a thematic map.
Defining and naming themes	Ongoing analysis for refining the specifics of each theme and the overall story that the analysis tells, generating clear definitions and names for each theme.
Producing the report	The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a report of the analysis.

Source (Vaismoradi, et al., 2013)

3.13. Chapter Summary

The chapter presents the research design, research philosophy, description of the population, sampling strategy, data collection methods, pilot study, unit of analysis, criteria for trustworthiness, ethical considerations, and data analysis. This chapter presents the research which took a direction of the qualitative research, which is exploratory in nature, which was created to uncover the reasons to change in scope during the turnaround and after the scope freeze days and the contributing factors. The interview schedule was piloted with a small group of people, to identify any challenges with the process and be able to get a standard duration of the interview. The chapter also noted the ethical considerations and limitations were raised. Chapter 4 presents the interview results that were followed to answer the research questions raised in Chapter 1.

CHAPTER 4 - PRESENTATION AND ANALYSIS OF THE RESULTS

4.1. Introduction

This chapter presents and analyses the results in response to research questions in Chapter 1. The semi-structured interview process was used to collect data via telephonic and voice recording means as the assessment was done during COVID-19 pandemic.

4.2. Participant's work experience

The nine experienced participants who participated in the study were professionals from Engen Refinery: two managers, one staff engineer, four lead engineers, one senior engineer and a lead supervisor. There was a repetition of the feedback received which was defined on Section 3.6.1 as data saturation from the participants which was the main factor for determining the final sample size of the participants.

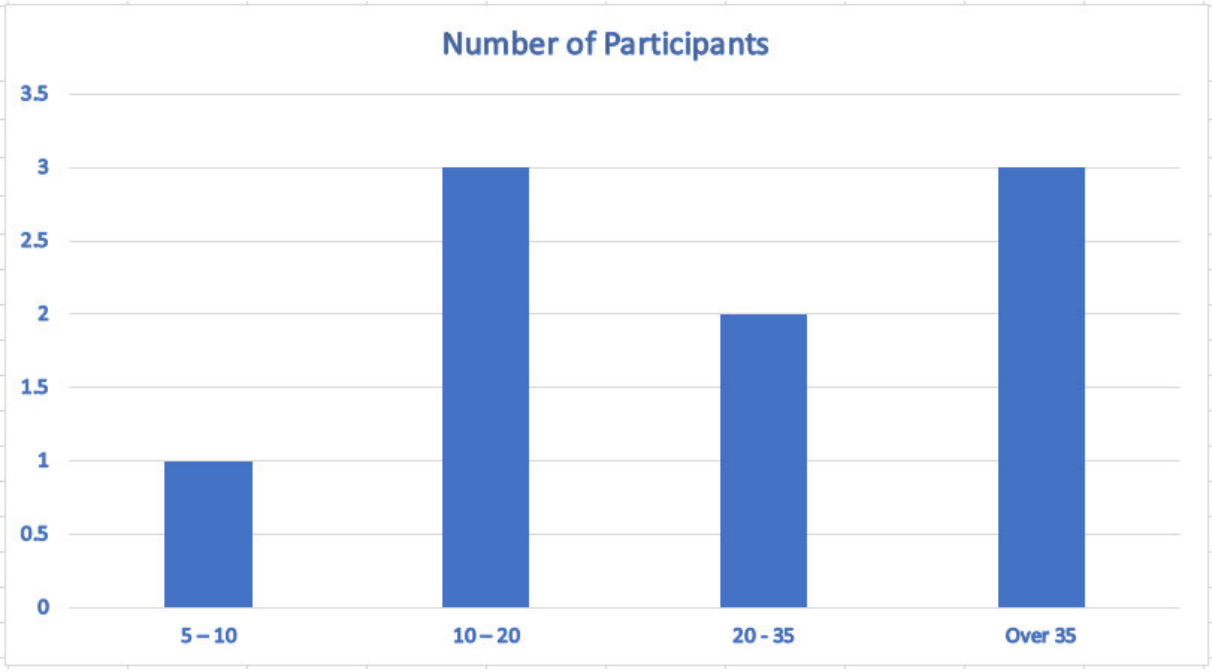

Figure 4. 1: Work experience of participants in the petrochemical industry

Figure 4.1 represents the work experience each participant has within the petrochemical industry. One participant has less than ten years of working experience, three participants were in a range between ten and twenty years of work experience. Two were in a range between twenty and thirty-five years and three had over thirty-five years of work experience, which indicates the amount of experience the individuals had in the petrochemical industry.

The sample of all the participants were taken from various engineering disciplines within the Maintenance and Turnaround Department. The distribution of technical disciplines within the Maintenance and Turnaround Department at Engen Refinery that took part in the interviews are given by Table 4.1:

Table 4. 1: Discipline and Organizational function of participants

Participant	Discipline	Organizational Function	Profession
P1	Instrumentation and Control	Technical	Technician
P2	Electrical	Technical	Engineer
P3	Instrumentation and Control	Technical	Engineer
P4	Reliability	Manager	Engineer
P5	Mechanical	Technical	Engineer
P6	Electrical	Technical	Engineer
P7	Mechanical	Technical	Engineer
P8	Mechanical	Technical	Engineer
P9	Turnaround	Manager	Engineer

Table 4.1 further indicates the participants' function within the organization, where two are managers and seven are technical professionals. This also gives a view of both management side and technical side on the topic. In Table 4.1, discipline represents the department which they are working for, and organisational function represents the management role or the technical role in the department and profession represents the educational background the participants.

4.3. Construction of Research Themes

This section presents twelve themes that came out from analysing the interview feedback from the participants. The summary of the themes is presented on Table 4.2 which presents twelve themes which were discovered using the generals scope management question and three research questions.

Table 4. 2: Highlights of project themes

Item	Themes
1	Scope challenge
2	Statutory Requirement
3	Resource Loading
4	Increasing working hours
5	Detailed planning and work experience
6	Contract strategy
7	Increasing turnaround cost
8	Cost control mechanism
9	Risk Assessment and challenge sessions
10	Known unknowns
11	Managing the deviation process
12	Work Culture

The themes were generated from the general management questions and the three research questions. The purpose of the general scope management section was to get insights into the general principles of Project Management and find out if the respondents applied the fundamentals of Project Management when planning and executing the turnaround scope.

Out of the nine participants, only one disagreed that formal educational background has any influence in the way that projects are conducted. The remainder of the participants agreed that formal educational background in Project Management influences the way projects are conducted. Below are the most significant statements that were quoted from the participants.

Participant P2 states that every industry has their own way of managing projects however the principles of project management apply to all industries the same, and his statement is as below:

"Because the skills that you learn in a tertiary institution when it comes to project management really gives you the insights when you are working in the organisation like Engen for project management. The organisation has its own methodology, but at the end of the day the principles is what project management is all about".

Participant P4 stated that educational background gives a more professional approach in handling projects: *"It adds too is the more professional approach to tackling different phases of the shutdown, or turnaround or project planning. So, having a formal background helps one in understanding from a professional point of view of how to put projects together".*

Participant P6 states that the theoretical background helps one to have more knowledge in executing projects: *"It does for simple reasons, your theoretical background simply outlines the required vision for you to be able to plan for the work to be executed".*

Participant P9 stated that having a project management qualification helps one to give global best practices. Participant P5 stated that "*Turnarounds is a project on its own, because it follows the processes of which in terms of presenting, requesting funds, scope management and development, meeting with contracts who are going to be doing the actual turnaround.*"

Table 4.3 presents the themes generated using general scope management questions and gives a brief description of the themes according to the participants views.

Table 4. 3: Themes constructed from general scope management questions

Theme	Description of the Theme
Scope challenge sessions	Participants emphasised the need to conduct the challenge session to minimise and optimise the turnaround work scope in terms of the following criteria: ▪ Cold eye review ▪ Lesson learned from previous turnaround
Statutory Requirement	The participants emphasised that the drivers of the turnaround are mostly made up of legal compliance and use the following to include the activities in the turnaround worklist: ▪ Risk-based inspection ▪ Compliance issues ▪ Safety, schedule, and cost

4.3.1. Scope challenge session

Participants outlined the need for benchmarking the turnaround work scope in order to include it on the final work list. They emphasised the need to conduct the challenge session to minimise and optimise the turnaround work scope using cold eye review and lesson learned from previous turnarounds.

Eight participants responded and the term cold eye review or formal reviews adopted by Petronas, which is the Malaysian National Petroleum Limited, were all mentioned by four participants when they are benchmarking and evaluating the work scope. In their context, they all mentioned that Petronas reviews the turnaround work scope and assists to ensure the turnaround is done successfully. Participant P2 states that using cold eye review allows the company to look into details of the scope submitted to the turnaround which is another way of challenging the scope and his words were as follows:

"When it comes to benchmarking, it very difficult to say, but we also use Petronas guides, they use cold eye review, they look at what we done, and they give us some guidance and say where we are, and we should be and give you some guidance for use that information to fine tune your plans".

Participant P3 states that the cold eye review form part of the challenge session to understand all dimensions of the scope:

"The turnaround work scope is reviewed extensively or exhaustively several iterations that the go through, theses also a cold eye review that is done by external parties in this case I'm talking about external to Engen that is Petronas. Petronas also does a review of our turnaround scope".

Participant P7 states that:

We get what is called cold eye review, which is specifically for turnaround. The turnaround department will, in their project schedule or milestones, one of the milestones is to have an external auditor that will come and review the situation. Benchmarks will be against the other OPU's where the cold eye review is done by other people coming from other different OPU's from Petronus. So, how we evaluate the turnaround work scope is through the challenge session that we must conduct for the different subset of our worklist".

Participant P9 states that the turnaround work scope is challenged on the next hierarchy of the company to understand the impact of omitting an activity from the turnaround. He stated as follows:

"We benchmark and evaluate our turnaround work scope, that is done by the Engineers that's responsible for a specific area. They work on a day-to-day basis on the plant, so they know what work is required for turnaround duration. That is then challenged on at the next level of the hierarchy of the company and further challenged at the next two levels in the company up to the general manager. We also get Petronas our parent company, Petronas also get involved in having formal reviews for the work scope, we did one in November last year".

Participant P6 and participant P8 states that the benchmarking of the scope includes the use of previous turnaround experience or lessoned learned. Participant P6 states:

"In terms of benchmarking is not a rigorous continuous close loop type of systems most companies are employing, it's more like an open loop type of a system were based on the previous experience, this is what we proposed to be the next one and that's how the turnaround manage to bring their initial proposal of scope".

Participant P8 states that:

"It's based on the legal requirement, historical recommendation. Most equipment in the turnaround is done mainly for statutory requirement. My team ensures that all the equipment that are due, are on the worklist. Any equipment that has previously been identified are added to the work scope if the user approves".

Participant P1states that to optimize and minimize the scope of work of the turnaround, the challenge session is done:

"We get engaged in scope challenge sessions, where people must justify why they must do that type of work, why can't it be done on the run".

Participant P7 there are two additional screening process with the challenge session and mentioned as give below:

"You get these two additional screening processes that optimise the worklist and minimise the work in order to ensure that you do not get an unnecessary item on the worklist".

4.3.2. Statutory Requirement

Participant P7 stated that statutory requirements are legal requirements needed to ensure compliance with the Pressured Equipment Regulation. The term statutory will be interchanged with legal in this context. The term statutory requirement appeared six times from all the participants. Both participants P2 and P7 mentioned four drivers such as safety, quality, and schedule as the main drivers of turnaround work scope, while one mentioned cost and compliance as last part of the drivers. Breakdown or jobs that cannot be done on the run were mentioned by two participants. Participant P7 stated that the turnaround work-scope is done by central and area teams, where central only focuses on integrity and area focuses on both integrity and statutory requirement. The term integrity appeared from two participants as other secondary drivers of the turnaround work scope.

The significant statement gives a high-level quote of each participant and the majority agreed that the statutory requirement is one of the main drivers of the turnaround work-scope followed by equipment integrity. Participant P7 states as below:

"The central team main drivers for the turnaround work-scope are essentially, integrity, there they are only looking at the repairs that we done to return that equipment back to its original state of integrity. The area teams are looking at both integrity and statutory requirement. So, statutory requirements are basically legal requirements that you need to ensure are complied with as per the PER- Pressured Equipment Regulation".

While Participant P8 states that "*Legal requirement and equipment integrity".* Participant P9 states that: "*The equipment on the turnaround you get two parts, either statutory equipment or opportunity. Every six years we do a statutory inspection on that equipment that falls under the Pressure Regulations".*

Participant P3 mentioned that statutory requirements shall be executed during turnaround and some of the preventative maintenance routines which cannot be done during normal working hours and his stated as below: *"There are statutory requirements and certain PMRs that can only be executed during the turnaround"*

Participant 4 stated that statutory inspections are mandatory, and his words were as follows:

"You cannot reduce the amount of statutory inspection but remembering risk-based inspection on the eyes of formal legal process of ensuring that scope is challenges. The drivers of a

turnaround work scope are going to be legal requirements from a pressure vessel point of view".

Participant P4 states that:

"How do we optimise the worklist, the inspection department looks at the risk-based inspection, and from the risk-based inspection, we can minimise the number of unnecessary inspections of equipment, that's one way of looking at optimised worklist, and you can reduce the amount of statutory inspection but remembering risk-based inspection on the eyes of formal legal process of ensuring that scope is challenges".

Participant P8 states that: *"If the requirement for the equipment is to be worked on the work list is due to statutory requirement, it's hard for you to not execute that job because that is the violation of legal requirement".*

Participant P4 stated that to benchmark the turnaround, the regulations stated in the Occupational and Safety Act shall be followed:

"According to the OHSAct under Pressurised Equipment Regulations, we need to do the statutory inspection and repairs on equipment, so on that we also have run limiters so basically your scope was put together or your planning was put together based around that and based on the project we want to execute".

Table 4. 4 presents the themes generated for the impact of changing in scope on schedule during turnaround, which reflects two themes which are resource loading and increasing working hours. The purpose of research question was to understand the impact of changing scope on the turnaround schedule. The participants understood the impact of changing work scope during turnaround. Participant P2 stated that the change is dependent on the impact it has on the critical path, and used question format to validate the impact of the change and stated that *"is it going to have an impact from the schedule? Does it impact on the schedule? Does it impact on the critical path? If it does impact on the schedule and critical path, then it's the serious problem. Can the change in scope can be done within schedule and within cost, without impacting on quality, then we don't have a problem? it all depends on what change we will encounter in that point in time."*

Participant P9 outlined that when the refinery is not able to start on time, there would be millions of rand losses as these impacts on production.

Table 4. 5: Themes for the impact of changing in scope on schedule during turnaround

Theme	Description of the Theme
Resource Loading	Participants emphasised the need to manage and control of the resources sent to site during turnaround in terms of: ▪ Material delivery ▪ Availability
Increasing working hours	Participants saw a need to increase working hours or adding more people to catch up with the schedule

4.3.3. Resource loading

Participants emphasised the need to manage and control of the resources sent to site during turnaround in terms of material availability and delivery. Participant P3 stated that the turnaround cost could increase when there are delays during start up and his words are as given below:

"Cost of the turnaround and they could also be impact on the schedule, in terms of increasing the time it taken to execute the turnaround causing delays in start-ups".

Participant P4 states that changing your work scope could influence on schedule and have a negative impact on the resources and his statement is as given below:

"Changing the work scope can influence your schedule, it can influence your resources, your resource loading that you might need to increase resources, it can also definitely impact on your cost because you adding to the actual scope of work"

Participant P5 stated that resources will be affected when the scope is included late in the turnaround and his statement is as given below:

"You can see clearly that from there, the resources will be affected, there is a good chance that you will need special vendors who are going to be assisting to do that kind of work".

Participant P2 states that changing the work scope impacts on schedule when there are safety concerns involved and his statement is as follows:

"When an issue happens, safety issue happens that impacts on the schedule. The next thing that impacts on the schedule are resources, when resources do not arrive on time for various reasons".

Participants indicated that when turnaround starting dates changes for any reasons, it impacts on your resources such as labour and long lead items. Participant P5 stated that should the date changed for any reason, it will not only impact on the cost but on the schedule of the turnaround and his words were as follows:

"If the dates do change, not only cost wise there might be for a specific date at the start of turnaround, then the next thing there is a change in the turnaround schedule that affects those dates. What's going to happen to those resources? You've organized specialist contractors, maybe in some cases specialist contractors comes from overseas, so all that is going to be affected and then cost wise".

Participant P8 stated that the impact is on the resources and the daily production is also impacted and his words were as follows:
"It got a big impact because, every change equates to resources which are more effective to turnaround and any delay in a day in the Refinery equates to 4 million a day, so it got a big impact. Any change has a big impact on the turnaround cost and schedule".
Participant P9 stated that the extension of the start dates is good for the turnaround as those materials which were not delivered would be delivered however is the schedule is brought forward, then that would not be good, and his words were as follows:
"It has good impact; your long lead equipment could be delayed. If you going to get those deliveries of materials then you will need to preserve them, that's not really a problem if you are moving the dates later. We've never had an experience of moving the turnaround earlier, in worse case, that would be setting yourself to failure if you going to do that".

Participants agreed that changing the work scope impacts on the schedule and most stated that in their departments, changing scope mostly affects the resources such as materials, skills and manpower. Participant P2 stated that in his department, changing the work scope normally affects the safety aspects of the turnaround and resources: "*The next thing that also impacts on your schedule is when an issue happens, safety issue happens that impacts on the schedule. The next thing that impacts on the schedule are resources, when resources do not arrive on*

time for various reasons, they under the influence of alcohol and drugs and you must change your resources".

Participant P3 stated that:

"When processing deviations, we must make sure that we have sufficient resources available to execute the additional scope, within the schedule so that it doesn't impact on the overall schedule".

Participant P4 further suggest that resources are affected when the work scope changes:

"Your materials firstly, how you must source materials? So, you could have the materials that could impact the schedule. How long could it take to get your materials here? Also, could impact in getting your materials, your labouring resources".

Participant P5 states that changing work scope affects the resources: *"It affects my resources number one, and it going to affect the cost as well. So those two items will be affected by the change in scope".*

4.3.4. Increasing working hours

Participants stated that when the activities are falling behind schedule, the key factors that are used to ensure the turnaround activities are brought back within schedule includes increasing time and adding more resources. The participants mentioned that changing turnaround work scope means adding a new scope of work or removing some activities in the turnaround work scope which could influence the turnaround budget and schedule. Participant P3 stated the following:

"Changing the scope can go either way you can descope, we sometimes descope certain tasks or in the case of the unknown item that emerges, if we talk about emergent work, its only during the turnaround that we discover certain items that needs to be included in the scope, so the impact of that is that the cost increases if there is emergent work. Cost of the turnaround and they could also be impact on the schedule, in terms of increasing the time it taken to execute the turnaround causing delays in start-ups".

Participant P7 stated that:

"The work scope can change in only two ways. Either you are adding more work, or you are taking out work, as descoping. The influence on the turnaround schedule is normally depending on the number of floats that you have on your schedule. A scope growth or a new scope will eat up your available float. In terms of descope, its normally not an issue on the schedule

specifically is reduces the schedule. So, you can incur the cost but not a schedule impact in terms of the descope".

Participant P1 stated that adding extra people or more hours help to bring the turnaround activity within schedule and his words are as given below:

"If your schedule is slipping out of time, you together with the turnaround leader, you need to inform him on time and then you can put a catch-up plan in place. It may be extra hours, hiring extra labour to catchup with the schedule".

Participant P3 supported Participant P1 and stated that the addition of hours and more resources could assist in bringing the schedule within the agreed one, and his words are as follows:

"One would be to work longer hours and to review the scope to see if there are any aspects can be implemented at the later date. Or bringing in the additional resources so, you must look at all three possible measures you can take to recover from a situation like that".

Participant P4 states that the turnaround calendar is changed to suite the need of the day, which includes working twenty-four hours with hot handover and his words are as follows:

"You can change calendars and you can make it 24 hours shift hot handover, you can increase resources, your labour resources".

Participant P5 stated that adding extra hours could assist in bringing the schedule within the agreed schedule:

"Must intervene and we work extended hours or workday and night shift to cover the required scope and to try and not to move to critical path".

Participant P6 said that more resources are requested at a price, or require the schedule to be extended:

"So, either you put more money in terms of increasing the number of resources, or you increase your schedule by putting more time to the process, of course that could come with cost or those two could be coming together at the same time.

Participant P7 supported Participant P4 by mentioning that twenty-four-hour calendar shall be introduces to ensure the project is within schedule and his statement is as follows:

"You find that for the critical path items will happen on a twenty-four-hour calendar and then other items will happen on the day shift calendar. So, not all items must be done on the twenty-four-hour basis, only the ones that require or have a schedule impact".

Most of the participants stated that when the turnaround is behind schedule, there will be a need to increase working hours to enable the activities to be completed. Participant P1 stated that

the project leader, together with the turnaround leader, need to put in place a catch-up plan which includes working extra hours and his words were as follows:

"It may be extra hours, hiring extra labour to catchup with the schedule".

Participant P3 stated that:

"*To catch up on a schedule for a project, there are few means available. One would be to work longer hours and to review the scope to see if there are any aspects can be implemented at the later date. Or bringing in the additional resources so, you must look at all three possible measures you can take to recover from a situation like that".*

Participant P7 stated that there are different calendars in one turnaround, "*You find that for the critical path items will happen on a twenty-four-hour calendar and then other items will happen on the day shift calendar."* The activities that are on the critical path or those highly impacted items will belong to the twenty-four-hour calendar, while the other activities will be done on a day shift calendar. Participant P7 also gave three mechanisms that are used to bring a project within schedule, one is to do all the high schedule impact activities on a twenty-four-hour calendar, the other is to change the calendar from day shift to twenty-four-hour shift and do what is called hot handover, the last one is to increase the number of manpower available.

Table 4. 6: Themes for impact if changing scope on cost during turnaround

Theme	Description of the Theme
Detailed planning and work experience	Participants emphasised the need to conduct proper planning and experience in terms of: ▪ Experience and strong technical skills ▪ Detailed planning
Contract strategy	Participants believed that the service providers which assist during turnaround shall be given a contract which will suite the companies objectives in terms of: ▪ Labour ▪ Scope removal or addition
Increasing turnaround cost	Participants emphasised the need to properly manage the number of deviations which are introduced: ▪ Adding new scope after freeze dates ▪ Cost controlling

Cost control mechanism	Participants emphasized the need to conduct cost estimation and control to manage: ▪ Deviations ▪ Overtimes ▪ Resources
Risk Assessment	Participants emphasised the need to conduct the risk assessment when selecting the activities which shall be included in the turnaround worklist.

4.3.5. Detailed planning and work experience

Participants emphasised the need to conduct proper planning and having right experience in terms of conducting a turnaround work scope and the key contributors mentioned by participants experience and not conducting a detailed planning.

Participant P2 spoke about planning and having experience to create a proper scope of work:

"So, the detailed planning is there, and a lot of experience is needed, for me we find that the same job can be done by an experienced person with virtually the reduction in cost, inexperienced person is doing the same job, the cost can go up twice as much or even more. It's all about the level of skill, knowledge and experience that really defines cost overruns, or you can reduce cost"

Participant P5 stated that a detailed planning could save cost during turnaround:

"If you did a proper planning for the turnaround, you could have saved cost when you compared to when you do something under high priority"

Participant P7 stated supported that scope of work shall be done by experience or knowledgeable person and stated, *"Are inefficiencies in work execution".* Participant P8 stated that having technically gifted personnel could save on cost and his words are as follows:

"It is to have a very strong technical team that evaluates every recommendation have introducing scope of equipment during the turnaround"

Participant P9 stated that turnaround is planned years before the actual turnaround date, therefore with time there would be new scope introduced into the turnaround worklist, however

with planning and coordination, the scope could be limited to what is needed during the turnaround, and he stated as below:

"You planned two years ahead planning for the turnaround, but once you frozen the worklist, the plant is still running, and there are deviations that comes about. So, your original budget that you requested from the board two years ahead will change".

Participant P2 and P9 spoke about including contingency when conducting the cost estimate to ensure there is no cost overrun during turnaround. Participant P2 states: *"During a shutdown turnaround so we do have a contingency that we have in place of 10 % to handle any changes in scope".*

Participant P9 states that: "once you frozen the worklist, the plant is still running, and there are deviations that comes about. So, your original budget that you requested from the board two years ahead will change. We do apply for contingency and deviations of work scope is part of that contingency".

4.3.6. Contract strategy

Participants emphasised the need to have a contract strategy which will empower the business when it comes to labour, resources and scope addition and removal. Participant P2 stated that late removal of turnaround activities solely depends on the contract strategy, and he stated as below:

"It depends on how the contract is written out, so it is very important that when a contract is set-up, it must be mindful of the contracting strategy"
Participant P4 stated that the resources have already been included in the turnaround scope and will be billed however the contract strategy could assist in minimising the impact, and he stated as below:

"Remember it's too late because we've already had all the labour come on board, we already erected scaffolding, during pre-turnaround phase, we already hired a crane, we already hired the tents, caravan and toilets"

Participant P6 also spoke about the contract and mentioned it could assist in minimising the cost incurred when removing activities during turnaround:

"Number one, because of budgeting, late removal of the work during the time of execution, in the short term in terms of the contract itself, it could make it longer or shorter."
Participant P7 supports the other participants and states that the way the contract is drafted could assist in minimising the cost incurred for late removal and his direct words are as follows:

"The question is that the contract is going to be suspended or delayed or cancelled affects the cost immensely, since you cannot recover the cost invested in doing these activities, so you incur a loss by removing work related to the turnaround".

Participants felt the contract strategy does not include the addition and removal of activities during turnaround. Participant P3 stated that emergent work are items that are discovered during the turnaround, and this could have an impact on the cost, as it could increase. Participant P7 stated that scope growth can eat up the available float, while descoping can only impact the incurred cost, but not on schedule.

Participant P4 gave an expression that changing the work scope can influence schedule, resource loading that might need to increase. Most of the respondents noted that changing the work-scope can increase the cost and schedule. Participant P4 indicated that:

"Changing the work scope can influence your schedule, it can influence your resources, your resource loading that you might need to increase resources, it can also definitely impact on your cost because you adding to the actual scope of work".

Participant P2, when asked about the impact of changing scope on schedule stated four items that impact the schedule, the first one is the scope growth and the second one is the capability of the service providers and the third one is the occurrence of any safety issues, the last one is the availability of resources. Participant P5 indicated that it is not always possible to manage scope growth during turnaround using internal resources, therefore, it affects the cost, as well as the turnaround schedule. Participant P9 stated most of the scope growth is caused by emergent work and responded by giving an example:

"If you find when you opening a vessel, and you do an inspection and you need to do the repair, if that repair can take either couple of hours or a couple of days, if that wasn't catered for in a schedule, those couple of days going to have a bottom line impact on your start up dates for the refinery, where you going to impact on tens of millions of Rands production loss because you starting up late. The impact is production loss, money".

Descoping is defined by Participant P7 as the removal of scope on the turnaround worklist, thus reducing the schedule while incurring cost of removal. Participant P7 stated the *"the term descope, its normally not an issue on the schedule specifically if it reduces the schedule. So, you can incur the cost but not a schedule impact in terms of the descope".*

Participant P3 stated that the term changing scope includes descoping and emergence work in the case of unknowns.

4.3.7. Increasing turnaround cost

Participants indicated that adding a new scope after the freeze dates contributes to the increasing turnaround cost and the key factors that contributes includes new scope and turnaround deviations. Participant P1 states that the addition of new scope affects schedule and cost and states as below:

"It will affect your schedule; and will affect your cost"

Participant P3 states that adding new scope has impact on the total turnaround cost as stated below:

"Adding new scope, after the turnaround work scope has been approved, has an adverse impact in terms of increasing the total cost of the turnaround"

Participant P4 states that any deviations brought to the turnaround team has a potential to increase turnaround cost and states as below:

"We measure it on that added additional work and we can show it as in variation order or by deviation, how much extra the cost is going to be".

Participant P5 states that any deviation in the system shall be assessed and its risk to be known and states *"any deviation will be risk ranked against all the turnround work.*

Participant P6 states that any addition to the scope affects the turnaround cost as there are service providers what are involved and states as below:

"If there is any cost implication as a result of additional scope, especially if you are talking service contracts, service providers which is what we use.

Participant P8 agrees with other participants that materials on an emergency situation impacts the cost *"Having to order the materials on P1 have a big impact on the cost".*

Participant P9 states that when the new scope introduced into the turnaround worklist, the service providers tend to shift the blame of not completing on agreed times to the new scope and his words are as follows:

"After that the main contractor attends to blame the delay in a schedule and the cost overrun due to a deviation and then the organisation is held at rand some where we have no option, but to pay that exorbitant cost. Always remember that labour rates during the turnaround period if far higher than labour rates in operating hours."

4.3.8. Cost control mechanism

Participants emphasised the need to conduct cost estimates and budget control to be able to manage the increasing cost during turnaround and the contributing factors that were mentioned includes the deviations, overtime and resources.

Participant P2 states that the turnaround cost estimates are done before the turnaround states and his words were as follows:

"Cost control is normally defined up front, all lot of cost control measures. From purchasing of materials, from working hours, from over time is capped so you keep cost under control also managing the vendors making sure you get maximum from the vendors"

Participant P3 states that for the cost to not escalate, overtime shall be controlled, and his words were as follows:

"To ensure that labour cost do not escalate out of control, and overtime, very careful control is maintained on overtime"

Participant P4 states that a ten percent estimate is included in the beginning of the turnaround to cater for any changes in the scope of work and his words were as follows:

"We get to a final ten percent cost estimate and from there we start controlling the actual budget because from an estimate it moves to a ten percent cost estimate, and it becomes a final budget. Managing that cost, we manage it by looking at our manpower reports, planned versus actual and we manage all our resources based on the earned value management scale"

Participant P9 states that the level of cost estimates that is done during turnaround improves the accuracy of the budgeted cost and his words are as follows:

"a different level of cost estimates that is done, which improves the accuracy of the budgeted cost, then a stage gate process involves".

Participant P7 states that the cost control mechanism shall be in place and his words are as follows:

"The cost control mechanism that is in place to decide, to say do you incur this cost or not?"

4.3.9. Risk Assessment

Participates states that the strategies used for inclusion of the turnaround activities with limited budget includes the challenge session where the activities are measured against the need and risk assessment. Participant P1 believed that a challenge session is a solution to the inclusion and exclusion of the turnaround activities, stating that: *"We have these challenge sessions, there are projects that are executed during the turnaround, but not necessary because they are part of the turnaround."*

Participant P2 states that a risk assessment is done to assess the activity to be included in the turnaround "*If the turnaround exceeds the budget, then we do a risk assessment, then we descope the work, it's all based on reviewing what's there and what is a risk if we are taking it off the turnaround and can it be done at another time. Can it be delayed for the next turnaround, or can it be done from the next opportunity, it all based on risk assessment".*

Participant P3 states that a risk matrix, guides the content of the turnaround work scope *"They are justified based on the risk matrix. So, depending on what risk you are addressing with that project, you can justify it by conducting risk assessment"*

Participant P7 stated that the committee which focuses on scope deviation uses the challenge session to assess the risk of not including the activities and the cost involved to conduct the project during turnaround, and his words are as follows:

"You have to go through via the deviation committee to justify in terms of the risk and cost and impact to the business if that project is not done. So, that is the process we must go through in order to ensure that the work is complete, if the risk to the business is huge and then you present it accordingly and is accepted by management".

Participant P8 stated that the risk assessment is done to assess if the project can be included in the turnaround by checking the need to conduct the project and his words are as given blow:

"Risk Assessments are done so that projects are then placed against each other in terms of risks, we also go and do intensive fitness for service, to see every item that we want really needs to be executed."

The term risk assessment echoed from four participants who used it to rank the risk of the project-it is the first thing that is done to see the importance of adding the job to the turnaround worklist. Risk assessment is another form that was identified by the participant to use to add a new activity on the scope of work after the scope freeze dates. Participant P3 states that *"The work must be identified, carefully defined all the requirements for the project and then very importantly must be a risk assessment carried out, to identity the risk associated with that job"*, further noting that the risk is categorised from low, medium, and high risk, *"based on that, management will give us the go ahead or will give us feedback on whether that can be included in a scope or not. So, the risk assessment is key to this whole process"*.

Participant P5 stated that:

"When you risk ranking you must do a risk assessment to be able to justify the needs in terms of Health, Safety and Environment. So, that you make sure you have a proper risk, you not adding something for the sake of adding work, so there is a gatekeeping system which is available".

Table 4. 7: Themes for the contributing factors of the change in scope after freeze dates

Theme	Description of the Theme
Known unknowns	Participants put strong emphasis on the contributors of scope change which are mostly as a result of the following: ▪ Not conducting inspections ▪ Lack of skills and experience ▪ Competency
Managing the deviation process	Participants raised their concerns in regard to the managing the scope addition and the key contributors are: ▪ Challenge session ▪ Risk assessment
Work Culture	Participants emphasised the need to look into work culture as contributor to scope increase and the key contributing factors includes: ▪ Behavioural issues ▪ Attitude towards turnaround ▪ Mindset

4.3.10. Known Unknowns

The known unknowns were the major contributing factor to the change in scope during turnaround and participant highlighted numerous activities which leads to the known unknowns which includes not conducting inspections, attitude, lack of skills and experiences and the competency of the personnel.

Most of the participants stated that the contributing factors to changing work scope include the unknow scope that one discovers after the scope freeze dates. Participant P1 stated that *"The equipment is fine until you open that piece of equipment, then you are forced to change the scope"*, while Participant P2 noted that:

"The major contributors are generally getting the unknowns, when you go there and open up something and you find things that were not supposed to be there, what we normally call knowns-unknowns, so that during your planning and preparation and scoping and putting a schedule together, you got to be able to build in those factors, of what if this happens and what if that happens".

Participant P2 further emphasised the need for understanding the equipment and the required skills are included in the turnaround and stated that: *"Your contributors are all based on your skills and experience, knowing your equipment doing a lot of statistical analysis and doing a lot of condition-based monitoring".*

Participant P3 defined the generation of emergent work and stated as indicated below:

"Emergent work, work that emerges during the turnaround itself that we were not aware of prior to the turnaround. There are sometimes referred to as known unknowns, we don't know exactly maybe something there, but we don't know when we open the equipment, we get a clear picture"

Participant P4 believed that some departments attitude contributes to unknowns during the turnaround since they do not take enough time to create the scope of work and towards the turnaround, they tend to start gathering the turnaround worklist and stated as below:

"Either the area or the inspection department has been sleeping and now during the actual shutdown turnaround they start discovering new work. That they haven't thought of, or they haven't foreseen because they haven't walked the plant"

Participant P6 stated that the contributing factor to unknown scope is the lack of experience and competence:

"What contributes is competency on our side, on human factor there's quite a few levels. There's experience, whether the guys have a specific experience in a specific environment, in a specific problem, secondly do they have the necessary competence".

Participant P5 also states that *"The major contributors are mainly the unknown scope".*

Participant P9 states that poor planning and preparations are major contributors and mentioned as stated: *"Poor planning and preparations in those two years will result in not as part of the major contributors results in deviations"*

Participate P9 further emphasised that if the planning process in not done correctly, there will be many unknowns during turnaround and his comments are as given below:

"*I have mentioned the know-unknowns, and the knowns-knows, and the unknown-unknowns. So, if that planning process of using history and using our historical data bases of what we found in previous turnarounds, if that's not used in our planning and preparations, then you not going to plan properly for that scope you should have been able to plan for as it did happen in the past".*

4.3.11. Managing the deviation process

Participants raised their concerns in regard to the managing the scope addition after the freeze dates, and the process used to add a new scope during turnaround. The key activities the participants believed shall be part of the deviation processes are the challenge session and risk assessment. Participant P9 stated that to add a new scope after the freeze dates, one needs to follow a deviation management procedure as stated below:

"We have a deviation management procedure where the definition of the scope is then captured in a form, either electronic or hard copy and different department managers sign off on that, and eventually goes up to the GM based on the LOA, based on the budget cost of that new scope. That form is traced and tracked and capped and records for five to ten years".

Participant P9 was supported by participant P1, participant P2 and participant P3 when they state that *"You follow a deviation process with justifications", "There is a deviation system, so you go via turnaround deviation"* and *"We have what we call a deviation process, we have a*

formal sign off from the relevant stakeholders that this work needs to be increased" respectively.

The risk assessment was part of the activities that the participants believed are mandatory when selecting which activities shall be part of the turnaround work scope. Participant P3 states as indicated below:

"The deviation process that you going to risk rank, when you risk ranking you must do a risk assessment to be able to justify the need in terms of Health, Safety and Environment".

Participant P7 states that: *"There is a deviation process whereby the area team that identified the scope of work will have to scope and do a cost estimation and a risk assessment and then apply through a formal document indicating a scope of work, a risk and a cost"*

Participant P8 stated that: *"There are deviations meetings where each item is getting to be presented and the deviation form must be submitted and signed by the turnaround manager".*

4.3.12. Work culture

Participants emphasised that the work culture displayed towards the turnaround does not assist the organisation to reduce the amount of scope changes which leads to the extension of the schedule and increased in scope, and the contributing factors are the behavioural issues and the attitude towards the turnaround. Most of the participants agreed in relation to work culture contribution to the increase in the scope of work, while some participants did not understand how culture could relate to the increase on turnaround work scope. Participant P2 and participant P4 spoke about the adopted culture where the people in the organisation every activity shall be done on the turnaround and the attitude where they leave everything to the last minute and add to the turnaround scope of work. In line to the last statement, Participant P2 stated:

"If your organizational culture is driven largely on the turnaround culture, where they believe all work needs to be loaded to a turnaround worklist, that does contribute to the culture of your organization"

Participant P4 stated:

"Different culture mindsets right of which you must pile on every bit of work that you can find, maintenance work you leave everything unforeseen additional scope at the bitter end and then you want to add it to the worklist."

Participant P6 spoke about the mindset possessed by the organisation is states as below:

"Some individuals their behaviour is not right as they sometimes delay the turnaround intentionally and it affect the whole organisation or turnaround itself in terms of meeting the required timelines."

Participant P5 supported Participant P6 when he spoke about the mindset of making money during the turnaround contributes to the increase in cost and delays the turnaround schedule and stated:

"You find out certain people during the turnaround, they look at turnaround as an opportunity to make money. Where else they are not made aware that we are doing this turnaround based on the statutory work and there is a schedule that you need to meet."

Participant P7 states spoke positively about the culture where everyone is encouraged to bring forward any items which may pose as a threat to the organisation and said:
"Culture basically encourages us to be open about items that we are picking up whether you feel that you've picked up this item late or whether you picked it up in due course, through your workflow systems, either way we always have to raise our hands and indicate that there is a high-risk item to the business"

Participant P9 spoke about the attitude of creating a scope beyond the requirements and the mentality of working in silo and said the following:
"People tend to over scope the required resources and then it creates problems in terms of safety."
"You find that a silo mentality is the biggest problem and how we get around that is by ensuring that we have turnaround progress or input into the turnaround planning and preparation as part of the persons IPC, which is the performance contract."

4.4. Chapter Summary

In summary, the results presentation and analysis are provided in this chapter. The results were analysed using thematic analysis, using repetition to construct themes which were used to present the findings. There were twelve themes that were discovered which includes scope challenge sessions, statutory requirement, resource loading, increasing working hours, detailed planning and work experience, contract strategy, increasing turnaround cost, cost control

mechanism, risk assessment, known unknowns, managing the deviation process and work culture.

Scope challenge sessions are useful in the amount of turnaround activities registered after scope freeze dates. The statutory requirements were found to be the main drivers of the turnaround which are always in service during the year. Resource loading was found to be the issue when changing the turnaround work scope as materials may be required for the unplanned activities. Increasing the working hours allows for catching up with the agreed schedule which have a potential to delay the refinery start-up. Detailed planning and work experience are required to ensure the scope is right the first time as those who are not familiar with the specific activity might not be able to create a comprehensive scope of work which will impact on the schedule and cost increase of the turnaround.

The contract strategy was found to be one aspect which will assist the company from external service providers should there be a change in the turnaround, the contract strategy shall specify the relevant terms and conditions of the contract. Increasing turnaround cost is caused by the amount of deviations not managed as they create the increase in scope of the turnaround. Cost control mechanism allows the project management team to understand the cost of each activity and if they will be included in the turnaround work list if there were not budgeted. Risk assessment is another system that was found to be effective in analysing the risk of the activity during the scope challenge session, this allows the team to understand the impact of excluding the activity on the turnaround work list. Known unknowns are activities that are expected when a particular activity is done, they shall be included in the scope of work to measure their impact on the general scope. Managing deviation process is another activity which was found to be crucial to manage as they have a potential of increasing the work scope thus increasing the turnaround cost and delays the starting of the plant. Work culture was described by participants as the beliefs and attitude and are known which were generally accepted which may not be correct, has an impact of increasing the turnaround work scope as people can include any activity to the turnaround which can be done during the run.

CHAPTER 5 – DISCUSSION OF FINDINGS

5.1. Introduction

This chapter discusses the findings presented in Chapter 4. The purpose of the chapter is to evaluate the project management aspects within the refinery and focus on the impact of deviations on the start and execution of the turnaround, as well as identifying the contributing factors.

5.2. Review of general scope management questions

There were two themes that were discovered on the general scope management questions which includes the scope challenge and the statutory requirement.

5.2.1. Importance of challenging the turnaround worklist

The term challenge session emerged twice, which is one of the ways the turnaround work-scope is evaluated. The participants stated that the challenge sessions help to ensure that the work-scope that is presented on the turnaround is necessary for the turnaround. One participant defined optimising as reaching a landing of ensuring minimisation of the turnaround work scope, then they could optimise how to go about using resources in the shutdown or turnaround.

There were four participants that spoke about scope challenge as a way of optimising and minimising the turnaround work scope. One participant stated that the worklist is challenged by taking the equipment out of the turnaround that can be done on the run, meaning when the plant is in operation. Another participant stated that scope and schedule challenge are the two screening processes that optimise the worklist to ensure one does not get unnecessary items on the worklist. The above perception supports the motion by O'Brien and Amarra (2016) who stated the ways in which the availability and economics of a refinery can be enhanced through the introduction of a robust strategy in reducing turnaround work scope and schedule. These examples by O'Brien and Amarra (2016) include disciplined control of turnaround work scope, rescheduling work that does not consist of the turnaround objectives, either or other shutdown or when the plant is online and assessing the possibility of moving other units out of the turnaround. Examples by O'Brien and Amarra (2016) include proper planning and scheduling, adopting an appropriate work pattern for critical work, and integrate capital projects into the overall turnaround plan or schedule.

5.2.2. Importance of statutory inspections

The participants stated that the inspection department considers risk-based inspection which is used to minimise the number of unnecessary inspections of equipment included in the turnaround worklist which can be used to reduce the amount of statutory inspection. The above statement corroborates with O'Brien and Amarra (2016), where they stated that turnaround work scope optimisation increases asset availability through reduced downtime, it reduces maintenance activities through risk-based work selection.

The improper scope evaluation process is another contributing factor which impacts on the change in scope during turnaround. The participants mentioned "cold eye" or formal reviews, followed by Petronas, were all mentioned by four participants when benchmarking and evaluating the work-scope. In their context, they mentioned that Petronas reviews the turnaround work-scope and assists to ensure the turnaround is done successfully. The other term that surfaced twice was the statutory requirements, where a turnaround must be benchmarked against the Pressurised Equipment Regulation, which is found in the Occupational, Health and Safety Act. The above statement supports the view by Benaya (2007) who indicated that the turnaround work scope is generated from statutory or risk-based inspection (RBI) requirements, which includes requests from different disciplines that they send after identifying defects that cannot be done during normal running of the plant.

5.3. The impact of change in scope on turnaround schedule

Sasol (2020) defined additional scope as any work that is added or removed on the worklist after the scope freeze which includes late work, extra work, activity that is cancelled and any discovery work, which is supported by the participant who noted that work can only change by adding more work, or work is removed from the turnaround worklist. The participant stated that any changes in the scope of work after the scope freeze dates could impact on the critical path, thus extending the duration of the turnaround.

Another participant stated that scope can be removed, or in terms of unknown's items that emerges which is work that is discovered during the turnaround that needs to be added in the scope. The above statements correspond with Mhlanga, et al (2016), who stated that changes in scope might not be prevented in projects and could be because of inspections when opening

and cleaning the equipment and this could result in major cost and delays in a project and shall be managed and controlled closely (Mhlanga, et al., 2016).

Descoping is defined by Participant P7 as the removal of scope on the turnaround worklist, thus reducing the schedule while incurring cost of removal. Participant P7 stated the "*the term descope, its normally not an issue on the schedule specifically if it reduces the schedule. So, you can incur the cost but not a schedule impact in terms of the descope".* This terminology corresponds with the literature that defined descoping as part of the additional scope, additional work is defined by all activities added or cancelled after the scope freeze dates (Sasol, 2020). Sasol further stated that work, which was planned, and resource committed is known as cancelled work, which is another term for descoping (Sasol, 2020).

In the literature, the scope of work on the "theory of constrains" was known to be the driving variable where any changes in scope changes the other two "weak" variables, therefore the participants supported the triple constraints theory as adding new scope on the turnaround activities have a potential to increase the schedule of the turnaround if the changes affects the turnaround critical path.

The study presented that impact of change in scope during turnaround on schedule and this includes the compromise in the turnaround baseline schedule, planning for resources and the increase in the daily working manhours.

5.3.1. Compromises the baseline turnaround schedule

Meeting the targeted dates to start the plant is one of the measures in place to assess if the turnaround was successful. It is evident from the study, that some participants believed that the scope growth can consume the available float, while descoping can only impact on incurred cost, but not on schedule. Participant P4 expressed that changing the work scope can influence schedule, resource loading that might need to increase. Most of the respondents stated that changing the work-scope can increase the cost and schedule. Participant P2 stated four items that impact the schedule, the first one is the scope growth, the second one is the capability of the service providers, the third one is the occurrence of any safety issues, while the last one is the availability of resources. Two participants stated that the main issue is the sourcing of materials, as this could impact on the required labour. Participant P7 also stated that the scope growth is one of the aspects that impacts on schedule.

The above statement echoes Bevilacqua et al. (2012) sentiments that not able to properly conduct the turnaround scope of work can cause constraints on available resources which leads to schedule slippage and cost escalation which is as a result of emergent scope during execution (Bevilacqua, et al., 2012).

The theory is supported as any change in the driving variable which is the scope of work will compromise the turnaround schedule. Should the materials not be delivered on time, the turnaround schedule is compromised as the delivery may take longer than required at short notice. This case does not influence the driving variable however it affects the "weak" variable which is schedule thus may result to project failure should the materials be delivered later for activities which affects the turnaround critical path.

5.3.2. Impact on resource loading

Participant P4 stated that the undefined start dates become a nightmare to plan for, as it could mean there would be a new scope that keeps on coming and could increase the cost of the turnaround. Participant P2 stated that it is a behavioural issue that cause the changes in start dates. The above statements confirm Ertl (2015) who indicated that operations, maintenance, inspections, safety, and other departments give the inputs to the turnaround planning and, depending on the plant needs, the plant operations may give the turnaround scope within the last minutes of the turnaround.

Most of the participants mentioned that the continuous changes in start dates affect cost mostly, and one participant said, for example, once the dates changes and there are overseas specialists, they are then kept longer than budgeted for, thereby increasing the cost of the turnaround. Another participant stated that there would be a lot of standing time charged against the company when contractors stay longer than initially planned for. This resonates with Ertl (2015) who argued that when listing the contributing factors to turnaround scope changes as market conditions that varies all the time, which can cause a company to consider their budget when doing scope, start dates may change from the original schedule, which in turn may affect the decisions on what scope can be included, the ability to plan for the jobs or material availability.

According to the study resource loading affects the execution of the turnaround scope of work as the specialist may arrive late or be requested later if there was a need to source more people

when the scope is increase. Once the scope of work is affected, the "weak" variables of triple constrain may change such as the turnaround schedule which agrees with the theory of triple constrains.

5.3.3. Increase in daily working manhours

Five participants spoke about extended hours or longer hours and increasing the number of workforces, depending on the activity to makeup time that is fallen behind original plan. The term 'hot handover' emerged from two participants who stated that it is where one supervisor is handing over to another, one artesian is handing over to another one to ensure that there are no breaks between work. Two participants highlighted the number of progress meetings that take place during the turnaround, where the projects and their challenges are presented. During these meetings relevant management are available, which makes assistance be provided quick during turnaround. All the above statements support Watt's (2014) assertion that project managers use the activity called schedule crashing, which is the act of putting more resources on the critical path activities to complete the activities quickly. Watt (2014) defined schedule crashing as a process of adding more resources or move around some resources to bring the project schedule within line.

One participant spoke about different calendars in one turnaround, "*You find that for the critical path items will happen on a twenty-four-hour calendar and then other items will happen on the day shift calendar."* The activities that are on the critical path or those high impacted items would belong to the twenty-four-hour calendar and the other activities would be done on a day shift calendar. Participant P7 also gave three mechanisms that are used to bring a project within schedule, one is to do all the high schedule impact activities on a twenty-four-hour calendar, the other is to change the calendar from day shift to twenty-four-hour-hour shift and do what is called hot handover, the last one is to increase the number of manpower available.

The schedule crashing will reduce the amount of time to execute the turnaround however compromise quality if the same service providers do the job which may require rework after which will further increase the turnaround duration as it will affect the unit starting up. This statement agrees with the theory of triple constrains.

5.4. The impact of change in scope on turnaround cost

Removing scope during turnaround does not help the turnaround in terms of cost, as it is classified as additional scope (Sasol,2020), as the activities were included in the initial scope.

One participant viewed cost over-run as caused by deviations, scope creep and the use of inexperienced personnel, as this could cause the activities cost to be as twice the amount when an experience person does the job. This statement is supported by Sasol (2020) who noted that late work and extra work overloads the employees, which inherently incurs a cost premium and safety implications, thus suggesting the need to fast track when they are introduced (Sasol, 2020). Six participants mentioned deviations or changes in scope as the primary cause of cost over-run, especially when not managed in a proper way. This statement confirms with Schroeder's (2016) statement that about forty percent of turnarounds experience a cost over-run and schedule delays caused by poor scope control prior to the shutdown, high rates of added scope, or discovery work during execution, poor planning, and preparation, as well as unrealistic cost and schedule targets.

5.4.1. The impact of not planning and lack of experience during turnaround

One participant stated that "*Having to order the materials on P1 have a big impact on the cost"* and gave an example that it may happen that the materials were to be air frighted at one's leisure and now it must be air-frighted at high priority, that could add more cost in getting the material under emergency to meet the schedule. Participant P9 stated that *"labour rates during the turnaround period are much higher than labour rates during operating hours", therefore* adding new scope would require labour, thus increasing the cost of the turnaround. Most of the participants hinted on external labour or service providers doing the work. Participant P6 stated that the additional cost comes about using service providers, which, if the internal resources were doing the job, one would have fixed cost within the labour, thus maintaining or reducing the cost. Participant P4 stated that *"We measure it on that added additional work and we can show it as in variation order or by deviation, how much extra the cost is going to be."* The above statements are supported by Obiajunwa (2010) who also noted that scope of work is dynamic, therefore, an increase in scope may results in the increase in cost, but situations differ as the cost may overrun the budget as an outcome of extra resources or contract cost adjustments to cope with the emergent scope which was not considered during planning of the turnaround.

The theory suggested that cost is a "weak" variable of the triple constraints which does not necessarily impact on the turnaround successes. Wen not able to plan for the turnaround materials will affect the cost of the turnaround as more materials could be requested and not

utilised. Experience people are required to create the project scope of work which will assist in preventing the unknowns. Therefore, the use of inexperienced people to conduct the turnaround scope of work affects the project overall success as there might be "unknown unknowns" on the scope that are not catered for which will results in the increase in project or turnaround cost with affects the theory of triple constraints.

5.4.2. Contractual obligations

Participant P2 stated that it depends on how the contract is drawn out, if the turnaround specialist companies are doing the job, the late removal would be a disaster as they still pay the capital amount agreed up front. However, if done in-house, there are no additional costs. All the participants stated that the late removal of planned work will affect the turnaround cost, since, during execution phase, materials have been bought, service providers on board and removing the scope would not reverse the cost of materials or service providers. The above statement echoes Obiajunwa (2010) who posited that reducing the scope of the turnaround can be achieved by removing some activities from the turnaround worklist and that may give rise to a possibility of a shorter turnaround. Most of the participants believed that removal of scope during turnaround would impact on resources already scheduled, and cost implications will be felt.

5.4.3. Increase overall turnaround cost

Participant P4 stated that a top-down approach is used to give a high-level estimate of the turnaround, where it can be considered how much the turnaround is going to cost. He stated the *"once we know how much the actual contract is going to cost us, we get to a final ten percent estimate and from there we start controlling the actual budget because from an estimate it moves to a ten percent estimate, and it becomes a final budget."* The above statement corresponds with Obiajunwa (2010) when he argued that most turnaround managers plan for unknown scope using estimates of anticipated scope and put a contingency of about ten to fifteen percent for unanticipated jobs, as this could help to avoid turnaround cost overrun while monitoring the emergent jobs.

Participant P6 stated that *"contingencies, your escalation factors, are factors which you normally put to the cost estimate especially at Financial Investment Decision to make sure that you cover all the uncertainties in your scope."* Most of the participants stated that the deviation

committee is the overall decision maker where they consider the risk and cost, and then decide to add on to the scope. The statement by participant P6 supports the definition on "unknown unknown outlined by Lawrence (2012) when he mentioned that *"unknown unknowns"* are uncertainties that were never included in the project that might happened when the equipment is opened for inspection, and the estimator shall put aside the contingency cost that may cover the cost of repairing the equipment (Lawrence, 2012).

Participant P9 stated that "*If the project is viable and high priority, the return on investment justifies its inclusion.",* while Participant P2 stated that *"If the turnaround exceeds the budget, then we do a risk assessment, then we descope the work, it's all based on reviewing what's there and what is a risk if we are taking it off the turnaround and can it be done at another time, Can it be delayed for the next turnaround or can it be done from the next opportunity, it all based on risk assessment."* The above statement complements what Lenahan (2006) stated, that the scope could be quantified, should cost estimates measured to be greater than the allocated budget. One way to do this is to reduce the turnaround worklist or the complexity of certain tasks, or defer some tasks to a later date, or another planned outage.

Participant P4 stated that:

"The only time that a turnaround will be certain of the cost allocated to the turnaround is when they are done with the twenty percent cost estimate and then if you do come up with a new scope after that, then you have to go through via the deviation committee to justify in terms of the risk and cost and impact to the business if that project is not done."

The above statement supports Lenahan (2006) on the statement that an alternative of the above as to request the budget increase from the steering meeting where the turnaround manager motivates the importance of the worklist, should the above cannot be done, since in the same meeting, the budget will be approved.

Risk assessment is done to limit the number of additional activities, which, if not monitored, would create a situation which is not manageable and results in turnaround cost overrun. Three of the participants spoke about risk assessment and Participant P8 stated that "*Risk Assessments are done so that projects are then placed against each other in terms of risks, we also go and do intensive fitness for service, to see every item that we want really needs to be executed."* Participant P1 stated that challenge sessions are done to ensure that projects are completed

during turnarounds. Lenahan (2006) also stated that options could be explored to ensure the cost is within the budget which could be achieve by challenging the unit cost of the resources.

The increase of turnaround overall cost impacts on the project success as when the turnaround cost overruns, then the turnaround could fail which suggest that the theory of constraints is applicable.

5.4.4. Lack of controlling cost during turnaround

Emerging works were defined by the participants as work that comes when one opens the equipment for inspection. These activities are one of the leading contributors to the change in scope. On the other hand, Sasol (2020) indicate the difference scope growth into four such as late work, extra work, cancellation and discovery work (Sasol, 2020). The participants mentioned all four definitions, such as work that is not known prior to scope freeze dates, as well as an activity that was discovered during inspection. The major drivers contributing to these effects were labelled as competency, human behaviour, people not scoping from the beginning. One participant stated that the schedule and cost overrun depends on the quality of people brought during the turnaround, while other two stated that piping is more relevant in their department. One stated that not using historic data from previous turnaround to properly scope the work is another cause. A few of the participants highlighted the scope growth, unknowns, human capital issues, materials issues, overtime, late addition, and late identification of work, as some of the causes of cost and schedule overrun in their departments. The participants' opinions support what Hansen and Schroeder (2016) stated as causes of the negative aspects: the poor scope control prior to the shutdown, high rates of added scope or discovery work during execution, poor planning and preparation, and unrealistic cost and schedule targets.

Not controlling the cost by an effective project cost estimate may increase the overall cost of the turnaround which affects the overall project success, and the theory of constraints holds.

5.4.5. Impact of not conducting a risk assessment on turnaround activities

To prevent the continuous addition to the turnaround activities, the challenge session is introduced to assess their impact on the overall schedule and turnaround cost implications. Risk assessment was another determining factor to rate the worth of the scope where a risk of a

project is ranked, and it is the first thing that is done to see the importance of adding the job to the turnaround worklist. This statement corresponds with Asquini (2017) who indicated that the turnaround team shall start by minimising the risks with the highest impact and they would be added to, or subtracted from the list, based on the identification of new risks, mitigation of existing risks and the changing conditions (Asquini, 2017).

5.5. The contributory factors on the change in scope during turnaround

There are numerous reasons behind the change in scope during turnaround. The reasons range from the work experience of the people who conduct the scope of work, lack of awareness from the plant on continuous addition of scope of work, and the behavioural issue during turnaround. One participant stated that there are only two subsets for any scope addition during turnaround project, which is scope growth and new scope. The new scope was defined as an item that broke down during the shutdown. One participant stated that they classify scope addition as deviations that comes before the turnaround and new scope that comes between freezing the worklist and starting of the turnaround. The contributing factors of late additions that were mentioned by participants range from people not properly inspecting the plant on time, not affording enough time in the planning and preparation to do detailed planning. These contributing factors align with what AMACS (2017) stated as common issues that impact the shortfall of work scope strategy which includes the scope of work with limited turnaround aspects such as unplanned scope addition, continuous addition of the scope after the scope freeze dates and not able to conduct and effective decision-making on time, limited available materials and equipment, and the scope of work which does not conform to the objectives of the turnaround (AMACS, 2017).

The measures in place to reduce cost over-run during turnaround were stated by the participants as the level of skills, experience, and detailed scope. One participant stated that "*to have a very strong technical team that evaluates every recommendation."* Participant P5 stated that using internal resources would help in reducing cost over-run. Four participants indicated proper or detailed planning as one of the measures that could reduce cost over-run during the turnaround. Participant P3 stated that the measure in place is to control and reduce scope changes by management of any deviations. Participant 4 stated that there is a contingency of 10% in place to cater for any deviations. Oberlender (2000) supported the above statement when he stated that the foundation of the success of the turnaround is related to an effective work scope and it

relates to performance, then reducing the cost, schedule parameters will see the success of the turnaround while ensuring the plan is reliable.

5.5.1. Impact of known unknowns during turnaround

The participants believed that minor scopes are not put forward to the turnaround worklist where no one assessed the impact of each activity, some may affect the critical path. The contributing factors were highlighted: when one does not consider the known unknowns properly during the planning and scheduling phase. This statement corresponds with what Hussain (2012) listed as the main causes of scope creep in a project which includes ignorance from key stakeholders until the project has started. Another issue includes the execution of a project years of study completion and scope definitions. The issue of scope definitions created by wrong people or people with insufficient knowledge, unrealistic targets regarding the outcomes of the project and the data were not enough when the scope was defined. The other factors defined by Hussain (2012) were bad management of project changes, the absence of scope management and control systems, the focus on major scope changes and ignore minor changes that could impact the turnaround objectives. Most of the participants stated that unauthorised work happens all the time during the turnaround, while one participant stated that it can be managed through contingency. One participant stated that only items with low risk and minor impacts are done without being registered. However, no one takes the risk of not registering the scope, should a project risk come out to be high and its impact also high. One participant stated that the only reason a person may do work without registering it is because of the person's understanding of the processes to follow, to enable them to continue with the job.

The "known unknowns" and the "unknowns unknows" are the variables that the participants suggested affects the turnaround cost as these changes in scope are not expected. This changes in scope affect both the turnaround cost and the schedule of the turnaround, therefore the triple constraints theory holds.

5.4.2. Binding turnaround service contracts

One participant stated that statutory requirements are legal requirements that are needed to ensure compliance with the Pressured Equipment Regulation. The term statutory requirement appeared six times from all the participants, with the majority agreeing that it is one of the main

drivers of the turnaround work-scope, followed by equipment integrity. This statement complements what Pevehouse (2015) stated; equipment that needs to be in the turnaround work list shall include the regulatory compliance items, equipment that cannot be taken off during the running of the plant, equipment that has reached the end of service life, and those that are due to inspections.

Some participants mentioned four drivers such as safety, quality, and schedule as the main drivers of turnaround work scope, while one mentioned cost and compliance as last part of the drivers. Breakdown or jobs that cannot be done on the run were mentioned by two participants. Participant P8 stated that their concern is only legal requirement: *"ours is to ensure legal compliance. We cannot compromise legal requirement for us to save money or shorten the turnaround. Statutory requirement which is led by the OHS Act is what drives us."*

Participant P4 stated that the entire turnaround is based and managed from cost point of view and stated that "*remember from the time you start your long-term schedule, you are looking at cost, from the time you start procuring your long lead items you started listing cost and schedule."* The above statement relates to Schroeder (2016) who indicated that about forty percent of turnarounds experience a cost overrun and schedule delay, the causes of these being the poor scope control, higher rates of added work scope, poor planning, preparation and unrealistic cost and schedule targets. Schroeder (2016) is supported by Obiajunwa (2010) who also posited that most of the turnaround scope are planned for unknown scope using estimates of anticipated scope and put a contingency of about ten to fifteen percent of unanticipated jobs, which could help to avoid cost overrun.

Participant P7 stated that the biggest cost in the turnaround is the labour, which falls between 30 to 40 percent of the cost. This concurs with Participant P9 who stated that "*The first thing that must have a lot of deliberation and challenge, is the labour."* Participant P7 stated that cost is not what is considered most, but schedule is what is mostly managed during turnaround.

The binging turnaround contract affect the schedule and cost, as during the removal of the activities on the turnaround worklist, the service provider may be paid full amount for the activities that were not done which increase the wasteful expenditure of the turnaround thus affecting the turnaround success. The triple constraints theory holds as any changes affect the other two variables.

5.5.3. Impact of mismanagement of the deviation process

The use of historical data allows the turnaround team to understand the lessons learnt from previous project and use them to improve the technical requirements and safety aspects of the new project to ensure mistakes are not carried to the new project. This statement was evident when Participant P9 states that the planning process shall include the use of historic database to understand what was achieved from the previous turnaround, and how to improve on the next. Participant P9 and others believed that poor planning is another contributing factor affecting the turnaround scope. This aligns with Sasol (2020) who noted that all disciplines shall be given an equal opportunity to identify their scope for considerations, consider previous turnaround work, and only work that cannot be done outside turnaround to be considered, and that can be done outside turnaround to be taken out of the turnaround worklist (Sasol, 2020).

The use of previous turnaround information, when used correctly, could prevent the change in scope, as the historical recommendations would be used to benchmark the turnaround. This is supported by Sahoo (2013), arguing that using reliable data helps in preparation for the turnaround and would improve the planning and scheduling efficiency using historical data obtained from SAP Database on previous turnarounds.

Most of the participants defined scope growth as the item that was registered on the frozen worklist, then, when doing the job, one discovers that they must do more than anticipated. They defined the new scope as the scope not registered on the frozen worklist, which brings new dimensions on the turnaround worklist. These definitions correspond with Kelly (2006) and Sasol's (2020) definitions of several types of additional work. Kelly (2006) stated that extra work is an activity that was not considered for turnaround by the planning teams and shall be recorded on a separate worklist (Kelly, 2006).

Most of the participants stated that there is a deviation procedure that is used to add new scope after the freeze dates, where the multidisciplinary team assesses the project risk and cost estimates and follow a formal documentation where the cost and risk will determine the level of approval. The statement agrees with Obiajunwa (2010) which spoke about establishing a procedure to control additional work which could improve the management of unexpected work more efficiently as it could need an approval before any change is completed as the procedure will reduce the time to approve the unexpected work.

The mismanagement of the deviation process affects the "weak" variables of the triple constraints theory which are schedule and cost. The addition of new activities on the turnaround worklist may affect the critical path or increase the turnaround overall cost, thus affecting the project success.

5.5.4. Impact of work culture during turnaround

The findings of the study revealed that work culture has a great impact on turnaround scope management, which can be negative or positive. Most participants described work culture as the attitude, behaviour and worth ethics of individuals during turnaround. To give an example, participant P4 states different cultural mindset where people include all the activities on the turnaround worklist which might not be listed on the final turnaround worklist. Participant P6 stated that some individual during turnaround displays an unprecedented behaviour where they intentionally delay the turnaround, while participant P5 complaints about the work ethics of many individuals who delays some activities with the purpose of staying longer to make more money out of the turnaround. On the other hand, participant P7 stated that work culture is driven by management where employees are encouraged to bring forward any threats within the organisation such as visible leaks, defective equipment and other issues to be reported so that the maintenance team could repair on time.

What the participants raised as the impact of work culture during turnaround was supported on literature by Ghazali et al. (2014) when they describe work culture as activities during turnaround which are performed by individuals from different companies which may have different work ethics. Ghazali et al. (2014) supported the participants and mention that work culture is crucial in fostering teamwork, and it comprise of ideas, experiences, attitudes, values, beliefs of all the individuals who are part of the turnaround. Ghazali and Shamim (2014) supported the participants views and mentioned that work culture is one of the social dimensions the company needs to put focus on to ensuring all individuals work together to ensure the turnaround is successful as it focuses on peoples' values and their work ethics.

The work culture affects the delivery of the required results which may affect the project or turnaround scope of work. Therefore affecting the scope of work impacts on the theory of triple constraints, thus affecting the project success or failure.

5.6. Chapter Summary

In summary, this chapter discussed the findings of the research study and compared it to the literature review outlined in chapter 2. These findings revealed that the change in scope during the turnaround has a negative impact on the cost and schedule of the turnaround. The change in scope compromises the turnaround schedule and it impacts on resource planning and increase in daily activities. The change in scope on turnaround cost is impacted when contractual services are underutilised and cancellation of scheduled work.

The discussion of the results was tested against the “Theory of Constraints” which held true for all the findings. The turnaround scope of work was known to be the major driving variable where any change may cause the project to succeed or fail.

CHAPTER 6 – CONCLUSIONS AND RECOMMENDATIONS

6.1. Introduction

The conclusions and recommendations of the study are presented in this chapter. The study evaluated the impact of scope changes in turnaround schedule and cost in the oil refinery industry. The study used the qualitative method, whereby respondents were selected based on their experience in the petrochemical industry. Data was collected using semi-structured interviews. This chapter concludes the research process and seeks to consolidate the findings of the research, providing a deep understanding of the impact and implications of scope changes during the turnaround, and offer future research recommendations.

6.2. Summary findings of the study

This research intended to qualitatively explore the impact of change in scope on turnaround schedule, cost, and the contributing factors on change in scope after the scope freeze dates and during turnaround at Engen Refinery. The researcher sought to establish insights on the Engen's ways of conducting the turnaround and how they complement the global standards of doing the turnaround. The principal findings for this research are presented as shown on the next section.

6.2.1. The impact of change in scope on turnaround schedule

The key findings on the impact of changing work scope on turnaround schedule included two factors, which are the resource loading and the increasing working hours. Resource loading is one of the factors that is affected when changing the work scope, which affects the material delivery and the availability of resources. Participants stated that the turnaround is a labour intense activity which requires diverse skills to undertake the turnaround activities. The participants emphasised the availability of required human capital such as specialist personnel as they are booked weeks before the start of the actual turnaround. Changing the turnaround work scope by adding activities affects the overall schedule of the turnaround as the service provider may have not prepared to add other personnel to assist at short notice, therefore exhaustion will kick in which impact the quality of the overall product thus compromising the turnaround schedule as there will be reworks which are found during start-up of the plant. Resource loading includes the material delivery, when there is a change in scope which requires the additional resources on the critical path activities will delay start-up of the plant. Material deliveries have a waiting period which might be longer than the turnaround duration which will

require more time to be put in place to allow for delivery. Participants emphasised the need for proper planning which will

Increasing the working hours for specialist service providers where they never prepared to put additional personnel as the lack of planning for additional scope compromise the turnaround schedule.

Increasing the scope of work will impact the turnaround schedule if one specialist service provider does many activities at the fixed schedule. This will cause the turnaround to be delayed as the service provider may not be able to complete the specific task at have, which may lead to exhaustion thus not able to complete the required task. The change in scope affects quality is the schedule is fixed and compromise the turnaround duration due to rework, thus causing the turnaround failure.

as human capital is determined by the task at hand, then changing the scope can affect that resource. Resource loading includes the distribution of materials, which is affected when changing the scope of work. Material delivery differs on the type of equipment, and some requires to be air freighted to minimise the time travelling time.

The professionals from the refinery highlighted that emergent work is one of the factors that contribute to schedule increase during the turnaround. The increased scope may put new dimensions in the previous scope as it could require more resources and time to complete thus increase schedule. Descoping was also mentioned, however, it is one factor that does not impact much on cost, but on reducing the turnaround duration. Descoping may impact on the cost since the materials may already be prepared for the scope, therefore the cost of not doing the job may be one factor that needs to be considered and should the job be needed at the later stage, the job may impact on organising the resources the following time. The service provider such as specialised vendors would be affected as they may have already committed on a particular scope and changing it may depend on the contractual agreement.

The float was identified as one of the measures in place to ensure the scope can be completed on schedule, with less cost. Management should consider putting more float in the schedule of the activities on the critical path to mitigate the delays that could contribute to increasing resources that would add more cost for the specific scope. Selecting qualified personnel to make a scope would ensure there are few unknowns and limit the amount of scope growths in

the turnarounds and that would ensure there is a right number and quality of human capital required for a specific task.

When a schedule of a specific activity is behind, adding extra labour increases the cost of the turnaround, thus reducing the schedule of the task. However, it assists in ensuring the refinery does not lose more operational costs as a day delay in starting the plant cost millions of rands. Additional labour has limits in terms of completion of the task, therefore, to achieve meaningful results during turnaround, using the twenty-four-hour calendar and use hot handover which enables one team to complete a task and handover to another team, without a break in the activities and that would ensure the task is within schedule.

6.2.2. The impact of change in scope on turnaround cost

The element that impacts costs when changing the work scope are defined by Engen Refinery Maintenance Professionals as deviations caused by lack of planning, committed resources, risk assessment and competency in human capital. Engen professionals explained that the cost of the turnaround depends highly on the human capital employed and the number of deviations raised during the turnaround. Deviations includes new scope, scope growth and descoping the task from the turnaround worklist. Each activity on the deviation has an impact on cost. The competency in human capital is one of the causes of cost overrun during turnaround, as human skills have a major factor in doing a successful turnaround. In most cases in the refinery, new scope and scope growths are normally done during the turnaround and are the major contributors to cost overrun.

The other aspect that was raised by the participants is the late removal of scope from the turnaround worklist. The later removal of turnaround activities contributes to waste as there could be committed resources including specialised service providers, specialised tools that may be required to complete the task and may include containers, cranes, and hotels. Late removal of turnaround activities could cause the company to incur cost such as callout fees of specialist service providers who were requested to be part of the turnaround. Late removal of the turnaround activities may assist a turnaround team to achieve an early handover time for the turnaround, however this action could impact on the quality of work done on the turnaround.

A process of a deviation was rated as one of the factors to measure the cost of adding a scope after the freeze dates. The causes include eclipsing the contingency amount, engaging third parties to scope or work that can be done inhouse and not managing scope growths. The measures in place to ensure the cost is kept under control includes using a challenge session to cut down work that can be done on the run and using a ten percent cost estimates to ensure one does not go beyond the budgeted amount. Use of top-down approach will be beneficial where one look at the overall amount of how much the turnaround may cost, which includes using historic data, and work until finer defined costs.

Risk assessment is a system of assessing the risk of a project that will assist management to make informed decisions to fund and add a scope on a turnaround worklist together with a cost estimate, and justification of a deviation.

6.2.3. The contributing factors on the change in scope after the scope freeze dates and during the turnaround

The exploration of the contributing factors to the change in scope was done. Most of the respondents believed that the lack of scope creation, which results from inexperienced personnel conducting a turnaround scope, is one of the contributing factors. They felt that experienced and knowledgeable personnel must conduct the scope of work. The respondents believed that the lack of understanding creates a situation where people see all activities as important as those on the turnaround worklist, as they look at the activities in the plant maintenance perspective. The participants indicated that the “known unknowns” and “unknown unknowns” are the major contributors to change in scope during turnaround as there is little control to estimate them.

The findings of the research indicated that the elements that influence the scope change during turnaround on cost and schedule are the use of historic data, deviations, statutory requirements, unqualified human capital, etc., these findings are discussed in the subsection below.

First the research has confirmed that formal education in project management may assist professionals to understand the project management requirements and use on the job training to practice the skills they learnt in school. It was confirmed that cold eye review is necessary after turnaround work-scope is completed, which will assist in ensuring that the scope is challenged by external auditors from Petronas. Statutory requirements were on the top of the

list as the main driver for turnaround, followed using historic data to benchmark the turnaround work-scope.

The contributing factors to changing the scope during the turnaround were indicated by the participants as human factors, deviations, overtime, and reworks. Human capital is one of the most important resources during the turnaround, as they could make the turnaround succeed or fail. Human capital controls the material usage and contributes to overtime, which is another factor that increases cost overrun during turnaround. Most participants stated that competency, skills, and experience of human capital are the main contributors in the change of the work scope, with one participant noting that not using historic data also contributes. The contributing factors for changing the work scope were defined to be known unknowns which add to cost, and schedule overrun, managing them using deviations could assist in ensuring they come down. Teaching turnaround role players how to add new scope during turnaround could ensure that there are no scope creeps during the turnaround.

Another factor that was stated was adding of new scope during turnaround, where the deviation process is followed. Adding new scope may be due to people bringing new scope late, re-evaluation of the project risk, ongoing maintenance programme and human capital not doing their job. Risk assessment is done as part of the deviation process to evaluate the risk of the new scope that needs to be added, should the risk and impact of the scope be high, management would add to the scope. However, should the risk be lower, management could request the job to be done on the next turnaround, or when the opportunity comes. The company culture could also impact in addition of new scope, as people are requested to be vigilant when walking the plant, should they see anything that could put the company at risk, they must report.

6.3. Conclusion of the study

In conclusion of objective one, the impact of changing the scope during turnaround on schedule contributed on few factors listed. The change in scope was presented to impact on the resource loading as there is no proper way to plan for new resources when the scope changes and no compromises the distribution of materials. The human capital was a major contributor as some activities could be added into the scope which compromises on the already committed resources. Material delivery becomes an issue as there is not enough time to source long lead items at later stages, which compromises the quality of materials thus impacting on the schedule as there might me rework. Emergent work impacts on the turnaround schedule as

work was schedule for a specific time, while working on that equipment, there is a discovery of extra work which could require more time to be done correctly, therefore adding more time on the existing turnaround schedule. The scope needs to be clearly defined to prevent change in schedule therefore competent personnel are required to conduct the scope on time. During the turnaround, there will be a need to commit most of the resources on the activities that affect the critical path in order to ensure the plant is delivered to operations, therefore working on the twenty-four-hour period and committing resources on the critical activities will assist in ensuring the turnaround is delivered on time.

Inconclusion of objective two, the impact of changing the scope during turnaround on the cost of the turnaround were contributed by multiple factors. These factors include deviations, committed resources, risk assessment and competency in people conducting the scope. Deviations is the broad term which presents the changes in the turnaround scope, such as addition of new scope, scope growth and descoping the task from the turnaround worklist. These deviations create enormous pressure to the turnaround team as they are not able to plan for, they as they already committed funds to plan for the turnaround. Human skills were found to be major contributors to scope which leads to the increase in turnaround cost. Engen Refinery personnel stated that the removal of scope on the turnaround worklist contributes to wasteful expenditure which the company may not be able to recover. There is a deviation process which Engen Refinery turnaround team use, however the continuous addition of unregistered scope into the turnaround highly contributes to cost increase as there are activities which utilises the turnaround resources such as materials and people.

Inconclusion of objective 3, the contributing factors to change in scope on turnaround after the freeze dates and during turnaround includes scope created by an incompetent person, the company culture towards turnaround and deviations. When people who are not competent on the specific activity or without relevant knowledge conducting the scope of work will create an incomplete scope which while may overlook the important part of the scope. The scope which is not clearly defined allows people to discover things which could have been included during scope creation which adds on the scope growth on that activity which will impact on schedule and cost. The scope which is not clearly defined promotes reworks and preventable overtimes. The company culture was highlighted as another contributing factor as it promotes Engine employees to instruct the turnaround team to conduct specific activities even when they

not part of the registered scope. This could impact on cost and schedule increase as these personnel would have been focusing on the activities listed in the turnaround.

6.4. Implication of the study

The study was done to raise awareness to the petrochemical industries and other industries that undergoes turnaround on the impact of changing the work scope during the turnaround and their contributing factors. The issues related to the study were established as they relate to the change in scope and their impact on the turnaround schedule and cost in the Oil Refinery Industry. It was discovered that the technical personnel focus during the turnaround is to ensure that the plant equipment is in good working condition and can last until the next turnaround and little concerns with the cost implications of their activities. This was evidenced by the work culture displayed by personnel during turnaround which allows maintenance personnel to dictate which activities can be added in the turnaround worklist.

The study discussed the impact of changing the scope of work on the schedule and cost of the turnaround, where the themes were used to formulate an overall sense of the data. The impact of the overall study, when changing the scope, includes compromising the turnaround baseline schedule which is a measure of the turnaround success. The study indicated that change could result in payment of contractual fees when the scope is removed from the turnaround worklist. The study confirmed that the turnaround rates are higher and once services providers arrive onsite, they start billing, including any hired materials such as scaffolding.

The study revealed that the impact of changing scope on turnaround cost is felt by the payment of contractual fees which were supposed to work, and scope removed, and the scope addition increases the overall turnaround cost. The contributing factors include known unknowns, the lack of planning and management of turnaround deviations. The study indicated that not having a professional background limited one from understanding the basic concepts of project management.

6.5. Recommendations

The findings of this research highlighted the need for management to consider them when conducting the turnaround, for it to be successful the first time.

6.5.1. Invest in skill development and formal education

Management needs to ensure that all the project role players need to undergo the formal training to understand the project management principles to help them improve efficiency in conducting the project. This allows the turnaround role player to quickly understand and adapt with handling the turnaround, as well as understanding the risks related to conducting a turnaround.

6.5.2. Acquire competent personnel for critical turnaround work

Management needs to acquire competent human capital to lead the turnaround and each department ought to have a competent person who would approve and guide the department project work scopes. This enables the department to minimise the number of scope growth, known unknowns and prevent any emergent work to surface during the turnaround or after the scope freeze dates. Competent person will be able to guide and approve the departmental scope, and that could assist in knowing the number of resources needed for the turnaround for their department.

The competent personnel will assist the turnaround team to provide good quality job and avoid reworks which may be done during the turnaround start-up.

6.5.3. Outline the required work culture during the turnaround period

Wok culture was defined to relates to beliefs, attitudes, experiences and work ethics of people participating in the turnaround, there for management shall display the procedures and hold meetings of what is required during the turnaround to ensure everyone is aligned with the overall turnaround plan. Supervision shall ensure every personnel abides to the company procedures and ensure everyone displays good work ethics and their attitude is in the right place.

Management shall ensure they encourage the employees to report any integrity issues which may affect the plant start up and give rewards where due to encourage all employees to participant in ensuring the turnaround is successful without and health and safety issues.

Management needs to educate their staff to poses right attitude in relation to what needs to be done during turnaround and what cannot be done, for example a supervisor can direct any turnaround personnel to do a specific task without registering the scope. Educating all

personnel in leadership positions would enhance the skills of the maintenance and turnaround team to understand the impact of adding a scope during turnaround.

In summarising the recommendations, the impact of changing scope may not be felt by the maintenance team, as their focus is on ensuring the plant equipment are in good condition. However, with training and development, they would understand the importance of their actions when adding scope on the turnaround worklist. Continuous development of the company personnel is more critical in ensuring the turnaround is completed successfully, while education and training of the team about the company culture would assist in ensuring people understand the importance of bringing forward any plant threats.

6.6. Limitations of the study

The interviews were initially planned to be conducted in person, however there was a change due to the restrictions that were put in place during the Covid-19 pandemic. The limitations of the research were identified on the above section which includes:

- The study is limited by focusing on several experienced individuals (their views in relation to maintenance and turnaround) within the petrochemical industry, which is Engen Petroleum Refinery.
- The study is also limited to turnaround scope and at changes towards and during the turnaround, and no other aspects of the project management principles which add value on achieving the turnaround objectives.
- The researcher did the study during the Covid-19 Pandemic, where movements were limited thus the researcher was not able to meet in person for the interviews.
- A purposive sample was used when selecting a sample, which suggests that the study findings cannot be extended to the entire population. Therefore, the findings that were obtained cannot be generalised to other Petrochemical Industries, but these are specific for Engen Refinery.
- The study was constrained to the Maintenance and Turnaround department. The study excluded the other Refinery Department such as Process, Operations, Finance etc.
- When selecting a sample, the Researcher only included Professionals from Engen Refinery with the Petrochemical experience and holding a leading role within the company. The study did not include every professional in the Refinery.

6.7. Areas of further studies

The study focused on the impact of changing the scope of work on schedule and cost of the turnaround and their contribution factors. The same study could be done on Engineering, Procurement, Construction and Management (EPCM) companies to assess the impact of changing scope on the cost and schedule of a project. The study could be extended outside turnaround and explore the impact of the change in scope on other project management principles. The study could be assessed to understand other departments' point of views on the impact of change in scope such as finance, operations, safety, etc. The study was confined to Engen Refinery, the same study can be extended to find the comparisons between other Petrochemical Industries in South Africa. The same study could be done for an individual project or turnaround activity to test the triple constraints theory for project success or failure when the customer or stakeholders initiate the change in scope, taking into considerations the definition of scope change in this study. The study could be done to assess the quality of work when increasing the number of hours in order to crash the turnaround schedule.

6.8. Summary of chapter

The findings of the three main research areas were discussed in this chapter. The data was analysed using the sources indicated in the literature review and the questionnaire to be able to present the findings. The conclusion presented the themes that stood out and their impact on turnaround success. The implications of the study were discussed which presented the impact in change in scope after the scope freeze dates impacts on the turnaround overall cost and compromises the schedule. There were three main recommendations that were presented in this section. The chapter highlighted the limitations faces when conducting this study and the areas of further studies.

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APPENDIX 1: INTERVIEW CONSENT LETTER

Informed Consent Letter 3C

UNIVERSITY OF KWAZULU-NATAL
GRADUATE SCHOOL OF BUSINESS AND LEADERSHIP

MBA Research Project
Researcher: Sphamandla Gordon Mkhwanazi [redacted]
Supervisor: Dr Christopher Chikandiwa ([redacted]
Research Office: HSSREC Research Office details (031 260 8350/3587/4557)

Dear Respondent,

I, S'phamandla Gordon Mkhwanazi a MBA student, at the Graduate School of Business and Leadership, of the University of KwaZulu-Natal. You are invited to participate in a research project entitled: *"The impact of scope changes on turnaround schedule and cost in the Oil Refinery Industry"*. The main aim for this study is to investigate the turnaround processes in relation to work scope and scope change and how it impacts on schedule and cost. The study will establish the project management processes at are used in the refinery to find the contributing factors to scope change during turnaround.

Through your participation, I hope to explore the impact of scope changes on turnaround schedule and cost and be able to make the organisation aware of the contributing factors to scope changes.
Your participation in this project is voluntary. You may refuse to participate or withdraw from the project at any time with no negative consequence. There will be no monetary gain from participating in this interview. Confidentiality and anonymity of records identifying you as a participant will be maintained by the Graduate School of Business and Leadership, UKZN.

If you have any questions or concerns about participating in the interview or about participating in this study, you may contact me or my supervisor at the numbers listed above.

The interview should take about 45 minutes to an hour. I hope you will take the time to participate.
Sincerely

Investigator's signature_____ Date_____

This page is to be retained by the participant

UNIVERSITY OF KWAZULU-NATAL

GRADUATE SCHOOL OF BUSINESS AND LEADERSHIP

MBA Research Project
Researcher: Sphamandla Gordon Mkhwanazi [redacted]
Supervisor: Dr Christopher Chikandiwa ([redacted]
Research Office: HSSREC Research Office (031 260 3587/3587/4557)

CONSENT

I.....(full names of participant) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project.

I understand that I am at liberty to withdraw from the project at any time, should I so desire.

I hereby consent/do not consent to record the interview.

SIGNATURE OF PARTICIPANT DATE

.....

APPENDIX 2: INTERVIEW QUESTIONS FORMAT

INTERVIEW QUESTION

Personal details questions for statistical purpose

1. Which department do you belong too, and which position do you hold in the organisation?
2. Do you have a formal background in project management?
3. How long have you been working in the petrochemical industry?
4. How many turnarounds have you been actively involved in and your role during turnaround?

General scope management questions

1. Does having a formal background in project management influence the way project management are conducted in your organisation?
2. How do you or your department benchmark and evaluate your turnaround work scope?
3. What methods do you use to optimise and minimise turnaround work scope? How effective are these methods?
4. What are the drivers of turnaround work scope in your department?
5. What percentage of your turnarounds, do you feel are managed tightly from a cost and schedule perspective? What do you feel we could do differently to improve this?

Research Question 1: What is the impact of change in scope on schedule during turnaround?

1. How does changing the work scope influence the turnaround schedule?
2. What aspects of changing work scope impacts schedule in your department and how do you ensure they do not impact on the critical path schedule?
3. What systems are available to make up time on the schedule of a project once it's fallen behind its original plan?
4. How does undefined or continuous changes in start dates impact on your turnaround deliveries especially in relation to schedule and cost? How often does this happen in your organisation?

Research Question 2: What is the impact of change in scope on cost during turnaround?

1. What are the causes and measures in place to reduce cost overrun during turnaround?
2. How does the late removal of the planned turnaround work scope affect the cost?
3. What are the cost implications of adding a new scope after the scope freeze dates, and how is this measured?
4. What measures are in place to ensure turnaround cost is kept under control during the project life cycle?
5. When turnaround work scope and cost estimates are completed, what strategies do you normally use to ensure your projects are included in a turnaround should the work scope exceed the allocated budget?

Research Question 3: What are the contributing factors on the change in scope after the scope freeze dates and during turnaround?

1. What are the major contributors to changing work scope during turnaround?
2. How do you classify late work addition and what are the contributing factors of late addition of new scope during turnaround?
3. What are the major contributors of schedule and cost overrun when conducting turnaround projects and which are applicable in your department?
4. The concept of scope creep is defined as the unauthorised addition of new scope during the project. How often are you faced with this concept and what are the factors that contributes to this concept during turnaround?
5. What processes are followed to add a new scope to the turnaround after the scope freeze dates?
6. What is your view on the difference between scope growth and scope addition and what are the major drivers contributing to these effects?
7. Does organisational culture contribute to increase work scope, and if so, how?

APPENDIX 3: ETHICAL CLEARANCE LETTER FROM UKZN

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

10 December 2020

Mr S'Phamandla Gordon Mkhwanazi (207512151)
Grad School of Bus & Leadership
Westville Campus

Dear Mr Mkhwanazi,

Protocol reference number: HSSREC/00002096/2020
Project title: The impact of scope changes on turnaround schedule and cost in the Oil Refinery Industry
Degree: Masters

Approval Notification – Expedited Application

This letter serves to notify you that your application received on 26 October 2020 in connection with the above, was reviewed by the Humanities and Social Sciences Research Ethics Committee (HSSREC) and the protocol has been granted **FULL APPROVAL** on the following condition:

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number. PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

This approval is valid until 10 December 2021.
To ensure uninterrupted approval of this study beyond the approval expiry date, a progress report must be submitted to the Research Office on the appropriate form 2 - 3 months before the expiry date. A close-out report to be submitted when study is finished.

All research conducted during the COVID-19 period must adhere to the national and UKZN guidelines.

HSSREC is registered with the South African National Research Ethics Council (REC-040414-040).

Yours sincerely,

[redacted]

Professor Dipane Hlalele (Chair)

/dd