Application of Change-Based Project Management Approach in Maintenance Repair and Overhaul (MRO) Projects

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Thesis Abstract

This research effort creates a new approach of Change-Based Project Management (CBPM), derived from Complex Adaptive Systems (CAS) theory, which offers a unique approach for the management of Maintenance Repair and Overhaul (MRO) projects in heavy industry. It is postulated that this approach could be considered a suitable method for managing these types of projects as compared to traditional plan-based methods or conventional Agile methods.

The Literature Review section of this research has a topical study of prevalent literature and trends in project management. A Systematic Literature Review identifies key gaps in the prevalent knowledge, namely the insufficient academic attention towards maintenance and repair projects, no observed study of maintenance projects using modern project management methods, and a strong industry-specific bias towards project management approach with modern methods primarily used in IT, software and product development and not in heavy industry. The systematic review, therefore, helps frame the research problem within the research landscape.

A review of Complex Adaptive Systems literature offers a theoretical basis for the new project management approach. The primary contribution is the proposed Change-Based Project Management (CBPM) approach, which relies on treating MRO projects as Complex Adaptive Systems. The research elaborates the contextual circumstances under which this approach may be expected to yield results on product delivery and project team satisfaction. A conceptual framework for the CBPM framework is presented on these lines.

Empirical testing takes the form of qualitative interviews with leaders and project teams in an organisation that has succeeded through more flexible project management techniques. The behaviours, practices and perceived outcomes support the theoretical framework and identify the key features of CBPM as autonomy, adaptability and accountability, summarized as a 'Triple 'A' mechanism for CBPM success.

Framework Analysis has been deployed for data analysis of both interview and case study data. Empirical findings have been used in a feedback loop to improve the conceptual framework (that had originally been created from theory) and present it in its final form. Management insights from data are presented as propositions which pave the way for future research to validate them.

The main contributions are (1) creation of a new Change Based Project Management approach, (2) the construction and validation of a Conceptual Framework for CBPM implementation, and (3) the 'Triple-A' mechanism (Autonomy, Adaptability, and Accountability) for successful CBPM implementation.

Key Words

project management ; change-based project management ; plan-based project management ; complex adaptive systems ; MRO projects ; Oil and gas ; upstream oil and gas ; systematic literature review ; agile ; complexity theory ; project plans ; conceptual framework ; drilling industry ; dynamic environment ; emergent scope ; case study ; semi-structured interviews ; participant observation method ; qualitative ; self-organising ; engaged scholarship ; documentation in projects ;

Dearest dad…I know you are watching.

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I will forever be grateful to my mom, not only for bringing me into the world, but for providing me with the perfect childhood. Her sacrifices have made me the person I am today, and I am sure she will read every page of this thesis, as moms do…

I signed up for this research degree in the month after my son was born. Everyone called me crazy as fatherhood, work, and my other hobbies were already being considered as an overwhelming drain on my time. Yet, his presence in my life has made me even more determined to not only be a good father, but a role model... and to show him that the difficulty of achieving a dream should never be an impediment to your pursuit of it.

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1. Introduction

Traditional plan-based project management techniques focus on avoiding changes to enable a predictable project lifecycle (Vinekar et al, 2006). The attempt is to generate a robust model of how the project will be executed, based on extensive planning prior to project commencement. The interface of scopes of work is attempted to be modelled, typically using a project plan, PERT, GANTT or other modelling techniques. Changes are considered detrimental to the execution of this baseline model (Saynisch, 2010) (Böhle et al, 2015) and require a comprehensive change management process that leads to amendments against the baseline model which, due to the importance given to this baseline, must go through management review and approval (PMBOK, 2017). Planned reviews where approval is sought to move to the next stage of the project, commonly referred to as Stage-Gates (Cooper, 1990), are usually deployed. Stakeholder engagement plans are also drawn, with stakeholders, including customers, appraised of project progress against the baselines in a pre-determined communication protocol (PMBOK, 2017). Industry standards on project management, historically, follow this project management methodology and project managers and teams around the world seek certification against these standards to showcase their abilities and competency (Chin and Spowage, 2010) (Geraldi et al, 2011). But are these methods suitable for all types of projects?

Maintenance, Repair and Overhaul (MRO) projects in heavy industry asset management tend to have a high degree of complexity (Boonstra and Reezigt, 2023)(Maylor et al, 2013)(Brady and Davies, 2014)(Maylor and Turner, 2017)(Morcov et al, 2020), because equipment condition is often only fully known when the equipment is stripped down during the project, and so the scope can only be pre-planned to a limited extent. As various such equipment and systems with emergent scopes interact with each other, the complexity becomes significant at the project level. This makes plan-based project management, even though prevalent in the industry, a really difficult choice for managing such projects. So, what options do practitioners have when dealing with such projects?

While less change-averse project management methods like Agile Project Management (Beck et al, 2001), have been around for a while now, most of the literature and application of these has been restricted to the software and product development industries (Cooper, 2016) and only recently rebranded as tools for broader application (Rigby et al, 2016). Williams and Cockburn (2003). This is because the focus of these methods has been on iterative development, which is not a workable fit for MRO projects, as iterative methods are best suited for new product development and not repair/overhaul/maintenance. In IT and software development, the iterative approach allows you to develop and review working copies of code and/or product at the end of each iteration, pacing the way for change management and improvement for the next iteration. Due to the nature of maintenance work, breaking a system or equipment repair into an iterative approach is not feasible because working product cannot be realized till the entire repair is completed. So, can agile methods be adapted to suit MRO projects that do not allow for iterative development?

This research effort is an attempt to answer all of the above questions. While all projects entail an element of uncertainty, in complex projects where the uncertainty affects multiple interconnected scopes and management aspects, the use of plan-based methods becomes unsuitable. MRO projects, as argued in this research, are such types of complex projects. In this research effort, MRO projects will be explored through the lens of Complexity Theory, suggesting that the management structures of these types of projects are better suited to be considered as Complex Adaptive Systems (CAS) than management structures with linear causality. Thus, a project management system that treats, sets up and allows MRO projects to behave like Complex Adaptive Systems could be considered a suitable

method for managing such projects. With this theoretical grounding, it will be discussed that in order to allow the project/system to have the requisite adaptability, a new project management approach called Change-Based Project Management is more suitable than a regimented plan-based one.

1.1. Research Question

The primary research question is: How can complex, non-iterative projects be managed with acceptance rather than avoidance of inevitable change?

In order to answer the research question, the following steps are taken:

1. Theory building: Conceptualize Change-Based Project Management as the suitable approach for managing non-iterative complex projects in certain contexts and develop a conceptual link between MRO projects and Change-Based Project Management through the lens of Complex Adaptive Systems.
2. Data collection: Qualitatively observe and study Upstream Oil and Gas MRO projects in a case study organisation where Change-Based Project Management principles are being deployed, and interview key personnel in the organisation.
3. Analysis: Analyse the data to validate and improve the conceptual framework showing how the Change-Based Project Management approach could be used to manage MRO projects.

1.2. Contributions

The contributions of the research effort to the academic and business community are:

1.2.1. Change-Based Project Management approach

This research effort creates a new approach of Change-Based Project Management, derived from Complex Adaptive Systems (CAS) theory, which has elements in common to other project management approaches but offers a unique approach applicable in identified contexts.

1.2.2. Conceptual Framework

This research effort constructs and validates a conceptual framework for the implementation of Change-Based Project Management approach for managing MRO projects, derived from literature, and validated and improved through empirical evidence.

1.2.3. Triple-A mechanism

This research effort postulates that the key mechanisms facilitating success in the Change-Based Project Management approach is end-to-end Accountability, which enables projects to behave like complex Adaptive systems by allowing self-organising behaviour and Autonomous management within set boundaries. Not only is this a contribution to the theory, because it explains the

mechanisms showing why CBPM should work and not just what it is and how it is conceptualized, but also a contribution to practice because it distils the framework into three key recommendations.

1.3 Research Overview

In this research effort, an organisation was identified in which a CBPM approach has been in use. The research focused on providing a theoretical explanation for its success and a more formal definition of practices that should comprise the CBPM approach. Using the organisation as the research setting, one in which this approach has been adopted but not clearly defined, helps this research effort document what CBPM is, how it works based on evidence from the research setting and why it works through connection to theory.

To address the research question, a qualitative method was used, with an organisation as a case study that was purposively sampled and two embedded cases of projects that were observed. Qualitative research is used to understand how and why the approach works, rather than to quantitatively test performance. However, a comparison of CBPM against plan driven project management is explored through the experience and perspectives of interviewees in this organisation compared with others, in order to understand the factors contributing to perceived success. While this perceived success of the studied organisation's project management team is quantified by them in terms of performance against budgeted time and cost (elaborated in Section 2.7), the research methodology also focussed on the qualitative aspects of how the projects were managed and how those could be studied by speaking to the employees and observing their interactions. Therefore, the methodology applied for this research effort has been on qualitative lines, not because the quantitative success metrics were overly simplistic, but because the research question requires qualitative richness to truly answer it.

The Research Overview is outlined in Figure 1, and will subsequently be discussed in greater detail in the Methodology Chapter 5

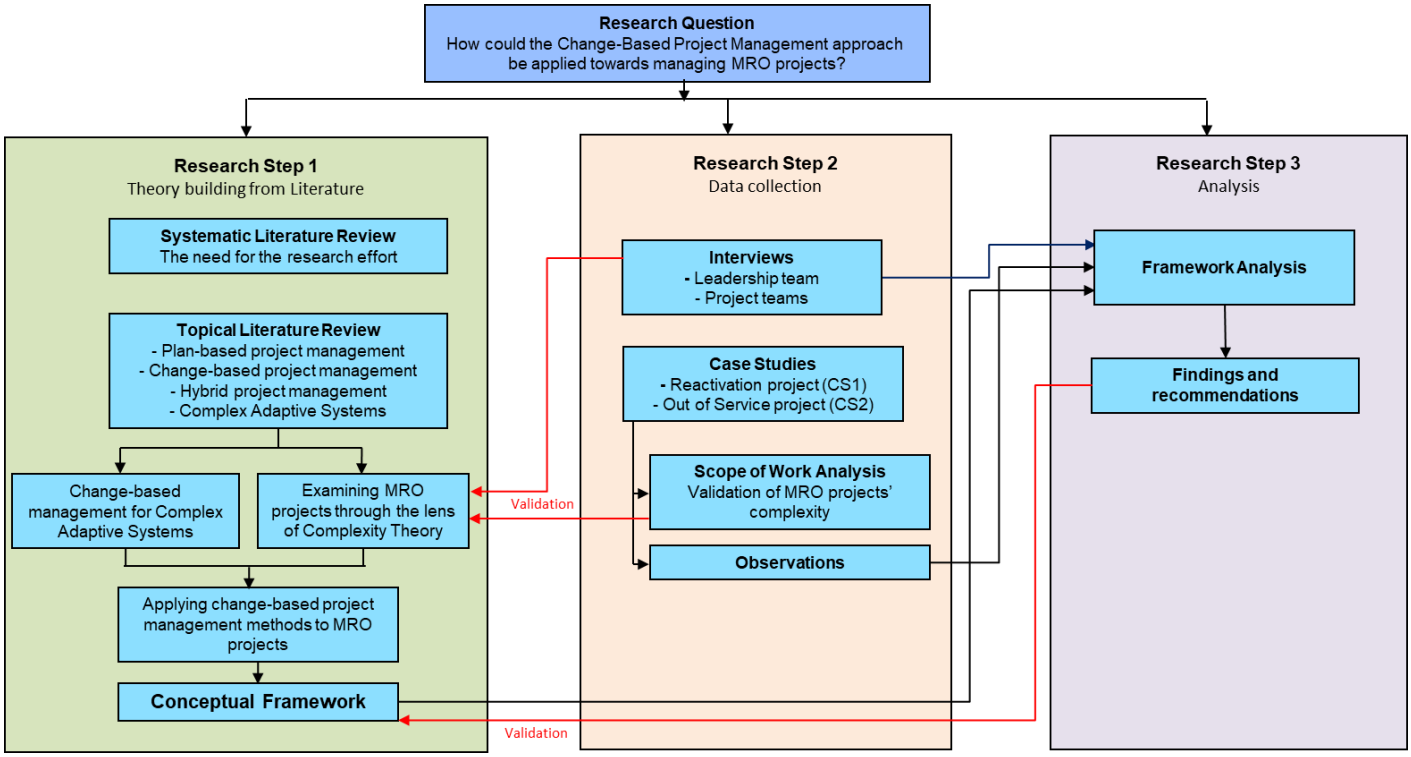


Fig 1. Research Overview

2. Background and Industrial Context

2.1. Overview of Upstream Oil and Gas MRO Projects

The Oil and Gas industry consists of two divisions – Upstream and Downstream (Salazar-Aramayo et al, 2013). The Upstream division consists of exploration, development and production of oil and gas fields, while the Downstream division consists of the storage, refinement, treatment, distribution, and monetization of the hydrocarbon produce. In this research, the author will take up the case of Upstream MRO drilling rig projects as he believes they are a good representation of the management challenges that MRO projects face.

2.2. Upstream Industry Players

The upstream Oil and Gas industry typically has the following players. Figure 2 illustrates the working arrangement on a rig site between them.

Operators: These are the companies/individuals who have the rights to drill on a certain piece of offshore or onshore land and lease out various services for the same. Some of the largest and most profitable companies in the world fall under this category e.g. Aramco, Chevron, ExxonMobil, ENI etc. The operator is typically responsible for the overall development of a field or program, and carry out (either themselves or via contractors) all the preparations before drilling is to commence e.g. seismic surveys, pipeline and infrastructure setup, regulatory approvals, well engineering and design, well material procurement etc.

Drilling Contractor: These are the companies/individuals that typically own and operate drilling rigs (sometimes the owner will hand over the rig operations to a dedicated service company). Drilling rigs are typically hired by Operators on a day-rate basis, for carrying out activities based on a well program designed by the Operator. The Drilling Contractor is responsible for providing the drilling rig asset in good condition and compliant with all applicable (industry, regulatory, customer) requirements, and for manning the rig with personnel who are proficient at running the rig and carrying out the drilling activities. These include crew who work on the drilling floor, marine crew for moving the rig and managing crew material, safety crew, maintenance crew, catering crew, radio operator, doctor, and rig management.

There are some projects where drilling contractors will be hired on lump-sum or turn-key contracts, but the typical model of the industry is based on day-rate contracting. This model is set up so that the drilling contractor will get paid the agreed rate (on a pro-rata basis) for all the time the rig is able to carry out the planned activities. If equipment breaks down, or if human error causes a delay, that is considered non-productive time and has commercial penalties. This model also means that whenever a drilling contractor must take a rig to shipyard for major maintenance or upgrades, this project has a significant commercial impact on the contractor's business as the rig is not generating revenue in the yard, while the costs for people and maintenance are continuing to rack up. This is the reason why rig maintenance projects have such a high focus in the industry because it is critical to the drilling contractor's business outcomes.

Service companies: The Operator will also hire 3rd party companies to work on the drilling rig for various aspects of the well construction that the drilling contractor typically does not handle. These include cementing services, handling of specific tubulars, using sophisticated down-hole tools while

drilling, managing the chemical composition of drilling fluids, and running logs on the well for data during and after drilling.

Service companies are usually hired on call-out basis by the operator, and their personnel typically don't stay on board once their specific job is complete.

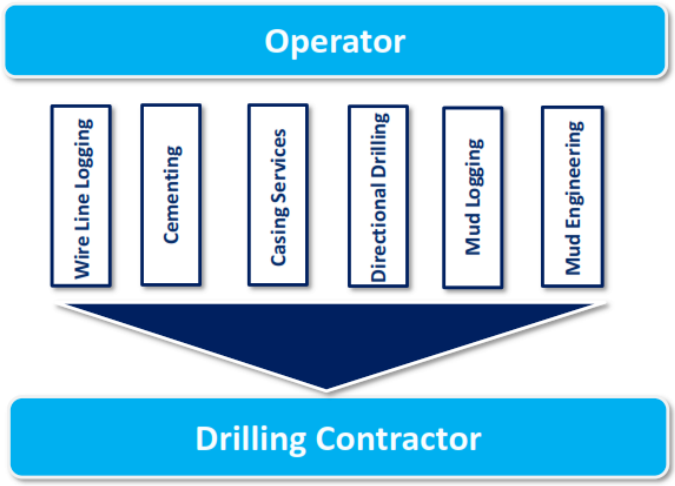


Figure 2. Upstream Oil and Gas Drilling relationship model

(Source: Studied Organisation investor presentation)

2.3. Drilling Rigs

Drilling rigs are facilities built and designed for working on oil and gas wells. Drilling rigs are usually deployed for carrying out oil and gas exploration, development, workover, and abandonment operations, and have equipment and personnel specific to those activities. Lately, drilling rigs are also being used for carbon capture and storage purposes. There are primarily 4 types of drilling rigs:

Land rigs – designed for operating on land. They are usually mobile and move from well to well using ground transport. They can vary from smaller, truck mounted units, to larger units requiring a comprehensive mobilization and rig-up/rig-down process.

Swamp rigs – designed for operating in very shallow waters and swamps. The equipment is either mounted on shallow draft boats or, more frequently, shallow draft barges. They typically operate in water depths < 3m, and in locations where currents are not very high.

Jack-Up rigs – designed for operating offshore, Jack-Up rigs are seaworthy vessels, where the hull is elevated on tall legs, which are planted on the seabed. Drilling activities are carried out with the hull elevated out of the water, and the legs are pulled up for moving the rig between drilling locations. Jack-Up rigs have several sub-types, including Independent Leg Cantilever (ILC) Jack-ups, mat-supported Jack-Ups, and self-propelled Jack-Ups. Jack-Up units are designed for operating in water depths ranging from 3 meters to 150 meters.

Floating rigs – designed for operating offshore, in deeper waters. These rigs perform their drilling activities while afloat, either using a mooring arrangement or using a Dynamic Positioning system (with thrusters). Floating rig hull designs are usually pontoon-based (called semi-submersible rigs) or ship-based (called Drillships). The largest semi-submersible rig is capable of operating in 10,000ft water depth, while the current generation of Drillships are designed for operating in 12,000ft water depth.

Fig 3: Land rig

(Source: NOV.com)

Fig 4: Swamp rig

(Source: litewellservices.com)

Fig 5: Jack-Up Rig

Fig 6: Drill-Ship (floating rig)

(Source: rigzone.com)

2.4. Drilling Rig components

Drilling rigs have various components, all of which serve a purpose, and all of which require maintenance and upkeep:

1. Hull – upkeep is governed by rules laid out by marine classification societies, and usually entails a steel thickness inspection every 5 years, along with an underwater inspection every 2.5 years of the submerged parts of the rig (the legs for jackups, and the submerged hull for floating rigs)
2. Derrick/Mast – this is tall structure erected above the hole through which drilling is done. It is via this that the drilling string (the pipe that connects to the drill bit) is pulled and run into the drilling hole. On land rigs, and sometimes on swamp rigs, the derrick can be rigged down for ease of transport. On Jack-ups and floating rigs, the derrick is usually permanently erected and has extensive equipment, cabling and piping in it.
3. Drilling Equipment – this is the heavy equipment (winches, pumps, sheave clusters etc) specific to the drilling operation. These are the most important part of any rig, and their construction and maintenance is governed by industry standards, with the standards by the American Petroleum Institute (API) being the most widely used. Drilling equipment usually requires a major inspection (strip-down and non-destructive testing, following by changeout of components that fail inspection, before reassembly and commissioning) every 5 years, unless otherwise specified by the equipment manufacturer (referred as OEM – Original Equipment Manufacturer).
4. Marine equipment – this is the equipment and systems for marine operations on the rigs e.g. cranes, helidecks, ballast control system, preloading system etc. as well as the equipment required for rig moves and positioning e.g. anchors, anchor winches, thrusters etc. Marine equipment usually requires a major inspection every 5 years, again recommended usually by API and OEM standards.
5. Power Generation – most rigs are powered by diesel engines on board. Maintenance on engines is usually on a time-based schedule linked to engine running hours, as recommended by the engines' OEM. Rigs usually also have an Emergency Generator, which is designed to be used if the main engines black out, and has key lifesaving equipment powered up from it.
6. Well Control equipment: While drilling, the primary means of preventing the uncontrolled flow of combustible hydrocarbons out of the well (called a 'blowout') is a column of heavy fluid (called 'drilling mud') maintained in the hole, with a designed hydrostatic pressure more than the pressures in the hydrocarbon carrying sub-surface zone. However, if this primary means of controlling the well fails, there are several control options available, which fall under the category of Well Control equipment. The most important part of well control equipment is called a Blow Out Preventer (BOP), which is a series of valves directly above the wellbore, designed to be closed if the primary well control method has failed. BOPs are rated for holding up to 20,000psi pressure and are the most safety-critical equipment on the rig, with extensive manufacturing, testing, maintenance, operational testing, and major overhaul requirements outlined by API and OEMs. Typically, BOPs need to be overhauled every 5 years, while some operators even insist on doing it every 3 years. There are other components of the well control system that support the BOPs and help gain control back of the well, and all of these also follow similar manufacturing, maintenance and testing regimes.

7. Safety Equipment – includes firefighting equipment, lifesaving equipment (lifeboats, liferafts etc.), DROPS measures etc. Due to the nature of the equipment and the criticality for personnel and asset safety, these usually require a major inspection at one- or two-year intervals. There are several industry and international marine standards that set the standards for safety equipment.
8. Living Quarters – rigs, especially offshore rigs, have accommodation on board for the personnel working on the rig. Living quarters are typically housed inside a large steel structural block, and have living rooms, recreational areas, offices, and a galley. The living quarters on drillships can house up to 220 people. Living quarters require a dedicated housekeeping and catering team during operations, and will often require maintenance of flooring, galley equipment, air conditioning system etc. during major maintenance projects. Also, living quarters are sometimes refurbished due to their aesthetics and not necessarily only due to integrity concerns.
9. Support Equipment – all other support equipment e.g. compressors, pumps, communication, and IT equipment etc. to support the operations on the rigs.

2.5. Drilling Rig Projects

For rig operators, a rig asset management project is when a rig is taken to a shipyard or standby location to carry out maintenance, repair and/or upgrades to the rig equipment/systems. These projects can be planned (in cases of scheduled major maintenance or contractual upgrades), unplanned (in cases of catastrophic failures) or opportunistic (when a rig is purchase and a project needs to be done immediately due to the rig's condition and/or contract requirements). The other type of activity considered a project for drilling contractors is a Newbuild project, where a rig is built from scratch. The focus of this research effort is MRO projects, and not Newbuilds.

Within the MRO projects for drilling contractors, there are two different types: Out Of Service (OOS) projects, where a working rig is taken out of service for a maintenance project; and Reactivations, where a rig has been idle and cold-stacked, with no maintenance being done on it, and needs to be brought back into service. More details of the intricacies of these two types of MRO projects can be found in the Case Study Data Chapter 6.

As mentioned earlier in this chapter, from a business perspective, an MRO project is of high importance as the rig is not earning revenue during the project, and funds are being spent on the scope of work and rig operating cost. On-time and on-budget delivery, completion of all targeted scopes of work, and a smooth customer acceptance process are key success metrics for most MRO projects in this context. Due to the above business pressures, there is a tendency in the industry towards planning the projects extensively and having robust systems and processes for change control in place, so that the projects can go as per the plan. However, the projects almost never go to plan due to a plethora of internal and external complexities. Some the internal and external contextual uncertainties (Hu et al, 2013) seen in MRO projects are:

2.5.1 Internal uncertainties

By their very nature, inspection based major maintenance scopes are unpredictable. As the inspection is only commenced during the project, when the rig has been taken out of

service, the repair scope can only be known once the project has commenced. This has impact on cost, time, resources et al.

Several rig systems are inter-dependent, and therefore the scope performance on one system can have non-linear and complex interactions with other equipment and systems, leading to inefficiencies in following a set plan.

Resources during the project are limited, and the same team-members are usually working on multiple scopes of work at the same time. As those scopes experience changes and evolve, the team members constantly need to re-shuffle priorities, time, and resources.

While equipment and systems are being worked on, unexpected failures are common. While the same failures can also happen during operations, customers are usually open to quick-fix solutions during operations but require certified and exhaustive repairs when the rig is out of service and undergoing a maintenance project.

2.5.2 External uncertainties

For executing most of the scopes, the project management team is reliant on the shipyard and other vendors who will execute the scope of work. While their performance is monitored and feedback regularly given, there is not too much that can be done if the vendor's performance is not as originally envisioned.

The scope of work requires procurement of parts and equipment from external parties. Lead times, production delays, supply chain disruptions, strikes, pandemics, damage during freight, delays in freight vessels etc. are some of the multitudes of ways where procurement efforts can derail and originally well-crafted plan.

Shipyard projects require physical interaction between the asset (the drilling rig) and personnel on the ground. Situations where movement gets restricted (e.g. the COVID-19 pandemic) can significantly affect the execution of projects in Shipyards because of movement and physical interaction restrictions.

2.6. The Case Study Organisation

The studied organisation is a drilling contractor that was formed in 2012, as a private-equity funded spin-off of a larger company's Jack-up rig business. The leadership of the company, from the time of company inception, outlined a strategy of the company being a pure-play Jack-up operator, with no intention of diversifying the asset holding and operations into land or deeper water drilling. The rationale behind this strategic move, as mentioned by the company's executive team in public forums, has been:

- Managing multiple asset types in the industry is not easy within the same organisation. Over the past 15 years, all large offshore drilling contractors, apart from two, who had multi-asset business models have decided to specialize in either shallow water (Jack-up) or deepwater (Drillships and Semi-submersibles). The technological and management

requirements for the two asset types are quite different, which makes it hard to set up a management system that can handle both.

- Dayrates of deepwater assets are typically much higher than Jack-ups, by a factor of 4X-10X. The deepwater assets also have a higher operating cost. So, if a company was managing multiple asset types under the same umbrella, most of the management decisions tend to favour the deepwater side of the business due to its significantly higher impact, per asset, on the business. When maintenance standards, fleet strategy, vendor strategy, management setup etc. all start being biased towards the deepwater business, it negatively impacts the efficiency of the Jack-up business.
- By focusing on one asset type, a more 'fit for purpose' and focused organisation and management structure can be formed, instead of a diversified one. This allows streamlining of business decisions towards Jack-up efficiency, leads to an easier to execute supply chain strategy, helps with managing employee skillsets and training requirements, leads to synergies and cost advantages, and allows for more technical innovations focused on the single asset type.

During the period of 2015-2021, a large majority of offshore drilling contractors went into bankruptcy proceedings due to the prolonged downturn in the industry. While being grounded in a highly cyclic commodity in oil and gas (Fig 7), the offshore drilling contractor business has historically been debt-fueled and asset-heavy, which led several companies to severe liquidity challenges and inability to service debt during a prolonged downturn.

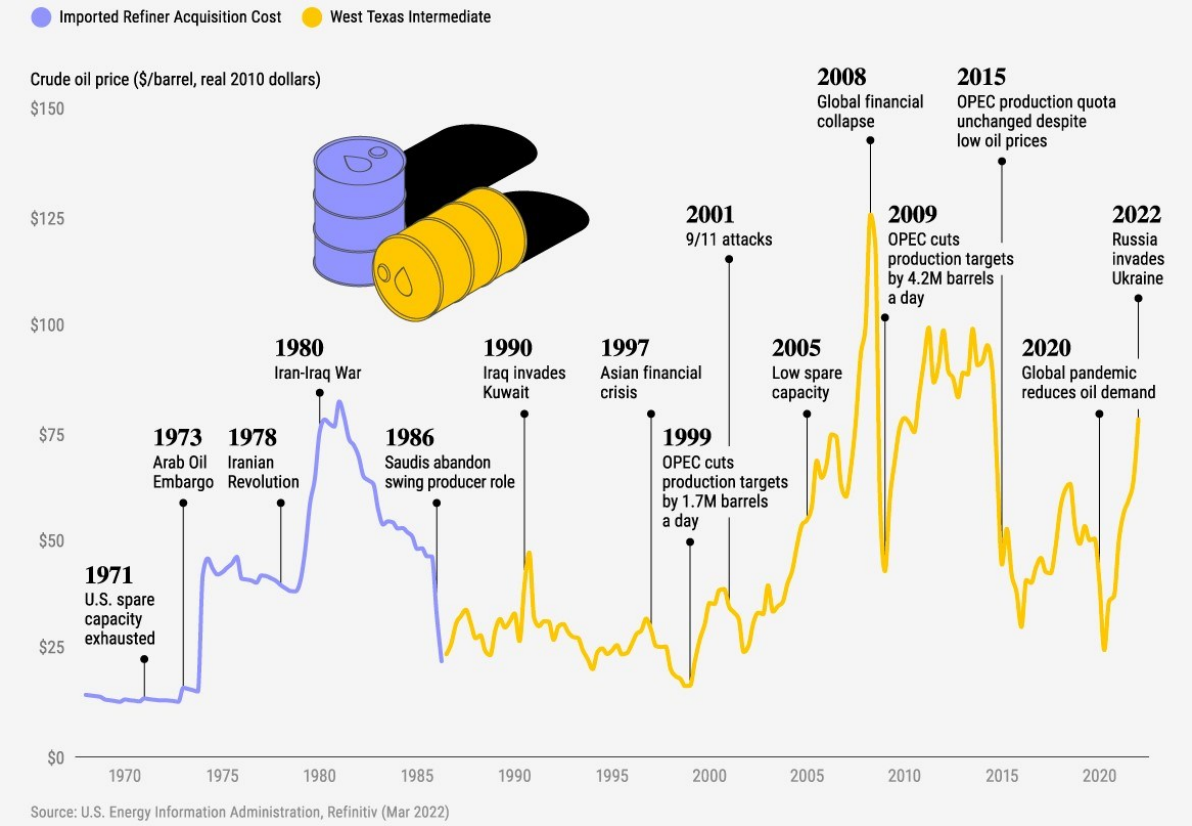


Fig 7: Crude oil price history

The studied organisation was one of the few international offshore drilling contractors that managed to avoid bankruptcy and maintained a healthy balance sheet during the downturn. So, even though the stock price (the company is listed on the Norwegian exchange) has meant significant capital erosion for investors, they still have a robust investor base because the company is deemed to have had good performance since inception, thanks to a stable leadership team, cost discipline, a good marketing strategy focused on longer term relationships with National Oil Companies (NOCs), a performance based culture in operations, strong project management performance, and opportunistic use of capital markets for maintaining a healthy balance sheet.

2.7. Project Management in the case study organisation

The Project Management team in the studied organisation was conceptualized, at company inception in 2012, to be materially different to the typical project management setup in drilling contractors at the time. This was fuelled by the key insight that drilling rig MRO projects, which was the primary responsibility of the project management team, will inevitably have changes. So, instead of setting up the management structure to try and achieve the seemingly impossible vision of a no-change project (which was the prevalent industry discourse then, and even now), the management structure should be designed to embrace and react to change at a rapid pace so that the outcome can be controlled. This led to several strategic decisions, which will become apparent as the data from the research is presented. While doing this research, it was interesting to note that the project management setup in the organisation seems to have been envisioned based on lived experiences of the organisational leaders and without much reverence given to typical guidelines like PMBOK or Agile Project Management.

During the data collection for this research effort, most of the interviewees had heard of the PMI and traditional project management methods, and the practitioners (project team) understandably had more knowledge of its principles compared to executive leadership. They recurrent theme amongst interviewees who were familiar with the PMI model was that it is a good theoretical construct and guidance, especially on the planning aspect of projects. But there was consensus that it is very hard to implement in practice in MRO projects' execution phase. Amongst the interviewees, only one leader (VPT) was familiar with the concepts behind Agile Project management, and he mentioned that while the agile approach was much more suited to the drilling industry MRO projects, he was of the firm opinion that it should be understood at a first principles level and not made prescriptive, else it stops being agile.

The project management function at the studied organisation has been an unequivocal success. Since company inception in 2012, as of the end of 2023, the studied organisation's project group had executed 68 projects worth $1.556 Billion, with an average outcome which was 4% ahead of planned time and 3.9% ahead of budgeted cost. While there is no industry body that compiles and publishes comparative project management performance within the industry, the researcher anecdotally knows that this is amongst the best, if not the top, project management performance in the industry.

As Mason (2002) puts it, qualitative research should be formulated around an intellectual puzzle – that is, something which the researcher wishes to explain. Having previously experienced project management in other organisations in the offshore drilling space and then being a part of the studied

organisation's project management team since company formation, the researcher witnessed this difference in approach and the positive results it brought. This prompted this research effort, as a way of formally understanding the management system and underlying theory that could help explain the success of this project management method which the company formed intuitively.

The problem this research effort tries to address is to bring to light the contextual challenges leading to failure of MRO projects managed with plan-based methods, and to develop theoretical grounds for understanding why the studied organisation's project management system has performed well in that business setting. The research motivation is, therefore, to explain why the different project management approach works in the studied organisation so that industry and academia could benefit from it. In doing so, the research presents a formal explanation of what CBPM is, how it can be applied to MRO projects and why it can be successful.

3. Literature Review

3.1 Overview

This chapter starts with a review of the definition of project management based on available literature (Section 3.2). This is followed by a Systematic Literature Review (Section 3.3) on relevant project management literature to study the trends in the field and identify pertinent knowledge gaps that this research effort can help address. Then, there is a review of some of the key tenets and learnings from previous research efforts and industry literature on traditional project management methods (Section 3.4). Complexity in project management (Section 3.5) is discussed to demonstrate how traditional project management methods can be inadequate in complex projects, leading to a discussion on modern project management methods are open to changes (Section 3.6). The differences between traditional and modern approaches in summarized in Table 6, where the context of application and the key tenets are highlighted. The Literature Review culminates with the theoretical concept of Complex Adaptive Systems (Section 3.7) and the key aspects such systems are expected to have, leading to the generation of Table 7 (an expansion of Table 6)

The aim of carrying out the Literature Review was threefold: Firstly, the Systematic Literature Review helps frame the research problem within the landscape of existing research discourse, and shows how a clear knowledge gap is being addressed through this research effort; Secondly, the topical Literature Review helps to summarize the key aspects and considerations on the relevant topics for this research, and helps build familiarity with the ongoing discourse on them; Thirdly, the topical literature review leads to the discovery of the contextual need for Change-Based Project Management and establishes the theoretical grounding for the approach. This lays the foundation for the conceptual framework for the application of Change-based Project Management to MRO projects (Chapter 4).

3.2 Project Management

The most popular industry definition of a project is the one endorsed by the Project Management Institute in the 'A Guide to the Project Management Body of Knowledge' (Project Management Institute, 2017), commonly known as PMBOK: ***A project is a temporary endeavour undertaken to create a unique product, service, or result.*** While there are other ways of defining projects in the literature, the above is a good representation as it successfully captures the key aspects of projects, namely that projects are temporary and not continuous, and have a distinct desired outcome (Lensges et al, 2018). These outcomes, often, are of immense importance to organisations, and the success or failure of projects can lead to existential problems for companies (Bloch et al, 2012).

There has been over six decades of research into project management (Padalkar et al, 2016), yet project management practice currently takes a largely normative approach, with the implementation of industry standards and bodies of knowledge considered to be the means to achieving good project performance (Geraldi et al, 2011). While the definition of project success remains a complex concept (Ciric et al, 2022) with multiple dimensions of interrogation possible, failure rates amongst projects when gauged against typical metrics of cost and time remain a problem, with studies showing that on average projects run over-budget and over-schedule, regardless of industrial context (Pace, 2019) (Merrow, 2011) (AIPM and KPMG, 2020) (Standish Group, 2015) (Wellingtone Ltd, 2024). The need for research on project management is, therefore, obvious, and there are journals dedicated to the same. Over the years, the management of projects has been studied (Crawford 2005) (Thamhain et al, 1977) (Malgonde

et al, 2014) to be influenced by project characteristics like size, duration, geographical location, complexity, uncertainty, level of risk, timeline pressures, the desired end product of the project, and how well the scope is defined. Cicmil et al (2006) argue, what is needed to improve project management in practice is not more research on what should be done or the frequency and/or use of traditional project management practices; instead, a research approach that takes seriously practitioner's lived experience of projects could help us find out more about the ''actuality'' of project-based working and management. There has also been research on the effect on project management by internal organisational factors like management support, project manager empowerment, organisational structure, accountability, and resource allocation, and external factors like socio-political context.

In recent years, the advent of change-based project management methods like Agile have gained popularity in the software industry (Alyatma, 2021), and to a lesser extent in other industries (Fig 8), and these methods are now recognized and addressed by the PMBOK. Research (Youker, 1999) (Crawford, 2005) also indicates that while industry sector is commonly linked to project management methodology, there is merit in looking at the management of projects across industries based on desired outcomes and similarity of the final product, and not just based on similarity of industry.

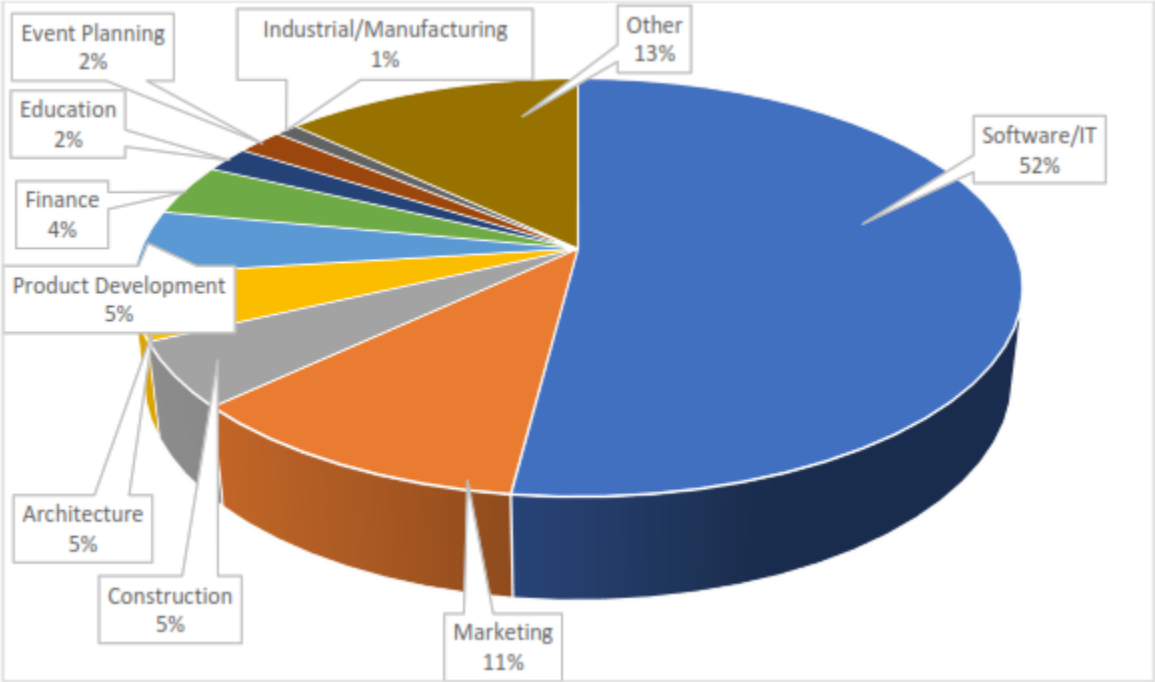


Fig 8: Trends in Agile Project Management usage by Industry (Alyatma, 2021)

3.3 Systematic Literature Review

A Systematic Literature Review was carried out on relevant research in project management journals, to get a snapshot of the current state of research in the field and carry out a rigorous analysis of available literature (Cronin et al, 2008) to identify gaps in the current knowledge. It was important to

carry out the systematic review to analyse the research done in the proposed research area, and to validate the academic need for the research effort outside of industrial context. The process followed was as prescribed by Kitchenham and Charters (2007).

As will be discussed later in the chapter, the differences between modern project management methods that are open to changes (e.g. Agile) and Change-Based Project Management are necessitated by the context and type of projects. Since the Change-Based Project Management terminology is being developed in this research effort and was not going to be readily found in the available literature, for the purpose of the Systematic Literature Review the contextual differences were put aside and the larger body of work (covering Agile and other modern methods open to changes) was clubbed under the change based project management approach categorization.

The search was limited to the following journals. While there has been an ample amount of literature reviewed from non-project management journals in this research effort, the focus in the Systematic Review was kept on Project Management journals in order to get an accurate representation of the state of relevant research in the field, without potential adulteration of data from tangential research in other fields like operations research. Primary Source for papers was via SCOPUS.

- International Journal of Managing Projects in Business
- International Journal of Project Management
- Project Management Journal
- Journal of Modern Project Management
- International Journal of Project Organisation and Management

The Systematic Review was carried out using the following steps:

- Step 1: Key words were identified based on the potential for the highest quality of relevant results in the research area. As the research is about the applicability of change-based methods in a space that otherwise does not deploy these methods, the aim was to find existing research covering certain project types, management methods and theoretical basis. It is hard to balance scale and quality - words that are too generic (e.g. complex) can give too many irrelevant results, while words that are too specific (e.g. change based project management) might eliminate papers with relevant research ethos but differing terminology. The author finalized the following key words as the most appropriate in quality and scale:
    1. Project type:
        - Dynamic Environment – 809 results
        - Emergent Scope – 70 results
        - Maintenance – 210 results
        - Repair – 32 results
    2. Management methods
        - Agile – 467 results
        - Self-organising – 355 results
    3. Theoretical basis
        - Complex Adaptive Systems – 298 results
        - Systems thinking – 645 results.

    Total: 2886 results

- Step 2: A Master list was made by removing duplicates – **1890 entries were identified (996 duplicates)**

- Step 3: Scan through Titles for relevancy based on the following criteria:
    1. Accept studies related to heavy industry and infrastructure projects.
    2. Accept Megaprojects and Portfolio level studies.
    3. Accept studies related to application of complexity theory in projects.
    4. Accept studies discussing management methods/styles.
    5. Reject HR and Medical/Pharma based studies.
    6. Reject research projects.
    7. Reject project selection papers.
    8. Reject 'organisational projectification' type papers.
    9. **Total: 506 selected after screening 1890. Publish date range was from 1983-Feb 2024**

- Step 4: Scan through abstracts for relevancy based on the following criteria:
    1. Accept studies related to heavy industry and infrastructure projects.
    2. Accept Megaprojects and Portfolio level studies.
    3. Accept studies related to application of complexity theory in projects.
    4. Accept studies discussing management methods/styles.
    5. Reject HR and Medical/Pharma based studies.
    6. Reject research projects.
    7. Reject 'organisational projectification' type papers.
    8. Reject papers focused on success metrics etc – focus on project methodologies.
    9. Reject papers related specifically to PM skillsets and training.
    10. Reject papers dealing only at portfolio level.
    11. Reject project selection papers.
    12. **Total: 185 selected after screening 506.**

- Step 5: Carry out analysis on the selected papers:
    - Breakdown of the selected papers by Primary category: The below breakdown is based on the central theme and findings of the research effort:

Table 1: Systematic Literature Review – breakdown by Primary Category

Category	Items
Change based Project Management Approach	54
Complexity in Project Management	43
Hybrid Project Management Approach	30
Traditional Project Management Approach	54
Maintenance Projects	4
Total	**185**

Comments and observations: Based on the selected keywords and exclusion criteria, a good mix of papers were found covering Traditional, Modern, and Hybrid project management. Project Complexity was also the primary study in several papers, showing the relevancy and requirement for research in the subject. There were only 4 papers dealing with Maintenance projects, supporting this research effort's intention of studying maintenance project management.

- Review of Secondary category: Several papers addressed a secondary aspect as well. Since the Primary/Secondary split is a subjective one, it is important to ensure that the secondary categories are reviewed to ensure there is no change in the observations:

Table 2: Systematic Literature Review – breakdown by Secondary Category

Secondary Category --> Primary Category	Change based Project Management Approach	Complexity in Project Management	Hybrid Project Management Approach	Traditional Project Management Approach	Maintenance Projects
Change based Project Management Methods	38	10	4	2	0
Complexity in Project Management	8	25	9	1	0
Hybrid Project Management Methods	4	6	20	0	0
Traditional Project Management Methods	1	5	2	46	0
Maintenance Projects	1	0	1	2	0

Comments and observations: While the majority of papers in each category did not have a secondary reference, there were some interesting findings. 18 papers looked at complexity theory and change based methods in the same research effort. This is supportive of the proposed conceptual link between the two. 46 out of 54 papers with traditional project management methods as the Primary Category stuck to the principles of the same in the research effort, 5 ventured into a study of Complexity theory, 2 into Hybrid management, and only 1 paper also addressed change-based project management. This supports the view that organisations and industries where traditional methods are the default option often tend to be closeted by that view.

Out of the 4 maintenance project papers, only one (Muriel et al, 2013) dealt with modern methods (Lean), and even that was focused on ongoing maintenance projects and not MRO projects. There were no papers making a connection between maintenance projects and complexity theory. This supports the knowledge gap being addressed in this research effort.

- Breakdown of the Primary categories by Research method, Industry and Project Type

Table 3: Systematic Literature Review – breakdown by Research Method

Research Method	Change based Project Management Approach	Complexity in Project Management	Hybrid Project Management Approach	Traditional Project Management Approach	Maintenance Projects
Case	16	10	5	14	2
Modelling	1	2	2	5	0
Theory building	8	12	7	7	0
Lit review	10	6	3	10	0
Survey/interview	14	9	8	11	1
Mixed Method	5	4	5	7	1

Table 4: Systematic Literature Review – breakdown by Industry

Industry	Change based Project Management Approach	Complexity in Project Management	Hybrid Project Management Approach	Traditional Project Management Approach	Maintenance Projects
IT	25	5	8	3	0
Construction	4	8	1	15	0
Aero/Defence	1	1	0	2	1
Nuclear	0	1	0	1	0
Agnostic	18	23	17	20	0
Consulting	0	0	1	0	0
Energy	0	1	1	3	3
Pharma	0	0	0	1	0
Rail	0	1	1	0	0
Manufacturing	0	1	0	0	0
Financial Services	1	0	0	1	0
Shipbuilding	0	0	1	0	0
Astrophysics	1	0	0	0	0
Healthcare	0	1	0	2	0
Road	0	0	0	2	0
Int Dev	1	1	0	3	0
Engineering	1	0	0	1	0
Entertainment	1	0	0	0	0
Telecom	1	0	0	0	0

Table 5: Systematic Literature Review – breakdown by Project Type

Project Type	Change based Project Management Approach	Complexity in Project Management	Hybrid Project Management Approach	Traditional Project Management Approach	Maintenance Projects
Software development	20	4	7	4	0
Product Development	4	1	1	2	0
Infrastructure/construction	4	5	2	17	0
Maintenance	0	0	0	0	4
Megaproject	0	6	1	5	0
Urban Planning	0	0	0	1	0
Agnostic	19	22	17	20	0
Multi-projects/Programs/Portfolios	1	3	1	1	0
Innovation projects	1	0	0	0	0
ERP projects	0	0	0	1	0
Manufacturing	0	1	0	0	0
Financial	1	0	0	0	0
Shipbuilding	0	0	1	0	0
International Development	0	1	0	2	0
E-commerce	1	0	0	0	0
Entertainment	1	0	0	0	0
Reorganisation	1	0	0	0	0
Public sector	1	0	0	1	0

Comments and observations: As expected, the majority of the papers on the change based approach was specific to the IT industry, though non-industry specific (agnostic) papers accounted for a good number – which bodes well for the applicability of the methodology outside the industry. Also as expected, research on heavy industry project types (construction, manufacturing) mainly featured traditional project management, but a smaller correlation with other project management types showed the expansion of traditional boundaries in that regard.

The Systematic Literature Review was carried out using relevant keywords in selected project management journals over a time span of 50+ years. The fact that research on maintenance projects was so limited shows a clear knowledge gap, and this research effort attempts to fill that gap. There were also no papers making a connection between maintenance projects and complexity theory, which this research attempts to make and will be a theoretical contribution of this effort. The review also showed that, albeit small, there is definitely an appetite for studying the application of a change based project management approach outside of IT/Software and product development industries, and this current research efforts hopes to study these specific to upstream Oil and Gas industry MRO projects.

3.4 Traditional Project Management – Focussed on Plans

Traditional project management methods could be considered plan-based, are widely accepted in industry, and are grounded in the need to have a predictive outlook of projects. One way of looking at plan-based project management is as a process trying to make projects into a closed system (Kerzner, 2006), by making all interactions with the external world either part of the pre-planning process or managed under a strict change-control process where the plan has to be updated to re-baseline the plan after accommodating the change. Sometimes also called waterfall or serial methodologies, these methods aim to establish an upfront plan and then execute that plan in a serial/waterfall manner (PMBOK, 2017). Attempts are made to minimize change through rigorous upfront scoping, analysis, planning, and design (Vinekar et al, 2006). External environmental impacts and changes are considered impediments to the plan-based process, and the system aims to, ideally, completely avoid them, in a bid to make the project manageable and predictable (Saynisch, 2010). The occurrences of unforeseen incidents or changes in scope is considered a result of poor planning and/or management control (Böhle et al, 2015); sometimes, the teams are therefore compelled to classify such events as something 'outside the control of the team', thereby absolving the planning process (and team) of all responsibility for the situation.

PMBOK and PRINCE2 are popular industry standards and guidelines for plan-based project management (Chin and Spowage, 2010) (Geraldi et al, 2011). PMBOK is a good reference tool with a vast amount of information and is more commonly used in the USA and Middle East. PRINCE2 is a working methodology, using essentially the same principles as espoused by PMBOK, and has its roots in UK, with prevalent use in Europe. PRINCE2 is simpler in its approach to decision making and has clearly defined roles and responsibilities across various management levels. PMBOK, being a more general guidance document, loses out on some of the specificity in the interest of a wider view. However, in terms of the core of the project management philosophy, the methods of both systems can be largely mapped to each other and provide a similar methodological guidance to practitioners (Jamali et al, 2016), with the intent to improve project management performance (Geraldi et al, 2011). In recent editions, PMBOK has started diving into Agile and iterative management methodologies, opening the door for a wider acceptance of these methods outside of the software development community. These bodies of knowledge are accepted to be rationalist and normative, with a positivist ontological stance (Lundin, 1995) (Packendorff, 1995) (Johnson and Duberley, 2000) – these underlying assumptions define the key aspects of the plan-based project management method espoused by these bodies of knowledge (Williams, 2005).

Contextually, traditional plan-based methods are considered good for use on relatively stable projects (Boehm et al, 2013) where requirements are largely determinable in advance and remain largely settled from there onwards, making the identification and management of changes a preferably low-frequency event. The Life-cycle model (Nerur and Mangalaraj, 2005) specifies the tasks to be performed and the desired outcomes of each phase, and assigns roles (such as systems analyst, programmer) to individuals who will perform these tasks. This is a very structured approach, and is suitable for large projects requiring coordination across large groups (Boehm et al, 2013), or for program level management where multiple projects across an organisation are setup for a high amount of control from the program office (PMBOK)

Some of the key aspects of Plan-based project management are:

1. Scheduling and Up-front planning, baselining of the plan.
2. Decoupling from the environment – change management and re-baselining.
3. Clear specifications of the project goals, objectives and requirements
4. Formal stakeholder management plan for customers and leadership
5. Documentation – detailed and controlled by PMO.
6. Process discipline – formal procedures, and clearly identified fixed roles for the team members, enhanced management control over the project team.

Scheduling and up-front planning remain the core foundation of traditional plan-based project management (and specifically planning methods like waterfall), and the PMBOK dedicates a lot more time to schedule planning than actually controlling the plan. While this could be considered a strength of the system by practitioners aiming to define all the steps and intricacies of the project up front in a disciplined manner, with the hope of establishing a predictable project life cycle, it also puts an undue focus on the initial specification of the project goals, objectives and requirements (Salameh, 2014), which may not always be possible. An over-emphasis on planning also leads to a tendency to formalize procedures (Böhle et al, 2015), which reduces the flexibility in the system, and is a flawed attempt to control the project based on data from the past, and not what is being encountered in the present. Metcalfe (1997) observes that the focus on detailed scope planning is designed to 'enhance the "calculability" of individuals by enforcing a system of control. The underlying assumption becomes that project management becomes an exercise in managing scope, which can be broken down into sequentially dependent chunks (Koskela and Howell, 2002).

Another way of critiquing this focus on planning is that as a construct, it is fundamentally flawed because it disregards the non-deterministic nature of time, which is the outcome of the interaction of people, processes, internal and external factors (Padalkar et al, 2016). A more non-deterministic view of these interactions and timelines would be the need of the day (a view, as we will later see, is best taken via the lens of the complexity theory).

Thesing et al (2021) found, based on qualitative interviews, that practitioners consider the systematic planning and documentation, along with the fixed roles for team members as a key advantage of traditional methods. At the same time, poor initial specification (and the difficulties of formulating it up front), leading to a poor planning effort, is considered by practitioners to be the biggest pitfall of traditional methods. Overly prescriptive initial plans also lead to conflict when changes do come about, rework, and delays (Boehm, 2002). Interestingly, these are the aspects of project management where change-based methods differ the most from plan-based methods. In fact, there is sufficient literature showing that deviation and uncertainty in a project context is inevitable (Hallgren et al, 2005) (Böhle et al, 2015), and the solution may be found not in more complex up-front plans, but in a methodology catering to an efficient resolution of the deviations. Eden et al (2000) note that when changes are encountered in projects, by taking actions that are recommended by conventional methods, project managers themselves are exacerbating the feedback and making the over-runs worse. Whitty et al (2009) acknowledge that schedule-based tools like Critical Path Method (and PERT) are useful in the planning of projects, but don’t account for the inevitable dynamics of real-world uncertainty and changes.

Clegg and Smith (2003) propose to frame the discussion around project management towards organisational setting and the people that are executing the projects in that setting (science of subjects), and not necessarily the project deliverables (science of objects). Metcalfe (1997) notes that the primary effect of plan-based project management methods is enhanced control over the conduct of the project management team, based on tight rules and limited empowerment. This method of control can lead to significant power effects within organisations and lead to a specific way of thinking within the company (Hodgson, 2002).

In a 1988 quantitative survey, Pinto and Slevin (1998) continue to elaborate on their Critical Success factors theory by studying them relative to the lifecycle of the project. However, the lifecycle envisioned is the one that falls under traditional plan-based project management, which was the prevalent methodological construct at the time. Interestingly, while the study reinforces some of the traditional focus areas like detailed scheduling (which is a result of following a planning-based project lifecycle), they also make some methodological recommendations that would eventually be embraced by the change-based project management methods vis client/customer engagement, and technical resourcing.

It is also important to consider the actual effectiveness of Plan-based project management from the eyes of the organisations where Plan-based project management is being implemented. Crawford (2005) advises that that there is no statistically significant relationship between project management knowledge as demonstrated by total scores on the knowledge test based on the PMBOK Guide and the measure of perceived effectiveness of workplace performance, namely supervisor ratings. Analysis of variance at the level of overall use of project management practices indicates that there is no statistically significant relationship between overall use of project management practices and supervisor ratings. This indicates that there is no direct relationship between how well project managers perform against industry standards for knowledge/practices, and how well they are perceived to perform by their supervisors/organisation. So, it seems that the industry benchmark for knowledge and professional standards is not the same as those valued by senior managers and the organisations. A key observation is also that perceived performance is a valuable marker for studying project management approaches and limiting effectiveness of approach to be justified by performance against typical parameters like cost, time or quality might not provide the required insights.

Howell and Koskela (2002) attempt to break down the components of project management in order to find the underlying theory of project management. They explore various theoretical constructions from operations management but, in the researcher’s view, because their analysis is grounded in plan-based project management, they are left dissatisfied with the results. Changing and ill-defined customer requirements, changes leading to movements away from the original plan, breakdown of the planning process etc all lead to the project being completed under a 'facade' of order. Howell and Koskela in an earlier (2000) paper discuss the inadequacies of the doctrines of the PMBOK, especially on the system’s reliance on the Critical Path Method (in which a series of tasks that are necessary for project completion and define the overall timeline are considered the critical path, and the flexibility of other tasks are managed relative to the critical path) for setting up project schedules and managing changes. They challenge the PMBOK’s assumptions about projects having well defined scopes and budgets and establishing relationships between activities that are simplistically sequential having basic dependencies. Similarly, in dealing with individual activities simplistically linked to each other, Plan-based project

management runs the risk of team members focusing on making individual activities' results look good without a care for the performance of the project as a whole.

Carrying out a systematic literature review on the definition of complexity in project management, Bakhshi et al (2005) found that researchers who took the PMI view of the problem, focused on multiple stakeholders and ambiguity as the main characteristics of complexity. It is the intent of this research effort to show that while these characteristics surely make project management difficult, identifying them as the key aspects of complexity is grounded in the tacit belief in change-averse plan-based thinking. When thinking about complexity with the plan-based lens, it makes sense to see complexity as a problem of having too many parties and ambiguity in scope definition, making detailed planning and change-control difficult. This research effort demonstrates later how a change-based system of management would look at complexity in a different way, which becomes very relevant to the type of complexity experienced in MRO projects.

Critical Chain Project Management (Goldratt, 1997) is usually considered as an improvement over traditional project management methods, as it introduces a mechanism for better resource utilization during the project. The project planning starts with a traditional network diagram, followed by identifying the critical path by resource levelling. In the next stage, the CCPM process recommends reducing the time allocation for each task, and thereby any inherent buffer in it, and moving all the buffer to the end of the project. Doing this reduces any potential idle and procrastination time of resources stuck on the original schedule and thereby helps overall efficiency and adaptability to uncertainty with buffers still available at the end. It is beyond the scope of the current research effort to do a deep dive into the pros and cons of the method, and it is sufficient to say that because the method's focus is on optimizing resource utilization and scope-level uncertainty, the method still falls under the category of Plan-based project management. CCPM is not a holistic project management system and should be considered a scheduling method (Ghaffari et al, 2015) since scope variance, introduction of unknown scopes, and other global change variants require the planning process in CCPM to be redone, and the strict adherence to the resourcing requirements leads to a similar management ethos as other plan-based methods. Raz et al (2003) state how many project managers know the principles of the CCPM method through experience and intuition, and CCPM's main contribution is on terminology more than innovation.

3.5 Complexity in Projects

There is common consensus in the academic community that the theoretical underpinnings of project management research have been weak to date (Padalkar et al, 2016) (Howell et al, 2002), with a historically deterministic outlook which may not be relevant in the present day. This deterministic mindset is clearly visible in the traditional plan-based industry-standard methods endorsed by the likes of PMBOK and PRINCE2. Crawford et al, (2006) suggest that very little interest has been shown in project management literature towards scope management, and most of the focus has been on planning, control, relationship management, resource and risk management.

Bakhshi et al (2005) classify projects on a scale from Simple, Complicated, Complex to Chaotic. Simple projects are those where cause and effect relationships are easy to predict, and therefore, good planning can lead to predictable outcomes. Complicated projects are the next stage, and are composed

of multiple simple projects, with varying degrees of coordination required between them. Outcomes can be predicted based on starting positions, as the linearity of input-process-outcome can be modelled (Sargut et al, 2011). Plan-based project management is, therefore, harder, yet achievable, with execution of plans and processes, clearly defined specifications and focus on robust documentation considered key to success (Kamensky, 2011). Complex projects are those where there is uncertainty, emergent scopes, non-linearity, agent autonomy etc viz the aspects of Complex Adaptive Systems mentioned earlier in Section 4.6. Geraldi et al (2011) question the applicability of industry standards as a generic means of project management in complex projects due their very nature. Finally, chaotic projects are usually disaster and crisis management scenarios where there is almost no aspect of planning possible. While the boundaries between these types are largely subjective, it is important to not exaggerate the complexity of a project just for the sake of evaluating it via a complexity theory lens. Just because there are uncertainties in a project, does not make it a complex one (Whitty et al, 2009), and the emergence, non-linearity and autonomy of agents are key aspects that need to be considered before declaring it so.

Cicmil et al (2006) demonstrate how project behaviour arising from the complex interactions of the various scopes and components of the project would not be predicted from an analysis of the individual parts of the project. Traditional decomposition methods, therefore, are inadequate for complex projects where the project behaviour is complex, non-intuitive, shows causal feed-back leading to non-linear behaviour. They identify three compounding factors in complex projects structures which can cause extreme over-runs when projects are managed conventionally: structural complexity, uncertainty, and a tight time-constraint. If these factors are evident in a project type, they recommend using newer methods like agile instead of conventional approaches, because the scope of these types of projects emerges rather than being entirely pre-planned; the management style is much more co-operative, there is recognition that the initial project plan is fallible and incomplete.

Baccarini (1996) observes that project complexity is usually defined along two lines – 1) borne out of the scope having a high number of inter-related parts, or 2) being complicated or intricate. While #1 can be largely operationalized and made objective, #2 remains a largely subjective definition which could vary based on numerous environmental micro and macro factors, as well as individual perception. Therefore, for the extent of this study, complexity in projects will be considered as rooted in having multiple different scope components, with varying degrees of connectivity and dependencies between them. Thompson (1967) elaborated on the types of interdependencies – pooled (where each scope element produces a distinct output), sequential (one scope element's output is another's input), and reciprocal (scopes affect each other mutually). Clearly, the last two types intensify complexity and make plan-based modelling hard to achieve.

Building on Baccarini's concept, Williams (2005) adds a third aspect of project complexity – Uncertainty. This could manifest in terms of uncertainty of scope, objectives, or management methodology. He goes on to demonstrate how traditional plan-based methods are ill-equipped to handle complex projects, as a method of decomposition of scope items does not account for the compounding effects of individual scope changes, nor the feedback loops or systemic effects of complex projects. Plan-based methods also struggle with projects where there is goal or method uncertainty, as those are building blocks of plan-based management.

Pace (Williams, 2005) (Geraldi et al, 2011) can also contribute to complexity, as tight timelines for project execution could lead to the requirements of concurrent work, further compounding the intricacy of the inter-dependencies. Since pace leads to the effects of the previously identified aspects to be exacerbated, this research effort shall not consider it an independent aspect as such, but a contributing factor to the strength of the others. Similarly, socio-political complexity (Geraldi et al, 2011) is a feeder to the other three variables, and therefore not considered an independent one.

Boonstra and Reezigt (2023) build on the research by Maylor et al. (2013), Brady and Davies (2014), Maylor and Turner (2017), and Morcov et al. (2020) to define project complexity along two dimensions: structural complexity and dynamic complexity. "*Structural complexity increases with the number of elements, the degree of differentiation between those elements, the number of disciplines involved, the connectedness of elements and their characteristics, the variety of work being performed, and the project's scope. Dynamic complexity increases with the rate of changes in the content and context of the project, the novelty of the project, the lack of technical and commercial maturity, rising dominance of previously unidentified stakeholders, variability, and unpredictability".*

Carrying out a systematic literature review on the definition of complexity in project management, Bakhshi et al (2005) found that researchers who took the PMI view of the problem, focused on multiple stakeholders and ambiguity as the main characteristics of complexity. It is the intent of this research effort to show that while these characteristics surely make project management difficult, identifying them as the key aspects of complexity is grounded in the tacit belief in change-averse plan-based thinking. When thinking about complexity with the plan-based lens, it makes sense to see complexity as a problem of having too many parties and ambiguity in scope definition, making detailed planning and change-control difficult. This research effort as well as literature on complexity of projects showcase different elements of project complexity, which need a management approach that is different than the traditional plan-based one.

Scheduling and up-front planning remain the core foundation of PPM (and specifically planning methods like waterfall), and the PMBOK dedicates a lot more time to schedule planning than actually controlling the plan. While this could be considered a strength of the system by practitioners aiming to define all the steps and intricacies of the project up front in a disciplined manner, with the hope of establishing a predictable project life cycle, it also puts an undue focus on the initial specification of the project goals, objectives and requirements (Salameh, 2014), which may not always be possible. An over-emphasis on planning also leads to a tendency to formalize procedures (Böhle et al, 2015), which reduces the flexibility in the system, and is a flawed attempt to control the project based on data from the past, and not what is being encountered in the present. Metcalfe (1997) observes that the focus on detailed scope planning is designed to 'enhance the "calculability" of individuals by enforcing a system of control. The underlying assumption becomes that project management becomes an exercise in managing scope, which can be broken down into sequentially dependent chunks (Koskela and Howell, 2002).

Another way of critiquing this focus on planning is that as a construct, it is fundamentally flawed because it disregards the non-deterministic nature of time, which is the outcome of the interaction of people, processes, internal and external factors (Padalkar et al, 2016). A more non-deterministic view of these interactions and timelines would be the need of the day

Thesing et al (2021) found that poor initial specification (and the difficulties of formulating it up front), leading to a poor planning effort, is considered by practitioners to be the biggest pitfall of traditional methods. Overly prescriptive initial plans also lead to conflict when changes do come about, rework, and delays (Boehm, 2002). Interestingly, these are the aspects of project management where change-based methods differ the most from plan-based methods. In fact, there is sufficient literature showing that deviation and uncertainty in a project context is inevitable (Hallgren et al, 2005) (Böhle et al, 2015), and the solution may be found not in more complex up-front plans, but in a methodology catering to an efficient resolution of the deviations. Eden et al (2000) note that when changes are encountered in projects, by taking actions that are recommended by conventional methods, project managers themselves are exacerbating the feedback and making the over-runs worse. Whitty et al (2009) acknowledge that schedule-based tools like Critical Path Method (and PERT) are useful in the planning of projects, but don't account for the inevitable dynamics of real-world uncertainty and changes.

Williams (2005) showcases how Plan based management can be disadvantageous for projects with strict time-limits, structural complexity, and/or exposed to high uncertainty, and that managing such projects with conventional methods can lead to extreme overruns. He suggests that newer methods like 'agile' and 'lean' might be more suited to such projects. Bianchi (2020) shows that adoption of Stage-Gate principles in software development was negatively associated with speed and cost performance.

Cicmil et al (2006), in promoting actuality-based research, suggest that context of the project is very important in the understanding the management of it. They argue that the mainstream research in project management has treated the function of project management to be the accomplishment of some finite piece of work in a specified timeframe, within a certain budget, and to agreed specification, which is a functionalist/instrumentalist view. In their view, project management research should explore the empirical reality of projects by considering different contexts in which projects are being managed, thus addressing complexity, non-linearity, values, multiple perspectives and social processes in project environments. This is a key point for this research effort's methodological approach, as project performance on tangible metrics like cost, time and scope completion while important, is not always the most relevant reason for proposing the contextual need for Change-Based Project Management.

3.6 Modern Project Management – Open to Changes

An appreciation of the challenges posed by project complexity has led to several approaches that move away from overly prescriptive and documented requirements, descriptions, scopes, change management and other project elements, and employ an emergent, potentially iterative, method of moving the project forward as more details are discovered and developed, with only larger macro-focused project mandates outlined at the start. This allows the practitioners to adapt to changes as they are discovered, react to market and customer requirements, and address challenges and scope-interdependencies in a faster and more nimble way. These modern methods can be deemed as change-based methods and while plan-based methods are geared towards avoiding changes, these change-based methods expect them. Of course, change-based methods are also better setup to take advantage of any opportunities that come as a result of unexpected changes (Böhle et al. 2015), which traditional

methods would struggle to fully exploit. This is usually done by employing a collaborative management style, as opposed to a command-and-control style employed by traditional methods (Salameh, 2014).

The concept of change-based project management is often misunderstood to be a recent development, with its genesis in the Agile Manifesto (Beck et al, 2001). However, at a conceptual level, this has been discussed for decades under different terminologies. Back in 1970, Royce's critique of linear software development execution models is starkly reminiscent of the current research effort. His solution to improve the model, based on front-loading design and customer engagement activities, has the same conceptual roots as agile and other change-based models that we know today. Unfortunately, his work is often misread as a promoter of the pre-planned waterfall method, which he only endorsed for the simplest of projects. For more complex projects, he emphasized the need of iterative and incremental development (Larman and Basili, 2003)

In 1986, Takeuchi and Nonaka challenged the sequential approach to product development by endorsing a 'rugby' type approach, where the entire team moves forward while passing the ball between the players, instead of a sequential relay race type arrangement. Arguments like these are the foundations of what was later formalized as a SCRUM methodology in modern agile practices. They discovered that the approach was built around certain pillars like high levels of autonomy for the project team, challenging tasks without prescriptive guidance, fluid hierarchal relationships, cross-functional learning, a start-up type atmosphere spurring the project teams to new heights, and 'subtle' management control. Even though these management lessons from >35 years ago were outlined within the sphere of product development, they remain very relevant today and will be a key part of this research effort even outside the product development world.

The most popular form of this modern approach embracing changes has been Agile. In 2001, several practitioners within the software development industry who shared a common frustration with plan-based project management and had been working on 'light' approaches in their spheres, got together to put together the Manifesto for agile software development, which was an amalgamation of their views on how software development management should be setup. The manifesto focuses on four main concepts – individuality and interactions instead of restrictive process frameworks, a move away from documentation-heavy methods towards outcome-oriented methods, working closely with customers, and embracing change.

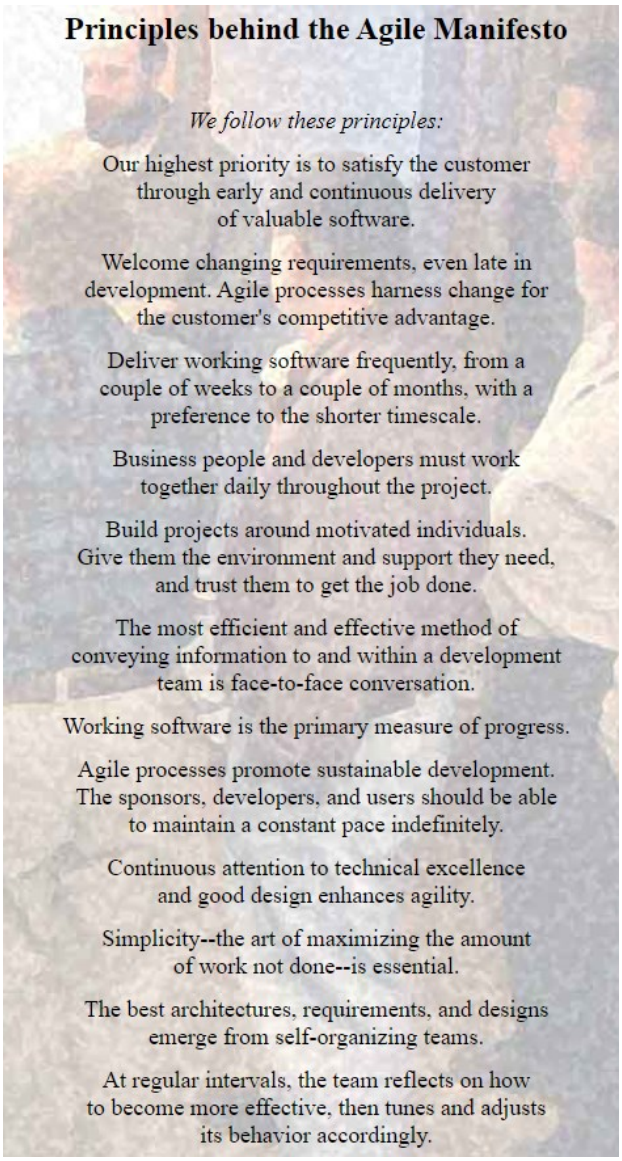


Figure 9: Extract from Manifesto for agile software development (Beck et al, 2001)

The principles behind Agile weren't suddenly discovered when the Agile Manifesto was written. Traces of their application in software development can be traced back to the 1960s (Williams and Cockburn, 2003). However, the manifesto helped collate, formalize and bring to the fore these principles in a concise framework that could be developed into working processes. While the manifesto helped give agile, as a methodology, some credibility, there is still no fundamental agreement in the academic or industry communities on the definition of agile (Conboy et al, 2004). This is all the more reason to consider change-based methods as the concept worth studying across industries, instead of trying to come up with overly specific definitions of agile. It is important to stay away from the trap of strict adherence to an agile-based process, that the essence of the intent is lost. Practitioners should focus on the principles behind Agile (Larman, 2004), and the associated focus on people and effectiveness of action, instead of strictly implementing a certain Agile process within their projects (Fernandes et al,

2008). The focus should be on matching the project requirements with the most effective management technique and retaining the flexibility and nimbleness which is the foundation of the change-based project management philosophy. Accordingly, Annosi et al (2020) discuss how Agile methods are probably better suited to smaller projects, as they focus on intra-team coordination, while inter-team issues can become problematic in large-scale project settings. They found that, in the studied case of large-scale agile implementation, the pace of development using agile was counter-productive in some key respects, as it stifled learning and the desire to innovate amongst the team. The stress introduced by the shorter delivery turnarounds introduced by the agile iterative method led to team members not looking to learn beyond the task at hand and often lead to poorer architectural (big picture) knowledge amongst the team as well.

Due to the popularity and origins of the Manifesto, most of the implementation of Agile and related project management methods has been in the software and product development industries, where it is used as a micro-planning-based tool, typically based on short cycle iterations, producing working code after each iteration (Cooper, 2016). Williams and Cockburn (2003) highlight the key difference between defined and empirical processes, and how software development, unlike repetitive manufacturing, is an empirical process. Managing empirical processes using plan-based management styles is fundamentally misaligned with their very nature, since the probability of changes is very high, and plan-based processes designed to reduce and avoid changes will be setup to fail in such endeavours. They also highlight three key areas where implementation of Agile could impact the larger organisation – the change required in work habits, the shifts in power structure of the organisation, and the requirements (or concerns) regarding quality control/assurance.

The context in which Agile has been identified as a suitable management method is for projects with high rate of change, turbulent environments (Boehm et al, 2013) and complexity (Williams, 2005), because incremental approaches lead to better results in cases where a full functional specification cannot be determined upfront (Mehan, 2012). The ability to break the project into iterations is a key aspect of contextual suitability, as Agile methods require the entire project to be broken into smaller projects, each comprising an iteration typically lasting between one to six weeks (Larman, 2004) - the project scope needs to be amenable to such a management system. So, the overall project follows an evolutionary-delivery model (Nerur and Mangalaraj, 2005) where the scope and the management plan evolve with iterations. This makes Agile typically suitable for relatively small projects with small teams and no space for bureaucracy (Boehm et al, 2013), with Agile methods '*almost entirely performed within in-house or dedicated development environments'* (Boehm et al, 2013)

While there has been significant interest in Agile and other change-based methods since the publication of the Manifesto, most of this research has been grounded in industry practice, and theoretical underpinnings of these methods remain academically weak (JSS, 2012). Even within the field of Agile software development, where the method has been studied the most, the research has been uncoordinated and along various lines, not always homogenous towards a central principle of Agile that could be filtered and put into practice. One can surmise that since the approach has been so uneven in the sector (software development) for which Agile was conceptualized, it shouldn't come as a surprise that cross-industry application has not been widely studied.

Rigby et al (2018) discuss how Agile can be scaled within organisations, and the broader changes required in organisational mindset and arrangement in order to maximize the potential of the approach.

Their key insight is that a phased scaling up, as opposed to hammering down large-scale changes, is likely to be a smoother implementation of Agile at scale. This, of course, would be applicable to companies which have the luxury of time and are deploying Agile in a bid to improve, and not as an urgent need for survival. While their research focuses agile more, as is usually the case, on product development and innovation, their insight regarding how corporate and other support functions can help agile teams (MRO project teams in the present research effort) is of interest to us

Of course, there is also the question if Agile works at all. Most of the evidence is anecdotal and there is a lack of empirical research in the subject area, and especially not in areas outside of the software development industry. Serrador and Pinto (2005) have written one of the very few papers attempting a quantitative study of agile project management effectiveness and therefore deserves detailed study. It is encouraging to see that the researchers found positive correlations between agile implementation and project success factors. The paper's position is objectivist (Lee & Lings, 2008). i.e. variables related to individual team performance or circumstances are not considered as significant enough to detract from the results, and the application of agile processes vs. the success of the process implementation is considered to be a function of the process implemented, and not the projects' idiosyncrasies. Care must be taken that the constructivist approach and important explanatory variables like team dynamics are not discarded without reason. Project management methodology, at its core, is a set of guiding principles and processes aimed at providing a framework for better execution of projects and so must not be considered as a science grounded in undeniable fact. It is, therefore, difficult to establish how the data from the implementation of agile practices can be considered to not be significantly clouded by the social actors that implement the practice, and the conditions within which these actions were implemented. While the study considered three moderator variables (Vancouver and Carlson, 2015), this is not an exhaustive list and the researcher does not believe that the consideration given to them is sufficient to take the projects into the realm of objectivity.

While it could be argued that if a large enough data set could be taken, comparing traditional vs agile methodologies should cancel out the individual idiosyncrasies of the projects and teams, the study (Serrador and Pinto, 2005) does not provide enough evidence of this because:

- the paper's data set is not large enough; and
- the potential correlation between project complexity and other dynamics and the success of the project are not given due consideration. This has also been mentioned as a limitation by the researchers; and
- the underlying project management methodological grounding is not strong enough to overcome the obstacle of implementation challenges overshadowing the method's performance; and
- individuality, interpersonal behaviour, and management practices within the project team have not been given due weightage towards sanitizing the survey results, especially as these factors could have a big influence on project performance (Lensges et al, 2018)

Due to the nature of the data collection, there seems to be no availability of industry breakdown or project type data among the survey responders, making it impossible to ascertain if all survey responders were from the software development industry, or if cross-industry applications have shown similar results. The other counter-intuitive finding from the research was the lack of correlation between

project success and the experience levels of the project team. While it is enticing to credit agile methodologies with the ability to provide good results where experienced personnel are not required, care must be taken to not misinterpret this finding in a way that agile is considered a panacea for teams without adequate skillsets.

Key aspects of Change-based project management methods:

3.6.1 Planning Process

The planning process is seen to be the main difference between plan-based and change-based project management methods (Thesing et al, 2021). Plan-based methods focus more on upfront planning, while Change-based methods focus on continuous short-term plans with a long-term vision, often in the form of iterations (Ciric et al, 2022). There is often a misconception that change-based methods are just a means of doing no planning, where the practitioners are constantly 'winging it' and riding their luck. This perception stems from the deep grounding of detailed up-front planning in most business contexts. In fact, it can be argued that due to the extensive number of smaller tasks, and the iterative and emergent management style, change-based methods require more planning than traditional ones (Koskella and Abrahamsson, 2004). Its just that instead of being a regimented and prescriptive upfront activity, it is a continuous and fluid one spread over the duration of the project (Coram and Bohner, 2005). Care must also be taken that the change-based method is understood by the team, philosophically, before they work on the process steps. Only then will the fluidity of the planning process show its merits, and not just become a set of mini-waterfalls (Dikert et al, 2016).

3.6.2 Change management

Plan-based project management methods consider changes an inconvenient and undesirable part of the project process, and the intent is for the project team to plan their way out of having to deal with changes. Of course, if changes do come about, because the entire process was based on a no-change assumption, it is significantly disruptive to the plan, schedule and all other methodological aspects. Accordingly, the minimization and adequate addressing of changes is usually lined out in detail in plan-based methods, and each change goes through rigorous review, management approvals, plans are re-baselined, schedules are re-made, and pretty much all aspects of the methodological construct get affected. While this exhaustive methodology provides good control in predictive environments, the team might not be able to keep up (Coram and Bohner, 2005) with the changes in dynamic environments because by the time plans are re-drawn based on change #1, change #2 has already happened.

Change-based methods attempt to turn this mindset on its head, by embracing change as an inevitable part of project management (Vinekar et al, 2006) (Jain, 2006) and setting up a nimble management system to not treat them as an inconvenience but as a necessary stepping-stone in turbulent business environments. Whether it is the sprints in a SCRUM process, the Iterations To Release in XP, or the flexible capability adjustment of DSDM, change-based methods have been embraced in the software development world, and the ability to recognize and respond to changes and errors is considered by practitioners to be one of their biggest advantages (Thesing et al, 2021).

3.6.3 The role of the customer

While it is not intentional, the intense focus on preliminary planning and detailed scheduling in traditional plan-based project management often leads to alienation of the customer, with the project team becoming predominantly internally focused due to the extensive planning, change management and documentation required. Customers are usually involved in up-front specification of the project (Nerur and Mangalaraj, 2005), but any change of requirements by the customers are treated as a negative impact on the project, further leading to a poor customer relationship.

Agile and other change-based methods attempt to address this unfortunate side-effect by encouraging constant customer engagement, not just when developing the initial specifications, but throughout the project lifecycle (Vinekar et al, 2006). Customer representatives are encouraged to be co-located with the project team and provide regular feedback on progress, iterations etc (Serrador and Pinto, 2015) (Ciric et al, 2022) (Boehm et al, 2013), and are often empowered by the customer's organisation to make quick decisions (Coram and Bohner, 2005) in order to gel well with the project team's change-based processes. Jain (2006) mentions that early and consistent customer engagement helps win trust, build rapport and respect, attain equal stakeholder status, and leads to better understanding of the customer's needs further enabled by frequent feedback.

A potential challenge to enhanced customer involvement is that there is a significant onus on multiple team-members to interact with the customer (as opposed to a more top-down traditional approach where this would usually be handled at a management level) (Conboy et al, 2011). Not all team-members might be comfortable with that. Also, in business settings where team-members are not in tune with the business objectives of the organisation and project, this could lead to friction between the customer's expectations and the team-members' outputs. It is imperative that the team-members have at least a basic alignment to the business goals of the project and the customer's requirements, in order to have a more collaborative environment with the customer.

Kadefors (2004) discusses trust between customers and contractors and endorses a partnership-based approach. While studying construction projects, which invariably use traditional project management methods and, therefore, have more prescriptive contractual relationships between parties, the author highlights that trust can be built up using economic alignment, joint goal formation, regular interaction between customers and contractors, and systems catering towards change management, problem-solving and continuous improvement. These recommendations are aligned with the principles of change-based project management methodologies, and the challenges and rewards from such implementation in the construction industry are a good reference point for considerations in Oil and Gas MRO projects.

3.6.4 The role of leadership

As Nerur and Mangalaraj (2005) put it, Agile and traditional organisational setups have conflicting cultures, management styles, organisational forms, and reward systems. Thus, it is imperative that the leadership buys in to the organisation's chosen project management philosophy and is not misaligned with it. O'Reilly and Tushman (2004) summarize a well-aligned organisational setup as the organisation having subunits that are highly coupled within subunits

and loosely coupled across subunits but are tightly integrated at the senior executive level. The organisation also needs to buy into the behavioural change required to implement a system not based on change-control but rather behavioural-control when changes are encountered. As Ouchi (1977) explains, organisational control is quite simply a scheme where only two phenomena can be observed, monitored, and counted: behaviour and the outputs which result from behaviour. The organisational setup relies on the monitoring and evaluation of one or the other, but it must be kept in mind that even in the case of output monitoring method, real control comes about only through affecting people's behaviour. Tiwari et al (2021) that senior management commitment and flexibility improves responsiveness in volatile and high-impact projects, with a direct positive correlation (in a study on IT projects) between management commitment and project success, enabled by flexibility.

As can be imagined, a move from plan-based to change-based methods is a significant one that needs leadership buy-in and engagement for successfully implementation. However, this buy-in can be hard to obtain considering their inclination towards reducing risk where visibility is limited (Coram and Bohner, 2005). Depending on the industry and business situation, this might need different ways of forecasting business performance, different ways of managing customer expectations and contractual obligations, and could even mean educating investors and shareholders on the difference of approach. In fact, Thesing et al (2021) found that fitting agile project management methods into existing or different corporate culture is considered by practitioners to be the biggest challenge related to agile implementation.

While studying the issues in large-scale implementation of Agile, Dikert et al (2016) discovered that top-down mandates towards the implementation of agile methods create resistance within the organisation. So, while leadership buy-in is a key element to successful implementation, the team needs to feel part of that decision making process and they should be made to understand why a move to agile is being seen as potentially advantageous, instead of just mandating them to do it. At the same time, a bottom-up approach was seen as inducing reluctance in the management team towards change. Management buy-in, both visible and supportive, played a key role in the success stories though, and to make this balance work is a key aspect of project management transformation. Open dialogue and flat-organisations that enable information flow contribute positively to this effort (Radan et al, 2015).

3.6.5 Communication

While communication is an important aspect of project management, regardless of methodology, it becomes a lot more critical to success in change-based methods. Traditional methods, due to their focus on detailed plans, structured team roles, high document focus, and controlled change management processes, rely less on day-to-day communication between stakeholders and more on adherence to the processual elements of communication. Agile, on the other hand, relies heavily on regular and free communication to further the collaborative methodology. There are three primary communication enablers often used in change-based methods – co-location of team members, daily stand-up meetings (Mann and Meurer, 2005), and retrospective meetings (Alyatma, 2021)(Diem, 2021).

Jain (2006) gives a glowing review of retrospective meetings, stating that "*It created a great platform for the team to express themselves and to think constructively to improve the*

project and to adapt. Involving the client in retrospectives gave them greater visibility. We used retrospectives to control the direction of our project. It helped us to identify issues and brainstorm about them. Retrospective was one of the most influential practices which helped the team succeed."

The high-communication system can be met with apprehension due to the fear within the team that their inadequacies and existing skill-levels could be exposed in the highly communicative and collaborative environment (Conboy et al, 2011). This 'no place to hide' feeling could be counterproductive. Also, the highly interactive environment relies on the social skills of the team members, which may not have been evenly developed in the past. The organisation must be aware of this, and plan for required training or other means of upliftment to ensure that the team members don't hold back their contributions due to their weak social skills, the team feels safe, and the team-members' skills are improved over time.

3.6.6 Team setup

Agile and other change-based methods are usually strong advocates of small project teams, with team members often operating in a multi-skilled way. Small teams enable collaboration and reduce the need for processes and planning for coordinating team activities (Nerur and Mangalaraj, 2005). This is advantageous as change-based methods aim at achieving innovation through individual initiative (Vinekar et al, 2006). This can also be a challenge as this puts a high skill requirement on the team members, which may not always be available, or not available for long term projects (Coram and Bohner, 2005). So, while it might make sense, as a methodology, to have a small multi-disciplinary team, assembling such a team might be difficult. It is also important to note that just because the team is small, and the team members are supposed to have a good cross-functional knowledge, does not mean that a 'master of all trades' requirement is mandated. Team members should be encouraged to nourish their core specialization, at the same time developing other skill sets as part of the agile group (Conboy et al, 2011).

Co-location of the project team is considered important in change-based project management methods. Jain (2006) suggests that when teams are designed to interact as closely as CPM methods require, trying to manage distributed teams can lead to trust issues, loss of context, and slowdown of the iterative feedback cycles. He also advocates team stability as a key enabler, with a high turnover of project team members requiring the constant rebuilding of trust and alignment.

The project manager's role is more of a coach and mentor, and less as a director (Coram and Bohner, 2005), especially as it is extremely difficult for an individual project manager to successfully see, and therefore direct, a complex project in its entirety (Sargut et al, 2011). This is also supported by Shahzad et al (2020) who study how despotic behaviour by project managers can be detrimental to project success. In larger scale agile implementations, this role of the project manager was considered problematic by practitioners as larger organisations have middle management that struggled with their new roles (Dikert et al, 2016).

Self-organising behaviour is a key aspect of change-based project teams (Highsmith, 2003), where the project manager steps back from the traditional role of planner, organiser, and controller, and instead becomes a facilitator or coach who encourages and manages

collaboration between team members without impeding their creativity (Nerur and Mangalaraj, 2005). Jain (2006) emphasizes how multi-skilled small teams of motivated individuals which self-organised was effective, efficient and lead to better customer engagement as well. He emphasized a direct negative correlation of effectiveness with project team size, as larger teams lead to complications in team dynamics and communication.

3.6.7 Documentation

Change-based methods try to reduce the emphasis on extensive documentation in favour of more functional milestones (e.g. working prototypes) and face to face communication (Cooper et al, 2016), saving project teams the significant amount of time and effort spent on maintaining exhaustive documentation (Coram and Bohner, 2005) (Vinekar et al, 2006). In projects conducted in dynamic environments, and exhaustive documentation requirement can quickly overwhelm the project team as they try to keep up with rapidly changing scenarios and the change-management, planning and execution documentation required for all the changes (Boehm, 2002). Also, the decentralized decision-making process of change-based methods reduces the reliance on documentation for communication through various layers of management, making documentation reduction more viable (Annosi et al, 2020). Care must be taken, though, that the approach isn't misinterpreted by the team as one with carefree lack of documentation (Dikert et al, 2016). Critical documentation which could be useful for other projects or larger organisational learning should still be maintained, and so a value-driven documentation approach is endorsed (Fernandez et al, 2008).

The differences between traditional and modern approaches in summarized in Table 6, where the context of application and the key tenets are highlighted.

Table 6: Traditional vs Agile approach in project management

Context	Traditional Plan-based Project Management	Agile Project Management
Context of Application	Good for use on relatively stable projects (Boehm et al, 2013) where requirements are largely determinable in advance and remains stable.	Projects with high rate of change, turbulent environments (Boehm et al, 2013) and complexity (Williams, 2005) Incremental approaches lead to better results in cases where a full functional specification cannot be determined upfront (Mehan, 2012)
	Life-cycle model (Nerur and Mangalaraj, 2005)- The life cycle model specifies the tasks to be performed and the desired outcomes of each phase, and assigns roles (such as systems analyst, programmer) to individuals who will perform these tasks.	Evolutionary-delivery model (Nerur and Mangalaraj, 2005) where the scope and the management plan evolves with iterations Agile methods require the entire project to be broken into smaller projects, each comprising an iteration typically lasting between one to six weeks (Larman, 2004) - the project scope needs to be amenable to such a management system
	Suitable for large projects requiring coordination across large groups (Boehm et al, 2013)	Suitable for relatively small projects with small teams and no space for beaurocracy (Boehm et al, 2013) Agile methods have been almost entirely performed within in-house or dedicated development environments (Boehm et al, 2013)
Management Aspect	**Traditional Plan-based Project Management**	**Agile Project Management**
Planning Process	High emphasis on up front planning (Thesing et al, 2021) Focus on meticulous planning and detailed specifications (Bagiu et al, 2022) (Asnawi, 2012), (Lozo and Jovanovi, 2012)	Continuous planning mindset (Koskella and Abrahamsson, 2004)(Coram and Bohner, 2005) Requirement's prioritization in each iteration, planning at each iteration start (Bagiu et al, 2022)
	Focus on predictability, stability, and high assurance (Boehm et al, 2013)(Padalkar et al, 2016)(Nerur and Mangalaraj, 2005) Plan-driven methods generally prefer formally baselined, complete, consistent, traceable, and testable specifications (Boehm et al, 2013) Focus on strategic over tactical objectives (Boehm et al, 2013).	Focus on tactical over strategic objectives (Boehm et al, 2013). The agile projects' speed and agility come largely from deliberate group planning efforts that enable operation on the basis of tacit interpersonal knowledge rather than explicit documented knowledge as represented in plans and specifications.
	Plan-driven methods use plans to anchor their processes and provide broad-spectrum communication (Boehm et al, 2013) Initiate – plan – manage product delivery – close the project (Bagiu et al, 2022)	Agile methods require the entire project to be broken into smaller projects, each comprising an iteration which focuses on a few specific features and ends with a working system as a deliverable (Larman, 2003)(Asnawi, 2012) Typically based on short cycle iterations, producing working code after each iteration (Cooper, 2016)
Change Management	Beuracratic and high formalization (Bagiu et al, 2022)(Böhle et al, 2015)(Nerur and Mangalaraj, 2005) Change Management is established as a rigorous process and change is typically exceptional (Bagiu et al, 2022) and method of control if progress is outside of tolerances (Boehm et al, 2013) Linear, sequential model (Diem, 2021) - project management becomes an exercise in managing scope, which can be broken down into sequentially dependent chunks (Koskela and Howell, 2002)	Short cycle iterations allow changes to be built into the planning of each iteration, enabling management of extensive changes. Agile methods count on their rapid iteration cycles to determine needed changes in the desired capability and to fix them in the next iteration (Boehm et al, 2013)(Ciric et al, 2022) Iteration in several days, check the requirements, attest the function and review with the customer (Bagiu et al, 2022)
	Change is considered a negative thing - Having too many changes could mean that the original objectives might be compromised (Grushka-Cockayne et al., 2015) and could escalate conflicts (Boehm, 2002) due to prescriptive processes.	Changes are usual part of the project (Bagiu et al, 2022)(Böhle et al. 2015) Recognizing the inevitability of change and embracing it, rather than attempting to cope with it through extensive planning, provides the nimbleness needed to survive in a turbulent business world (Vinekar et al, 2006)(Jain, 2006)
The role of the customer	Typically high customer involvement at specification stage, but lesser during the project execution stage (Nerur and Mangalaraj, 2005)	Customer representatives are encouraged to be dedicated to the project and co-located with the project team and provide regular feedback on progress, iterations etc (Serrador and Pinto, 2015) (Ciric et al, 2022)(Boehm et al, 2013) Customer representatives interact with various members of the project team (Conboy et al, 2011)
	As-needed customer interactions, focused on contract provisions (Bagiu et al, 2022)(Kadefors, 2004) Plan-driven methods generally depend on some form of contract between the developers and customers as the basis for customer relations (Boehm et al, 2013)	Dedicated, knowledgeable, collaborated, collocated onsite customers (Bagiu et al, 2022) The active participation and constant involvement of the customer in systems development yields greater benefits than the fulfillment of predetermined requirements specified in a contract (Vinekar et al, 2006)(Coram and Bohner, 2005)(Nerur and Mangalaraj, 2005)
	Plan-driven people count on their process maturity to provide confidence in their work (Boehm et al, 2013)	Agile developers use working software and customer participation to instill trust in their track record (Boehm et al, 2013)(Kadefors, 2004)
The role of leadership	Mechanistic organisational structure (Bagiu et al, 2022)	Collaborative management style (Bagiu et al, 2022)(Salameh, 2014).
	Process-centric control (Nerur and Mangalaraj, 2005) Plan driven projects focus on process over people (Highsmith and Cockburn, 2001)(Metcalfe, 1997)	People-centric control (Nerur and Mangalaraj, 2005) Open Dialogue and flat organisation preferred (Radan et al, 2015)
	Command and control management style (Bagiu et al, 2022)(Metcalfe, 1997)(Nerur and Mangalaraj, 2005)	Management buy in towards high autonomy in the project team (Rothman and Kilby, 2019)(Nerur and Mangalaraj, 2005)(Tiwari et al, 2021)

Table 6 (contd): Traditional vs Agile approach in project management

Management Aspect	Traditional Plan-based Project Management	Agile Project Management
Communication	Strict, formal communication and reporting activities (Bagiu et al, 2022)(Nerur and Mangalaraj, 2005)	Informal communication (Bagiu et al, 2022)(Nerur and Mangalaraj, 2005) Agile methods generally rely on more frequent, person-to-person communication (Boehm et al, 2013) (Mann and Meurer, 2005)
	Plan-driven methods rely heavily on explicit documented knowledge. With plan-driven methods, communication tends to be one-way. Communication is generally from one entity to another rather than between two entities (Boehm et al, 2013)	Agile methods rely heavily on tacit, interpersonal knowledge for their success (Boehm et al, 2013)(Nerur and Mangalaraj, 2005). Knowledge is specifically gathered through team planning and project reviews (an activity agilists refer to as "retrospection"). Retrospective meetings are a key part of the model (Diem, 2021)(Alyatma, 2021)(Jain, 2006)
Team Setup	Assure the user involvement primarily through the reporting process (Bagiu et al, 2022) Plan driven projects focus on process over people (Highsmith and Cockburn, 2001)(Metcalfe, 1997)	Active users are part of the development team itself (Bagiu et al, 2022) Agile projects consider people an important part of the project management solution and rely more on that vs processes (Highsmith and Cockburn, 2001)(Fernandes et al, 2008)
	In a plan-driven culture, the people feel comfortable and empowered when there are clear policies and procedures that define their role in the enterprise. This is more of a production-line environment where each person's tasks are well-defined. The expectation is that they will accomplish the tasks to specification so that their work products will easily integrate into others' work products with limited knowledge of what others are actually doing (Boehm et al, 2013).	In an agile culture, the people feel comfortable and empowered when there are many degrees of freedom available for them to define and work problems. This is the classic craftsman environment, where each person is expected and trusted to do whatever work is necessary to the success of the project. This includes looking for common or unnoticed tasks and completing them. (Boehm et al, 2013) The ingenuity and competence of people as well as their interactions and collaborations are of greater value than tools and processes (Vinekar et al, 2006)(Nerur and Mangalaraj, 2005)
	Manage by exception approach – project manager has a strict budget and all important changes must be reviewed by board. It takes time and additional effort (Bagiu et al, 2022) Project manager as a director (Coram and Bohner, 2005) - follows a command and control management style (Nerur and Mangalaraj, 2005)	The traditional role of a project manager as planner, organiser, and controller disappears,- and the role of a facilitator or coach who- effectively manages the collaborative efforts of team members without stifling their creativity takes its place (Highsmith, 2003)(Nerur and Mangalaraj, 2005)(Coram and Bohner, 2005).
		Self-organisation is one of the key traits (Vinekar et al, 2006)(Asnawi, 2012)(Nerur and Mangalaraj, 2005)(Highsmith, 2003) Promotes the skills of each team member and thus helps to achieve the best possible results in a collaborative effort (Rothman and Kilby, 2019)(Nerur and Mangalaraj, 2005)(Conboy et al, 2011)
Documentation	Heavy-weight documentation with both the process plans and rich content (Bagiu et al, 2022)(Thesing et al, 2021); produce a large amount of documentation that codifies process and product knowledge. Communication among project participants is formalized through these documents.(Nerur and Mangalaraj, 2005) Plans make up a large portion of the required documentation in most plan-driven approaches (Boehm et al, 2013) For high-assurance, safety-critical projects, following a thorough, documented set of plans and specifications is the only way to meet existing certification standards (Boehm et al, 2013)	Keeping requirements and documentation lightweight (Nerur and Mangalaraj, 2005) and value-driven (Fernandez et al, 2008), and acknowledging that change is a normal and acceptable reality in software development (Bagiu et al, 2022) Delivering a high-quality working system to the customer is more important than producing copious documentation (Vinekar et al, 2006) Reduce the emphasis on extensive documentation in favor of more functional milestones (e.g. working prototypes) and face to face communication (Cooper et al, 2016), saving project teams the significant amount of time and effort spent on maintaining exhaustive documentation (Coram and Bohner, 2005) (Vinekar et al, 2006)(Annosi et al, 2020)

3.7 Complex Adaptive Systems (CAS)

A Complex System is a group of components that interact with each other. Depending on how much agency and self-organising behaviour the components exhibit, the complex systems are classified as disorganised or organised (Weaver, 1948). Disorganised systems are ones where the system components interact, but do not work actively to organise themselves e.g. the interaction of inanimate objects. In organised systems, the interacting components collectively combine to adapt and form emergent properties that could not necessarily be explained or understood at the individual level but can be at a global level (greater than the sum of the parts), and the system is called a Complex Adaptive System (CAS) (Carmichael et al, 2019) (Kaufman, 1992). The system components are often governed by simple sets of rules at the component level but can exhibit distinct global behaviours that are hard to understand or model/predict by studying the individual components (Ellis et al, 2011) (Lansing, 2003). The system constantly adapts to the environmental conditions, and therefore the behaviour of the system, while it could be driven by some system-wide goals, can display different adaptive patterns. (Harkema, 2003). While studying CAS, therefore, the focus needs to be less on the individual components and more on the interaction of the components/agents (Stacey et al, 2000) – something easier said than done, since acceptance of the distinct global behaviour usually comes with the resignation that individual component/agent behaviour are no longer completely understandable (Lansing, 2003).

A typical example of a CAS is the flow of traffic on a freeway. Each driver follows a simple set of rules at the individual level e.g. staying within one's lane, maintaining a safe distance from the next vehicle, accelerate or slow down based on the next vehicle, stay within the speed limit, move towards a particular destination etc. However, as we all experience, the ebb and flow of traffic often causes much bemusement or frustration because the behaviours of the system as a whole do not seem to be an extrapolation of these simple rules – in fact, there wouldn't be many traffic jams (without accidents) if the system was not complex, and neither would jams resolve themselves if the system was not adaptive. It is through these multitude of interactions and feedback loops of observing other vehicles, giving way, speeding up and slowing down, that traffic flows in a certain way.

While Complex Adaptive Systems could be chaotic i.e. events and actions could seem random and disorderly, the most efficient systems are deemed to be operating at the 'edge of chaos' – a term commonly associated with high performing CAS. (Sweetman et al 2018) (Thomas et al, 2008) (Singh et al, 2002) (Daniel et al, 2019). So, a massive traffic jam in Mumbai could be considered chaotic as drivers often abandon all individual rules in a bid to get ahead, thereby leading the system to inefficient chaos. While a jam in Dubai could be considered on the edge of chaos, because even though drivers wish to get ahead, they understand that in the bigger picture it makes sense to give way to others in a seemingly ordered manner so that everyone can move forward.

There is research literature available supporting the link between CAS and Agile project management. Carmichael et al (2019) show how Complex Adaptive Systems release the agents from both the hierarchical bias (e.g. the Project Manager knows more than others, and is therefore entitled and expected to control more aspects of the project) and complexity bias (e.g. the Project Manager needs to have a stronger skillset as he has a more complicated job) – making change-based mindsets (like Agile) much more useful for managing project teams. Johnson (2001) echoes this with the example of a colony of ants, where the queen simply would not have the capability to communicate with all the

other ants. The colony functions as a CAS with simpler communication and higher autonomy amongst the ants. Boehm et al (2013) say that Agile approaches have a world view that organisations are complex adaptive systems, with emergent requirements that cannot be pre-specified, and are therefore useful in projects where the environment is 'turbulent' and 'high-change'.4

In one of the most relevant studies, Alaa et al (2013) map Agile principles with key features of Complex Adaptive Systems to support the claim that agile software development projects could be looked at as Complex Adaptive Systems. While specific to IT development projects and not directly application to heavy industry MRO projects, the mapping construct is conceptually aligned with how this research effort has approached it. They also find that while all the agile principles are supported by CAS, there are some CAS principles which are not being utilized in prevalent agile methods in the IT development space and could pave the way for further improvement. Through a conceptual framework, the study shows how IT Agile development could be grounded in CAS principles. However, because of the nature of iterative development in IT and IS projects, which is not directly applicable to MRO projects, Agile becomes the core but also the limitation of the work. The study of Change-based Project Management methods, as defined in the current research effort, broadens the scope of the idea, and takes the link between CAS and project management to a first principles level.

The key properties of Complex Adaptive Systems, from literature, can be translated into project management aspects for complex projects.

3.7.1 Agents with schemata

It is an important aspect of CAS that the agents of the system have their own schemata (rules, behavioural quirks, principles et al), based on their perception of the environment (Daniel et al, 2019) (Harkema, 2003) (Holland, 1998) (Ellis et al, 2011) (Cachon et al, 1999) (Alla et al, 2013) (Choi et al, 2001). It is key that the agents don't have a fixed set of rules or too stipulative a rule mandate at the component level, because that will not allow the components the flexibility to respond to environmental changes. Usually, the agent schemata are simple rules at a local level, and the agents might not have the full global picture within their cognitive grasp (Carmichael et al, 2019), but do have a basic understanding of the common purpose of the system (Sweetman et al, 2018)

Translated project management aspect: To be considered as agents with schemata within a CAS framework, the project team would not have an overly prescriptive set of rules and guidelines and would be allowed to manage their parts of the scope and the associated changes in a nimble and flexible manner. This is aligned with the principles behind change-driven approaches like Agile project management.

3.7.2 Feedback and connectivity, Self Organisation

CAS components receive feedback from each other and have connectivity which enables them to steer the system in the desired direction (Holland, 1998) (Weaver, 1948) (Daniel et al, 2019) (Edson, 2012) (Carmichael et al, 2019) (Alla et al, 2013) (Ellis et al, 2011) (Sweetman et al, 2018) (Aritua et al, 2009). However, it is key that the connectivity is not 100%, because that will make for an unstable system (Cachon et al, 1999) (Choi et al, 2001) (Jain et al, 2004)

Translated project management aspect: Co-location with a flexible communication process which is not overly prescriptive will allow the project teams to have the desired connectivity within a CAS framework.

3.7.3 Non-linear, emergent behaviour

The behaviour of the system, as a whole, cannot be linearly extrapolated from the individual agents' actions, as the entire system is dynamically responding to external and internal factors. The system's patterns of behaviour can be markedly different in both kind as well as amplitude from the individual agents' behaviour. As individual agents respond to environmental and internal factors, share feedback with each other and respond based on their own schemata, patterns emerge at the system level that steer the system in particular directions that would not be apparent by calculating the sum of the parts (Carmichael et al, 2019) (Alla et al, 2013) (Ellis et al, 2011) (Choi et al, 2001) (Aritua et al, 2009) (Bakhshi et al, 2005) (Edson, 2012) (Kauffman, 1992) (Jain et al, 2004).

Self-organisation in CAS is a means by which agents, driven by their own set of rules, tend to work in an orderly fashion in a bid to achieve the collective goals (Edson, 2012) (Alla et al, 2013) (Ellis et al, 2011) (Sweetman et al, 2018) (Choi et al, 2001) (Aritua et al, 2009) (Bakhshi et al, 2005) (Jain et al, 2004). This is an important facet in the face of changing environment conditions, as the response to these changes does not require a central command and control mechanism relaying revised responsibilities to agents. Instead, the agents organically react to the changes and self-organise towards an effective response.

Translated project management aspect: Having a collaborative communication protocol with frequent review meetings, retrospective discussions, and course-correction without time-consuming approval requirements would allow the project team to share feedback with each other and self-organise to respond to emergent scope challenges.

3.7.4 Adaptiveness, Anticipation and co-evolution

Agents in a CAS learn from their successes and failures and adapt their actions towards a higher likelihood of a positive outcome going forward (Carmichael et al, 2019) (Alla et al, 2013) (Sweetman et al, 2018) (Aritua et al, 2009) (Jain et al, 2004). To inculcate the lessons from previous attempts is an important aspect of the CAS, as we all know that failure to adapt to changing environment, whether it is in the animal kingdom or in business, does not aid longevity. In a Complex Adaptive System, the individual components anticipate the actions, behaviours, and circumstances of other internal and external agents (Holland, 1992). Sticking to our traffic analogy, when you notice that the driver in front of you is talking on the phone while driving, you anticipate that their driving might become erratic, and you decide to either change lanes away from them or slow down to keep a distance more than usual from them. Either way, this anticipation creates a ripple effect on the other drivers around you, who also make their own judgement calls on how they view, understand, and anticipate your actions. Drivers also anticipate externalities like weather, the behaviour of their vehicles on wet roads, the safe driving distance when visibility is poor due to fog etc. All of these anticipatory actions can have a significant effect on the overall system's performance. (Alla et al, 2013)

Translated project management aspect: Having a change-management process that is flexible and allows the project team to adapt to emergent situations, anticipate problems and adjust various scope components accordingly. This flexibility in change management is not available in traditional plan-based management methods.

3.7.5 Variety

While not explicitly mentioned in a lot of CAS literature, the concept of variety adds a layer of texture to the CAS concept that is quite intuitive. For the system to be successful, there must be the requisite amount of variety in the skillsets of the agents and the resources available to the system, in order to efficiently fulfil the systemic requirements (Edson, 2012) (Alla et al, 2013) (Sweetman et al, 2018). If there is insufficient variety of skills in the system, the response to environmental changes might not be optimal as the system might not have the required tools at their disposal. Similarly, if resources are scarce, the ability of the system to effectively manage the changing conditions gets impacted negatively.

Translated project management aspect: This can be achieved by either having multi-skilled team members in the project team, or by creating teams with complementary skillsets that work together closely throughout the project.

Using Complex Adaptive Systems as a theoretical lens for understanding the change-based approach (like Agile) for managing complex projects is a key step towards appreciating the role played by project type and project context in the design of a suitable management system. Table 6 is now updated to Table 7 to incorporate the management aspects highlighted by the Complex Adaptive Systems theoretical foundation, and their link to Agile Project Management.

Table 7: Traditional vs Agile approach in project management, viewed through the lens of CAS

Management Aspect	Traditional Plan-based Project Management	Agile Project Management	CAS Properties
Planning Process	High emphasis on up front planning (Thesing et al, 2021) Focus on meticulous planning and detailed specifications (Bagiu et al, 2022) (Asnawi, 2012), (Lozo and Jovanovi, 2012)	Continuous planning mindset (Koskella and Abrahamsson, 2004)(Coram and Bohner, 2005) Requirement's prioritization in each iteration, planning at each iteration start (Bagiu et al, 2022)	Agents with schemata; Non-linear emergent behaviour
	Focus on predictability, stability, and high assurance (Boehm et al, 2013)(Padalkar et al, 2016)(Nerur and Mangalaraj, 2005) Plan-driven methods generally prefer formally baselined, complete, consistent, traceable, and testable specifications (Boehm et al, 2013) Focus on strategic over tactical objectives (Boehm et al, 2013).	Focus on tactical over strategic objectives (Boehm et al, 2013). The agile projects' speed and agility come largely from deliberate group planning efforts that enable operation on the basis of tacit interpersonal knowledge rather than explicit documented knowledge as represented in plans and specifications.	
	Plan-driven methods use plans to anchor their processes and provide broad-spectrum communication (Boehm et al, 2013) Initiate – plan – manage product delivery – close the project (Bagiu et al, 2022)	Agile methods require the entire project to be broken into smaller projects, each comprising an iteration which focuses on a few specific features and ends with a working system as a deliverable (Larman, 2003)(Asnawi, 2012) Typically based on short cycle iterations, producing working code after each iteration (Cooper, 2016)	
Change Management	Beuracratic and high formalization (Bagiu et al, 2022)(Böhle et al, 2015)(Nerur and Mangalaraj, 2005) Change Management is established as a rigorous process and change is typically exceptional (Bagiu et al, 2022) and method of control if progress is outside of tolerances (Boehm et al, 2013) Linear, sequential model (Diem, 2021) - project management becomes an exercise in managing scope, which can be broken down into sequentially dependent chunks (Koskela and Howell, 2002)	Short cycle iterations allow changes to be built into the planning of each iteration, enabling management of extensive changes. Agile methods count on their rapid iteration cycles to determine needed changes in the desired capability and to fix them in the next iteration (Boehm et al, 2013)(Ciric et al, 2022) Iteration in several days, check the requirements, attest the function and review with the customer (Bagiu et al, 2022)	Adaptiveness, Anticipation and co-evolution
	Change is considered a negative thing - Having too many changes could mean that the original objectives might be compromised (Grushka-Cockayne et al., 2015) and could escalate conflicts (Boehm, 2002) due to prescriptive processes.	Changes are usual part of the project (Bagiu et al, 2022)(Böhle et al. 2015) Recognizing the inevitability of change and embracing it, rather than attempting to cope with it through extensive planning, provides the nimbleness needed to survive in a turbulent business world (Vinekar et al, 2006)(Jain, 2006)	
The role of the customer	Typically high customer involvement at specification stage, but lesser during the project execution stage (Nerur and Mangalaraj, 2005)	Customer representatives are encouraged to be dedicated to the project and co-located with the project team and provide regular feedback on progress, iterations etc (Serrador and Pinto, 2015) (Ciric et al, 2022)(Boehm et al, 2013) Customer representatives interact with various members of the project team (Conboy et al, 2011)	Feedback and connectivity; Adaptiveness, Anticipation and co-evolution
	As-needed customer interactions, focused on contract provisions (Bagiu et al, 2022)(Kadefors, 2004) Plan-driven methods generally depend on some form of contract between the developers and customers as the basis for customer relations (Boehm et al, 2013)	Dedicated, knowledgeable, collaborated, collocated onsite customers (Bagiu et al, 2022) The active participation and constant involvement of the customer in systems development yields greater benefits than the fulfillment of predetermined requirements specified in a contract (Vinekar et al, 2006)(Coram and Bohner, 2005)(Nerur and Mangalaraj, 2005)	
	Plan-driven people count on their process maturity to provide confidence in their work (Boehm et al, 2013)	Agile developers use working software and customer participation to instill trust in their track record (Boehm et al, 2013)(Kadefors, 2004)	
The role of leadership	Mechanistic organisational structure (Bagiu et al, 2022)	Collaborative management style (Bagiu et al, 2022)(Salameh, 2014).	Feedback and connectivity; Self organisation
	Process-centric control (Nerur and Mangalaraj, 2005) Plan driven projects focus on process over people (Highsmith and Cockburn, 2001)(Metcalfe, 1997)	People-centric control (Nerur and Mangalaraj, 2005) Open Dialogue and flat organisation preferred (Radan et al, 2015)	
	Command and control management style (Bagiu et al, 2022)(Metcalfe, 1997)(Nerur and Mangalaraj, 2005)	Management buy in towards high autonomy in the project team (Rothman and Kilby, 2019)(Nerur and Mangalaraj, 2005)(Tiwari et al, 2021)	
Communication	Strict, formal communication and reporting activities (Bagiu et al, 2022)(Nerur and Mangalaraj, 2005)	Informal communication (Bagiu et al, 2022)(Nerur and Mangalaraj, 2005) Agile methods generally rely on more frequent, person-to-person communication (Boehm et al, 2013) (Mann and Meurer, 2005)	Feedback and connectivity; Self organisation; Non-linear emergent behaviour
	Plan-driven methods rely heavily on explicit documented knowledge. With plan-driven methods, communication tends to be one-way. Communication is generally from one entity to another rather than between two entities (Boehm et al, 2013)	Agile methods rely heavily on tacit, interpersonal knowledge for their success (Boehm et al, 2013)(Nerur and Mangalaraj, 2005). Knowledge is specifically gathered through team planning and project reviews (an activity agilists refer to as "retrospection"). Retrospective meetings are a key part of the model (Diem, 2021)(Alyatma, 2021)(Jain, 2006)	

Table 7 (contd): Traditional vs Agile approach in project management, viewed through the lens of CAS

Management Aspect	Traditional Plan-based Project Management	Agile Project Management	CAS Properties
Team Setup	Assure the user involvement primarily through the reporting process (Bagiu et al, 2022) Plan driven projects focus on process over people (Highsmith and Cockburn, 2001)(Metcalfe, 1997)	Active users are part of the development team itself (Bagiu et al, 2022) Agile projects consider people an important part of the project management solution and rely more on that vs processes (Highsmith and Cockburn, 2001)(Fernandes et al, 2008)	Non-linear emergent behaviour; Variety, Feedback and connectivity; Self organisation
	In a plan-driven culture, the people feel comfortable and empowered when there are clear policies and procedures that define their role in the enterprise. This is more of a production-line environment where each person's tasks are well-defined. The expectation is that they will accomplish the tasks to specification so that their work products will easily integrate into others' work products with limited knowledge of what others are actually doing (Boehm et al, 2013).	In an agile culture, the people feel comfortable and empowered when there are many degrees of freedom available for them to define and work problems. This is the classic craftsman environment, where each person is expected and trusted to do whatever work is necessary to the success of the project. This includes looking for common or unnoticed tasks and completing them. (Boehm et al, 2013) The ingenuity and competence of people as well as their interactions and collaborations are of greater value than tools and processes (Vinekar et al, 2006)(Nerur and Mangalaraj, 2005)	
	Manage by exception approach – project manager has a strict budget and all important changes must be reviewed by board. It takes time and additional effort (Bagiu et al, 2022) Project manager as a director (Coram and Bohner, 2005) - follows a command and control management style (Nerur and Mangalaraj, 2005)	The traditional role of a project manager as planner, organiser, and controller disappears,- and the role of a facilitator or coach who- effectively manages the collaborative efforts of team members without stifling their creativity takes its place (Highsmith, 2003)(Nerur and Mangalaraj, 2005)(Coram and Bohner, 2005).	
		Self-organisation is one of the key traits (Vinekar et al, 2006)(Asnawi, 2012)(Nerur and Mangalaraj, 2005)(Highsmith, 2003) Promotes the skills of each team member and thus helps to achieve the best possible results in a collaborative effort (Rothman and Kilby, 2019)(Nerur and Mangalaraj, 2005)(Conboy et al, 2011)	
Documentation	Heavy-weight documentation with both the process plans and rich content (Bagiu et al, 2022)(Thesing et al, 2021); produce a large amount of documentation that codifies process and product knowledge. Communication among project participants is formalized through these documents.(Nerur and Mangalaraj, 2005) Plans make up a large portion of the required documentation in most plan-driven approaches (Boehm et al, 2013) For high-assurance, safety-critical projects, following a thorough, documented set of plans and specifications is the only way to meet existing certification standards (Boehm et al, 2013)	Keeping requirements and documentation lightweight (Nerur and Mangalaraj, 2005) and value-driven (Fernandez et al, 2008), and acknowledging that change is a normal and acceptable reality in software development (Bagiu et al, 2022) Delivering a high-quality working system to the customer is more important than producing copious documentation (Vinekar et al, 2006) Reduce the emphasis on extensive documentation in favor of more functional milestones (e.g. working prototypes) and face to face communication (Cooper et al, 2016), saving project teams the significant amount of time and effort spent on maintaining exhaustive documentation (Coram and Bohner, 2005) (Vinekar et al, 2006)(Annosi et al, 2020)	Agents with schemata

3.8 Conclusion

In this chapter, a summary of the studied literature was presented for each of the topical areas of interest for this research effort. After reviewing the definition of project management, a Systematic Literature Review was used to get an overview of the current research interests in the field of project management and validate the academic need for this research effort to fill the knowledge gaps in current research. The key knowledge gaps identified were

1. firstly, that maintenance projects have not received enough academic attention and require further research to better improve the understanding of their management. Considering their importance to the desired business outcomes of organisations, and the complexity and unique circumstantial aspects of their scope, further research and study on maintenance projects would be beneficial for both academia and industry.
2. Where maintenance projects are addressed in literature, the inevitability of change is not acknowledged and therefore management of change due to complexity is not explored.

3. There is limited cross-fertilisation of project management methods across sectors. Heavy industry and construction project primarily assumes traditional plan-driven project management methods. Meanwhile agile methods are assumed to be applicable only to IT, software and product development projects so their application to MRO projects is not understood.

Apart from the identified knowledge gaps, there was also positive support from the Systematic Literature Review for the proposed link between complexity theory and change based project management methods. Embracing complexity and a somewhat non-deterministic mindset towards project management style and outcomes is one of the key theoretical underpinnings of the Change-Based Project Management approach endorsed in this research effort, and having academic support for complexity in project management is vital for meeting the needs for academic validation.

Subsequently, literature on traditional (plan-based) and modern (change-based) project management approaches were reviewed along with the key tenets and aspects of these methods, with project context and complexity identified as key drivers for selection of a suitable management style. Finally, literature on the theory behind Complex Adaptive Systems was presented, and key properties of these systems were listed and translated into project management aspects.

For the research objectives to be met, it was vital to ensure that outside of the industrial context, this research stands firm in an academic context as well. The Systematic Literature Review was especially helpful as a validation step because the prevalent industrial discourse was clearly reflecting in academic discourse as well, and this reinforced the need for this research effort. During the data collection for this research effort, one of the lines of questioning in the interviews was the interviewees' familiarity with the concepts of PMBOK and Agile Project Management. In fact, apart from one leader (VPT), none of the executive leadership or project team members were familiar with Agile project management. This reinforces the findings from the Systematic Literature Review that in heavy industry MRO projects, practitioners have not been formally exposed to any change-based project management methods.

It was also noted that while project performance along tangible metrics like cost and time is important for organisations' business outcomes, the context of the project, as used in actuality-based research (Cicmil et al, 2006), should be considered as an important variable. The aim should be to understand and address the empirical reality of projects so that their complex, non-linear and context-sensitive idiosyncrasies can be better built into the design and selection of the desired project management approach. This research effort utilizes this mindset while proposing the Change-Based Project Management approach for MRO projects in heavy industry.

This chapter provided the academic backing for the discussion on project context, complexity and project management aspects that will become the vocabulary and grounding for the conceptual framework for Change-Based Project Management presented in Chapter 4 and further evaluated against empirical evidence in later chapters.

4. Conceptual framework for applying Change-Based Project Management for MRO projects

4.1 Overview

In the previous chapter, the extant discourse in project management was reviewed, and traditional (plan-based) and modern (agile) project management methods were discussed. Project complexity and context were identified as drivers for management approach selection, and the desire to have complex projects behave like Complex Adaptive Systems was translated from theory into practical project management aspects.

This chapter brings Maintenance Repair and Overhaul (MRO) projects' context into perspective and establishes the need for a project management approach that requires a change-based approach (unlike traditional methods) but is not a good fit with the popular Agile methodology. Change-Based Project Management (CBPM) is introduced as the solution for this context, and a conceptual framework developed for the approach using Complex Adaptive Systems as the underlying theory. The conceptual framework is built based on the literature and concepts reviewed in the previous chapter, and for brevity and focus, these component literature references have not been re-referenced in this chapter.

As envisioned, CBPM is a management system that allows for more contextual sensitivity and is not restricted to some of the strict requirements of Agile. With the principles of being change-based and having the project work like a Complex Adaptive System at the heart of it, CBPM is adaptable to context, industry and project types. Later in this research effort, the CBPM conceptual framework will be validated with empirical data and improved based on findings from the field.

4.2 The Complexity of MRO projects

While it was seen from literature that an Agile project management approach is better equipped to deal with complex projects, most of the research and application, as seen from the Systematic Literature Review, has been in the fields of IT and product development. The fact that such a project context is suitable for an iteration-based development process greatly helps the use of Agile. But what about complex projects where iterations are not possible?

Maintenance, Repair and Overhaul (MRO) projects in heavy industry settings are a good example of projects with a high level of complexity but limited ability for iterative development. This is because these projects involve the strip-down and maintenance of multiple components of structure and equipment, which then need to be put back together in a certain sequence for the equipment/system/unit to be tested and commissioned. Several such equipment/systems/unit are typically part of the larger project, which can be envision at 3 levels.

Equipment overhaul – There are various equipment that interaction with each other in a unit's operations. The overhaul of each equipment comprises of a strip-down, inspection and rebuild. Very often, the condition of the equipment is not known till the strip-down and inspection is carried out – this leads to a high level of uncertainty. Depending on the result of the inspection, parts may be reused or have to be replaced and the scope of the rebuild may vary greatly. Therefore, each of the multitude of parts has inspection-linked uncertainty in its overhaul sequence, which can then result in an impact on the overall commissioned readiness timeline of the equipment. Further, there is no possibility for iterative development because no working product/code can be generated in intermediate steps in an

overhaul process – the entire overhaul needs to be completed for the equipment to be tested and considered operational.

System readiness – One level above the individual equipment level, is the system level, which comprises of multiple equipment operating in a system. Because the individual equipment overhaul timeline is uncertain, and there is a high level of dependency and interaction between the equipment within a system, the system readiness planning and projections can become very complex and dynamic. Due to these complex interactions of multiple equipment, each of which cannot be broken into iterative product readiness, system-wide iterations with working product/code are also not possible due to the various sub-component equipment being in various stages of overhaul at any point.

Operations readiness – at the final level is the operations readiness of the unit, which is when the various systems are tested in unison (an operations simulation or test drive) to prove that the unit can perform the desired work after the maintenance program has been completed. Clearly, due to the complexity at the system level, trying to plan the final testing and acceptance process where all systems need to perform at the same time is another step up in complexity, and further does not allow for an iterative development at the product level.

Not only is there the complexity and uncertainty in the individual/systemic scope components, but also in how the team deals with it, because the team's reactions to the problems, their ways and means of addressing it, their understanding of the wider implications of these changes, and their resource allocation towards this, all impact how the project will perform. This makes the project unsuitable for simulation or management based on traditional plan-based methods (Böhle et al, 2015). While in IT and product development Agile projects, teams can be assigned to iterative tasks with a level of review of resources and cross-task utilization at the end of each iteration, in MRO projects where breakdown into iterations is not practical, the team is typically working on multiple equipment/systems at the same time, and the team members are allocated based on technical skillset (e.g. electrical, mechanical, structural) across a gamut of scopes (and sometimes across the entire spectrum of the project scopes), instead of having team-members dedicated for individual scopes.

Boonstra and Reezigt (2023), although not explicitly discussing change-based or plan-based methods, make a framework for management styles based on the type of project complexity (Fig 10). Based on their categorization, MRO projects would fall under the High Structural Complexity and Low Dynamic complexity segment, and therefore they recommend a stakeholder management style which has a team of experts which work on the project, facilitated by the project manager and organisational management, to create a cooperative multi-disciplinary problem-solving approach based on high level constraints and flexibility within the management team. This is, at a first principles level, aligned with the conceptual framework.

		Structural Complexity	
		Low	High
Dynamic Complexity	Low	*[1] Uniform projects* → Instructionism	*[2] Pluriform projects* → Stakeholder management
	High	*[3] Unfolding projects* → Learning and experimenting	*[4] Ambiguous projects* → Symbolic dialogues on divergent future states

Fig 10: Complexity Framework with Four Generic Project Types and Related Project Management Strategies (Boonstra and Reezigt, 2023)

Cachon et al (1999) offer a valuable insight when they endorse using multi-level Complex Adaptive System theory over models based on simpler dependency between variables at a single-level, because it is the aggregation of behaviours and outputs at lower levels that will help us understand the aggregate behaviour at the upper level. Therefore, organisations working in dynamic environments (vis MRO Project teams) should be given strategic direction such that their self-organising and improvisational behaviour is enabled and made more effective. The role of the project manager (and other enabling leadership roles in the organisation), then, is not to direct or command, but to influence the environment of the team in a way so as to allow them to flourish as an adaptive system.

There is available literature on the challenges on implementation of change-based project management methods which needs to be considered. Coram and Bohner (2005) highlight how implementation of Agile methods can be challenging in industries where a statement of work might be a contractual requirement with very little flexibility (like O&G drilling contractors). Hard lined deliverable and documentation requirements, mandatory schedules, and customers not willing to move to collaborative relationship could be potential challenges in these business environments if one wants to move to change-based methods. When it comes to MRO projects, deliverable and documentation requirements are usually quite common and are considered as a standard output for the project. However, it is important to distinguish between external deliverables/documentation i.e. the ones owed to customers or regulatory bodies, and internal deliverables i.e. documentation generated for internal consumption within the organisation. Change-based methods work towards reducing the expenditure of effort towards the latter, while the former is usually the documentation related to certification of completion of work and easily attainable. Mandatory schedules, while problematic in an agile product or software development setting, are quite commonplace in MRO projects, as the asset being maintained needs to return to service ASAP and usually in line with the customers' requirements. This rigid end-point is one of the reasons why the complexity theory view is more suited in such projects, so that the project team has the flexibility and empowerment to adapt and overcome challenges to achieve the end goal. Finally, the customer engagement piece is a real challenge – there are several operators in O&G who do not want to get involved at all in the drilling contractor's project activities and will only carry out their acceptance process once the rig is considered 'ready to go'. This is sub-optimal and defeats the

point of an adaptive change-based management approach. Efforts need to be made towards customer engagement in this regard to reap the true benefits of the approach.

4.3 Change-Based Project Management – A Conceptual Framework for application in MRO projects

The primary reason why this research effort is building CBPM and not trying to enforce Agile in heavy industry, is due to the heavy focus on iterative development of software/products in Agile methods, which is not considered a contextual fit for MRO projects. While iterative cycles are a useful tool for manifesting the principles behind change-based methods, it has limited (if any) utility in applications where a new product or service is not being developed. In project activities where an incremental benefit is of no utility to the end user (e.g. a partially completed maintenance activity on an equipment does not provide a usable end product at the end of that 'iteration'), iterative development cannot be the cornerstone of change-based methods. As envisioned, iterative development is part of the toolkit of the larger change-based project management method, but it is possible to gain the benefits of the method without deploying that tool. It is the mindset and positive attitude towards change that help change based methods create value for customers and high engagement within teams, and not just the iterative process aspect of Agile (Papadakis et al, 2020). Zhou (2003) succinctly states that stability brings with it the advantages of discipline and automation and the disadvantage of being overly restrictive; Agility, on the other hand, brings with it the advantages of flexibility and human initiative while inhibiting repeatable processes.

The other aspect where CBPM in MRO projects differs from Agile is the way the project team is organised. Because the project is not setup with iterations in mind, the same project team members are typically involved in a multitude of scopes, and sometimes even all of them. Instead of creating scope level teams that work on improving their product iteratively, as done in Agile, the teams in CBPM are constructed using functional expertise, with functional superintendents (e.g. mechanical, structural, electrical) are then involved in their functional capacity across the project scopes. As an example, instead of having a team working on steel replacement, a team working on pumps overhaul, and a team working on living quarters refurbishment, the CBPM MRO project management team would have an electrical superintendent helping with the electrical aspect of all those scopes, the mechanical superintendent helping with the mechanical aspects of all those scopes, and so on. This type of team setup requires further emphasis on the communication and self-organising aspects of CBPM, because team-members have to coordinate and organise their plans and actions across multiple scopes.

Based on above, an update to of Table 8 is now generated, showcasing the traditional (plan-based), modern (Agile) and CBPM approaches, with the underlying theoretical grounding of Complex Adaptive Systems theory. This summary table helps frame the context and requirements which CBPM needs to solve for, to provide practitioners the required tools for managing such projects. This is, then, the set of requirements that the Conceptual Framework **(section 5.4)** must meet.

Table 8: Traditional vs Agile vs CBPM approach in project management, viewed through the lens of CAS

Management Aspect	Traditional Plan-based Project Management	Agile Project Management	CAS Properties	Change-Based Project Management (CBPM) design criteria
Planning Process	High emphasis on up front planning (Thesing et al, 2021) Focus on meticulous planning and detailed specifications (Bagiu et al, 2022) (Asnawi, 2012), (Lozo and Jovanovi, 2012)	Continuous planning mindset (Koskella and Abrahamsson, 2004)(Coram and Bohner, 2005) Requirement's prioritization in each iteration, planning at each iteration start (Bagiu et al, 2022)	Agents with schemata; Non-linear emergent behaviour	Aligned with Agile (continuous planning)
	Focus on predictability, stability, and high assurance (Boehm et al, 2013)(Padalkar et al, 2016)(Nerur and Mangalaraj, 2005) Plan-driven methods generally prefer formally baselined, complete, consistent, traceable, and testable specifications (Boehm et al, 2013) Focus on strategic over tactical objectives (Boehm et al, 2013).	Focus on tactical over strategic objectives (Boehm et al, 2013). The agile projects' speed and agility come largely from deliberate group planning efforts that enable operation on the basis of tacit interpersonal knowledge rather than explicit documented knowledge as represented in plans and specifications.		Aligned with Agile (tactical planning instead of process driven assurance)
	Plan-driven methods use plans to anchor their processes and provide broad-spectrum communication (Boehm et al, 2013) Initiate – plan – manage product delivery – close the project (Bagiu et al, 2022)	Agile methods require the entire project to be broken into smaller projects, each comprising an iteration which focuses on a few specific features and ends with a working system as a deliverable (Larman, 2003)(Asnawi, 2012) Typically based on short cycle iterations, producing working code after each iteration (Cooper, 2016)		For projects where scope breakdown into iterations (as used in Agile) is not optimal. Instead, cross-functional teams use the same principles for project-level management, not iteration level management like Agile.
Change Management	Beuracratic and high formalization (Bagiu et al, 2022)(Böhle et al, 2015)(Nerur and Mangalaraj, 2005) Change Management is established as a rigorous process and change is typically exceptional (Bagiu et al, 2022) and method of control if progress is outside of tolerances (Boehm et al, 2013) Linear, sequential model (Diem, 2021) - project management becomes an exercise in managing scope, which can be broken down into sequentially dependent chunks (Koskela and Howell, 2002)	Short cycle iterations allow changes to be built into the planning of each iteration, enabling management of extensive changes. Agile methods count on their rapid iteration cycles to determine needed changes in the desired capability and to fix them in the next iteration (Boehm et al, 2013)(Ciric et al, 2022) Iteration in several days, check the requirements, attest the function and review with the customer (Bagiu et al, 2022)	Adaptiveness, Anticipation and co-evolution	For projects where scope breakdown into iterations (as used in Agile) is not optimal. Instead, cross-functional teams use the same principles for project-level management, not iteration level management like Agile.
	Change is considered a negative thing - Having too many changes could mean that the original objectives might be compromised (Grushka-Cockayne et al., 2015) and could escalate conflicts (Boehm, 2002) due to prescriptive processes.	Changes are usual part of the project (Bagiu et al, 2022)(Böhle et al. 2015) Recognizing the inevitability of change and embracing it, rather than attempting to cope with it through extensive planning, provides the nimbleness needed to survive in a turbulent business world (Vinekar et al, 2006)(Jain, 2006)		Aligned with Agile (considers change inevitable and embraces it)
The role of the customer	Typically high customer involvement at specification stage, but lesser during the project execution stage (Nerur and Mangalaraj, 2005)	Customer representatives are encouraged to be dedicated to the project and co-located with the project team and provide regular feedback on progress, iterations etc (Serrador and Pinto, 2015) (Ciric et al, 2022)(Boehm et al, 2013) Customer representatives interact with various members of the project team (Conboy et al, 2011)	Feedback and connectivity; Adaptiveness, Anticipation and co-evolution	Aligned with Agile (early and continuous customer interface encouraged).
	As-needed customer interactions, focused on contract provisions (Bagiu et al, 2022)(Kadefors, 2004) Plan-driven methods generally depend on some form of contract between the developers and customers as the basis for customer relations (Boehm et al, 2013)	Dedicated, knowledgeable, collaborated, collocated onsite customers (Bagiu et al, 2022) The active participation and constant involvement of the customer in systems development yields greater benefits than the fulfillment of predetermined requirements specified in a contract (Vinekar et al, 2006)(Coram and Bohner, 2005)(Nerur and Mangalaraj, 2005)		Aligned with Agile (collocated, active customer participation encouraged).
	Plan-driven people count on their process maturity to provide confidence in their work (Boehm et al, 2013)	Agile developers use working software and customer participation to instill trust in their track record (Boehm et al, 2013)(Kadefors, 2004)		Aligned with Agile (trust built on working together).
The role of leadership	Mechanistic organisational structure (Bagiu et al, 2022)	Collaborative management style (Bagiu et al, 2022)(Salameh, 2014).	Feedback and connectivity; Self organisation	Aligned with Agile (collaborative management style).
	Process-centric control (Nerur and Mangalaraj, 2005) Plan driven projects focus on process over people (Highsmith and Cockburn, 2001)(Metcalfe, 1997)	People-centric control (Nerur and Mangalaraj, 2005) Open Dialogue and flat organisation preferred (Radan et al, 2015)		Aligned with Agile (people-centric, flat organisation).
	Command and control management style (Bagiu et al, 2022)(Metcalfe, 1997)(Nerur and Mangalaraj, 2005)	Management buy in towards high autonomy in the project team (Rothman and Kilby, 2019)(Nerur and Mangalaraj, 2005)(Tiwari et al, 2021)		Aligned with Agile (Management buy in towards autonomy).

Table 8 (contd): Traditional vs Agile vs CBPM approach in project management, viewed through the lens of CAS

Management Aspect	Traditional Plan-based Project Management	Agile Project Management	CAS Properties	Change-Based Project Management (CBPM) design criteria
Communication	Strict, formal communication and reporting activities (Bagiu et al, 2022)(Nerur and Mangalaraj, 2005)	Informal communication (Bagiu et al, 2022)(Nerur and Mangalaraj, 2005) Agile methods generally rely on more frequent, person-to-person communication (Boehm et al, 2013) (Mann and Meurer, 2005)	Feedback and connectivity; Self organisation; Non-linear emergent behaviour	Aligned with Agile (informal, direct communication).
	Plan-driven methods rely heavily on explicit documented knowledge. With plan-driven methods, communication tends to be one-way. Communication is generally from one entity to another rather than between two entities (Boehm et al, 2013)	Agile methods rely heavily on tacit, interpersonal knowledge for their success (Boehm et al, 2013)(Nerur and Mangalaraj, 2005). Knowledge is specifically gathered through team planning and project reviews (an activity agilists refer to as "retrospection"). Retrospective meetings are a key part of the model (Diem, 2021)(Alyatma, 2021)(Jain, 2006)		Aligned with Agile (retrospective meetings encouraged)
Team Setup	Assure the user involvement primarily through the reporting process (Bagiu et al, 2022) Plan driven projects focus on process over people (Highsmith and Cockburn, 2001)(Metcalfe, 1997)	Active users are part of the development team itself (Bagiu et al, 2022) Agile projects consider people an important part of the project management solution and rely more on that vs processes (Highsmith and Cockburn, 2001)(Fernandes et al, 2008)	Non-linear emergent behaviour; Variety, Feedback and connectivity; Self organisation	Aligned with Agile. Key difference is that the same team members are involved in several scopes, and due to the lack of iterations, this adds further emphasis on the communication and self-organising aspects
	In a plan-driven culture, the people feel comfortable and empowered when there are clear policies and procedures that define their role in the enterprise. This is more of a production-line environment where each person's tasks are well-defined. The expectation is that they will accomplish the tasks to specification so that their work products will easily integrate into others' work products with limited knowledge of what others are actually doing (Boehm et al, 2013).	In an agile culture, the people feel comfortable and empowered when there are many degrees of freedom available for them to define and work problems. This is the classic craftsman environment, where each person is expected and trusted to do whatever work is necessary to the success of the project. This includes looking for common or unnoticed tasks and completing them. (Boehm et al, 2013) The ingenuity and competence of people as well as their interactions and collaborations are of greater value than tools and processes (Vinekar et al, 2006)(Nerur and Mangalaraj, 2005)		Aligned with Agile. Key difference is that the same team members are involved in several scopes, and due to the lack of iterations, this adds further emphasis on the communication and self-organising aspects. Project team carry out multiple interdependent tasks rather than interdependent teams working on separate tasks, requiring self-organising behaviour instead of central coordination.
	Manage by exception approach – project manager has a strict budget and all important changes must be reviewed by board. It takes time and additional effort (Bagiu et al, 2022) Project manager as a director (Coram and Bohner, 2005) - follows a command and control management style (Nerur and Mangalaraj, 2005)	The traditional role of a project manager as planner, organiser, and controller disappears,- and the role of a facilitator or coach who- effectively manages the collaborative efforts of team members without stifling their creativity takes its place (Highsmith, 2003)(Nerur and Mangalaraj, 2005)(Coram and Bohner, 2005).		Aligned with Agile (project manager as coach and mentor).
		Self-organisation is one of the key traits (Vinekar et al, 2006)(Asnawi, 2012)(Nerur and Mangalaraj, 2005)(Highsmith, 2003) Promotes the skills of each team member and thus helps to achieve the best possible results in a collaborative effort (Rothman and Kilby, 2019)(Nerur and Mangalaraj, 2005)(Conboy et al, 2011)		Aligned with Agile. Key difference is that the same team members are involved in several scopes, and due to the lack of iterations, this adds further emphasis on the communication and self-organising aspects
Documentation	Heavy-weight documentation with both the process plans and rich content (Bagiu et al, 2022)(Thesing et al, 2021); produce a large amount of documentation that codifies process and product knowledge. Communication among project participants is formalized through these documents.(Nerur and Mangalaraj, 2005) Plans make up a large portion of the required documentation in most plan-driven approaches (Boehm et al, 2013) For high-assurance, safety-critical projects, following a thorough, documented set of plans and specifications is the only way to meet existing certification standards (Boehm et al, 2013)	Keeping requirements and documentation lightweight (Nerur and Mangalaraj, 2005) and value-driven (Fernandez et al, 2008), and acknowledging that change is a normal and acceptable reality in software development (Bagiu et al, 2022) Delivering a high-quality working system to the customer is more important than producing copious documentation (Vinekar et al, 2006) Reduce the emphasis on extensive documentation in favor of more functional milestones (e.g. working prototypes) and face to face communication (Cooper et al, 2016), saving project teams the significant amount of time and effort spent on maintaining exhaustive documentation (Coram and Bohner, 2005) (Vinekar et al, 2006)(Annosi et al, 2020)	Agents with schemata	Aligned with Agile in focussing on functional documentation. Documentation is dependent on customer requirements and often focused on final project deliverable documents and not on process documents.

Having looked at the context-based need for CBPM from literature, and the key differentiators of the approach from traditional plan-based and Agile project management methodologies, a simplified version of Table 8 is developed and presented as the Conceptual framework for managing MRO projects using Change-Based Project Management (Table 9)

Table 9: Conceptual framework for managing MRO projects using Change-Based Project Management

MRO Projects Management aspect	Change-Based Project Management Approach	Complex Adaptive Systems
Planning Process	Continuous Planning mentality; Suitable for projects where scope breakdown into iterations is not possible; Accountability of the team is continuous from the planning to execution to closeout phases.	Agents with schemata; Non-linear emergent behaviour;
Change Management	Change is inevitable; swift and nimble change management; Adaptive management style	Adaptiveness, Anticipation and co-evolution
The role of the customer	Customer engagement and active participation throughout the project lifecycle and at all levels	Feedback and connectivity; Adaptiveness, Anticipation and co-evolution
The role of leadership	Leadership buy-in towards the approach; Autonomy of the project team.	Feedback and connectivity; Self-Organisation
Communication	Communication over processes (Stand-up Meetings, retrospective meetings, co-location). High-frequency informal communication to facilitate self-organising behaviour	Feedback and connectivity; Self organisation; Non-linear emergent behaviour
Team Setup	Smaller teams with varied skillsets spread across multiple scopes; Ability to be multiskilled; Project manager as a mentor and guide; Self-organising behaviour	Non-linear emergent behaviour; Variety, Feedback and connectivity; Self organisation
Documentation	Decentralized decision making, leading to low documentation emphasis; Extent of documentation driven by final project deliverables	Agents with Schemata

4.4 Hybrid Project Management methods

Having seen the two main schools of thought in project management practice, viz plan-based and change-based methodologies, let us look at endorsements of the need for Hybrid methods available in the literature. Williams (2005) urges the need for developing ways to mix the contrasting methods of project management (maintaining the project plan (Plan-based project management) vs constant replanning (CPM). Collyer et al (2010) elaborated on the role and management of dynamic environments in projects, by collating interview data from practitioners in various industries. They found that traditional, up-front planning-based methods, faced challenges in dynamic environments due to changing material, resources, tools and techniques, changing relationships to other projects, services or products, and with changing goals. In the study, they found that where dynamic environments are affecting projects, there is little support for approaches which help minimize changes by attempting to make the environment more static. There was widespread support for 'emergent planning' methods, where only a high-level plan is developed first, and finer details are filled in as they emerge. In an attempt to build a theory on managing dynamism within projects, the authors recommend a process wherein the planning for static and dynamic scope elements should be treated in more traditional and emergent ways, respectively.

Shenhar (2001) recommends that the project management style should be based on project types and recommends that management should formally classify projects based on complexity (of product, task or organisation), time frame, uncertainty, skill of the labour force etc. in order to utilize the best management style. For instance, projects with lower uncertainty could be managed in a formal style (Plan-based project management); whereas in projects with higher uncertainty, management should employ a more flexible attitude and tolerance for change and trade-off between project requirements. If requirements change frequently, timelines are short and resources are skilled, agile methods can be chosen; while if the requirement is clear, and projects are larger, Plan-based project management models like Waterfall can be chosen.

Papadakis et al (2020) carry out a systematic literature review specific to tradition-agile hybrid methods and elaborate how such hybrid methods can help organisations increase their flexibility while still improving their process frameworks. Serrador and Pinto (2015) endorse a balance between traditional and agile methods, depending on the project characteristics. Depending on the complexity and scale of the project, a certain amount of upfront planning might be required, while operating the same project in a high-change dynamic setting would require application of agile methods during the execution phase

Vinekar et al (2006) envision an ambidextrous approach to management, where agile and traditional project management methods coexist within an organisation. These would be run as two separate units, one running a traditional project management setup with the project manager would have hierarchal authority over a team of developers working under him, while the other would run an Agile system where small teams of developers would work in a flexible, decentralized structure.

Ciric et al (2022) conclude that a combination of agile and traditional methods should be combined to benefit from the positives from both approaches, but how the combination is envisioned should be based on project characteristics, context and other short/long term factors.

Boehm (2002) says that, depending on the specific requirements and situational constraints of the project, a sliding scale can be theorized on which the traditional vs agile methods' utility can be plotted. Due to the very nature of their approaches, these curves will move in the opposite directions for the traditional vs agile methods and usually meet in a 'sweet spot'. The attempt in project management should be to achieve this sweet spot wherein the traditional plan-based methods provide the right amount of structure for the more fluid agile methods to thrive.

Boehm and Turner (2004) recommend finding a balance between stability and agility. After analysing the individual characteristics (application, management, technical and personnel) of each, they postulate that the choice between plan-based (traditional) and change-based (agile) project management methods is contingent on five factors, and a balance could be found based on the project characteristics: The size of the project and team (larger projects bias towards Plan-based project management); The criticality of the project (critical projects bias towards Plan-based project management in the author's eyes); The degree of dynamism or volatility of the environment (a higher degree of uncertainty bias towards CPM); The competence of personnel (CPM requires personnel with higher competence); and compatibility with the prevailing culture (combating change can be difficult).

Coram and Bohner (2005) highlight how specific business challenges in using a full-fledged agile approach can be mitigated by introducing formality in certain features/processes, in order to cater to the business case. In larger scale agile implementations, Dikert et al (2016) found that a co-existence of new (change-based) and old (plan-based) methods were often seen as problematic by people within the organisation. This was usually the case when the methods were being changed while the project was ongoing and had been setup traditionally. Bianchi et al (2020), in a study specific to the software and new product development industry, advise that Stage Gate and Agile don't work well together at a project level, but if deployed differently, where Stage Gate is done at the macro level for product development while Agile sprints are used for day-to-day project management, a hybrid approach might add value. They recommend that such a hybrid approach could be used as a stepping stone towards making an organisation move from traditional management to agile.

Lensges et al (2018) focus on the behavioural aspects of project management and stress the point that even though there is a common misconception that the implementation of agile or traditional project management methodologies is mutually exclusive, they share a common lineage. Depending on the complexity and uncertainty in a project, a traditional, agile or hybrid approach may be most suitable. In projects with low uncertainty and low complexity, traditional methods work well as there is a high likelihood of the plan being adhered to. In projects with high complexity and high uncertainty, iterative agile methods work well since it gives the team ample opportunity to adapt to the constantly changing requirements. High complexity-low uncertainty, and Low complexity-High uncertainty projects are good candidates for a hybrid approach, benefiting from some pre-planning but also needing flexibility during the working phase of the projects to deal with changes and technical challenges

Cooper (2016), focusing on manufacturing industries, indicates that a hybrid model of plan-based and change-based project management can work very well, especially in projects dealing with high levels of uncertainty, and that the advantages of each approach can be adequately exploited in such a model. A similar sentiment is echoed by Boehm and Turner (2004), who also warn that how the balance is stuck is key to the success of the model.

While there is theoretical justification for applying change-based methods, there are several scopes (like steel replacement) where prior inspections can be done during operations and the likelihood of surprises or changes is low during the project execution phase. It would be sensible to pre-plan the material and resources for these in traditional ways, and control the scope based on plan-based methods like percentage complete or resource-levelling. This hybrid marriage of plan-based and change-based management would allow the team to focus their energy on the dynamic scopes and leave the predictable scopes on 'auto-pilot' after the initial plan is formulated. Any minor issues encountered in the plan-based scopes can usually be resolved using the team's inherent ability to manage changes flexibly (Carmichael et al, 2019), and larger issues can be controlled akin to the change-based scopes of the overall project.

Lensges et al (2018) focus on this behavioural aspect of project management and stress the point that even though there is a common misconception that the implementation of agile or traditional project management methodologies is mutually exclusive, they share a common lineage. Depending on the complexity and uncertainty in a project, a traditional, agile or hybrid approach may be most suitable. In projects with low uncertainty and low complexity, traditional methods work well as there is a high likelihood of the plan being adhered to. In projects with high complexity and high uncertainty, iterative agile methods work well since it gives the team ample opportunity to adapt to the constantly changing requirements. High complexity-low uncertainty, and Low complexity-High uncertainty (like O&G MRO projects) projects are good candidates for a hybrid approach, benefiting from some pre-planning but also needing flexibility during the working phase of the projects to deal with changes and technical challenges.

4.5 Summary

In this chapter, a conceptual framework was constructed for managing MRO projects using a proposed Change-Based Project Management approach. This approach is underpinned by Complex Adaptive Systems theory and draws on established practices from agile PM, using CAS to explain why agile methods are not suited to complex projects such as MRO. This framework builds on and extends existing PM literature by drawing on theory and lays a foundation for empirical testing in this research. The following sections report on investigation of an empirical research setting in which it is believed that elements of a CBPM approach have been in use since 2012. This research gives a formal prescription of how the approach should be applied and tests empirically the proposed framework developed from theory, to identify what works in practice and explain why. This framework, developed based on available literature and incumbent knowledge, lays the theoretical foundation for this research effort. While being a standalone academic contribution on its own, this framework will subsequently also be used for evaluating active projects being managed by the studied organisation. Details of how this was done are discussed in the following chapter on Methodology.

5. Methodology

5.1 Overview

In order to understand the apply methodology, it is important to revisit the research question: How can complex, non-iterative projects be managed with acceptance rather than avoidance of inevitable change?

To answer the research question, the following steps are taken. The first two are foundational steps (theory building and data collection) leading up to the key third step (analysis and validation):

1. Theory building: Conceptualize Change-Based Project Management as the suitable approach for managing non-iterative complex projects in certain contexts and develop a conceptual link between MRO projects and Change-Based Project Management through the lens of Complex Adaptive Systems. This was done and a conceptual framework proposed in Chapter 5.
2. Data collection: Qualitatively observe and study Upstream Oil and Gas MRO projects in a case study organisation where Change-Based Project Management principles are being deployed informally (without formally defining it as a unique project management approach), and interview key personnel in the organisation. The methodology for this step will be covered in this chapter.
3. Analysis: Analyse the data to validate the conceptual framework showing how the Change-Based Project Management approach could be used to manage MRO projects. The methodology for this step will be covered in this chapter, the analysis of the data done in Chapter 7, and discussion of the results in Chapter 8 and 9.

The research effort has been designed on qualitative lines, analysing the case study organisation's project management setup using generated data (Ritchie and Lewis, 2013) from semi-structure interviews (Bell et al, 2018) (Tracy, 2020) (Mason, 2002) with employees, and naturally occurring data (Ritchie and Lewis, 2013) from multiple project studies (Saunders et al, 2019) (Creswell et al, 2018) where behaviours and interactions were observed in a participant-observations setting (Eden and Huxham, 1996), (Argyris et al, 1985), and projects' scope of work analysed. This chapter will elaborate on each of these mentioned aspects of the research methodology and justify the research design (Mason, 2002).

5.2 Qualitative Research

Qualitative research was the chosen method due to the nature of complex MRO projects where no two projects are the same and each project deals with complexity due to various internal and external factors. There is insufficient comparative quantitative data to enable a comparison between projects and a comparison is only possible at an organisational level, by comparing an organisation's overall project performance over time vs another's, but not between projects. Understanding the CBPM application in MRO projects is also a "how" question (Silverman, 2000), which suits a qualitative case study approach (Yin, 2003) that allows in depth investigation of something in order to understand how/why it works.

While organisational success metrics are, without a doubt, important for business and an important criteria for evaluating a project management approach's effectiveness, there is ample literature critiquing the use of success metrics like budget, time or quality (Pinto and Slevin, 1998) (Atkinson, 1999) (Kerzner, 2003), and suggestions that a more holistic approach of evaluating project success is required, with the impact on the customer and the organisation as key considerations outside of the usual triple constraints (Jugdev and Muller, 2005) (Thomas et al, 2008). As Cicmil et al (2006) argue, what is needed to improve project management in practice is not more research on what should be done or the frequency and/or use of traditional project management practices; instead, a research approach that takes seriously practitioner's lived experience of projects could help us find out more about the ''actuality'' of project-based working and management. In the face of complex and constantly changing projects, this research attempts to address both the organisational success metrics as well as actuality-based research by focussing on the effectiveness of the project team and how people in the organisation perceive its management and success against the organisation's success metrics. So, the intent is not just to study what happens in a project but how/why. Qualitative methods are more suited towards addressing why and how questions, while quantitative methods help answer who, what, where and when questions (Silverman, 2000). Accordingly, the current research effort is a study of a management system and involves studying human interactions and processes in a social setting, lending itself to a qualitative research method (Creswell, 1998). Therefore, in the academic epistemological paradigm where the nature of knowledge is considered either via Positivism or Constructivism, the position taken in this research effort is constructivist (Lee & Lings, 2008) (Denscombe, 2002), with an interpretivist ontological position (Weber, 2002) where MRO project management is being studied as an interplay between management structure, organisational guidelines, and the subsequent interpretation of those structures and guidelines by people to manage a technical scope of work.

The researcher believes that the most optimal method of study for these processes and answer the research questions (Crabtree & Miller, 1999) (Denzin & Lincoln, 2000) is by observing the interactions of the team members, understanding their viewpoint on how the process aspects are affecting them, and observing how project specific changes are being managed based on the CBPM approach (how this data was gathered is discussed later in this chapter). As Collis et al (2003) argue, qualitative research methods' foundational support from the natural environment makes them the strongest research method in a business context.

Mason (2002) set outs some expectations from good qualitative research, which are listed below together with how the current research attempts to meet them. He articulates that qualitative research:

- should be systematically and rigorously conducted and not be bound by requirements for being rigid or structured. The key difference being that qualitative research should be allowed some flexibility and not be bound by too many rules yet should not be done in a casual or ad hoc manner. Careful thought and rigor need to be put into the research plan. This will be covered in this chapter on Methodology.
- should be fallible and accountable, giving the reader the material based on which the research can be judged. Chapter 8 discusses this in detail.
- should require the author to perform self-scrutiny, with the understanding that it will not be possible to completely detach their influence on the knowledge and evidence being generated and instead, he should attempt to critically understand his role in the process. This has been addressed in Section 5.3 of this chapter.

- should be strategically conducted, yet flexible and contextual. Decisions should be taken on a sound research strategy but should be able to adapt to contextual changes. This will be evident from the case study projects data, which strategic in how it was obtained yet flexibility was maintained to ensure key meetings or interactions were captured and data gathering was not based on a fixed schedule.
- should produce explanations or arguments, and not just descriptions. By attempting to explain the successful project management method in the studied organisation using an underlying theory (Complex Adaptive Systems) and established project management approach (Change-Based Project Management), this research attempts to provide an explanation for the phenomenon and not just a description.
- should produce generalizable explanations and the researcher should be able to explain the extent of the generalizability. This is discussed at length in Chapter 8

As outlined by Patton (2002), the qualitative data in this research effort will be constructed via interviews, observations, and excerpts from organisational documents and case histories, with most of the data in the form of text and transcripts. Research into what constitutes good quality qualitative research has shown that while the quality of quantitative research is simpler to assess (Symon and Cassell, 2012) using well established criteria like reliability and validity, assessing the quality of qualitative research requires a deeper understanding of the method, where objectivity is not the goal and subjectivity and interpretation play key roles in the research findings. Guba and Lincoln (1989) draw up a Parallel Quality Criteria, comparing established positivist quality criteria to equivalent naturalistic ones. Particularly, their view of transferability as a criterion is very relevant to this research as the intent should not be to make the qualitative research generalized to all contexts, but to provide enough context and details of the research case to allow readers to be able to assess how the research findings may apply to their context.

Johnson et al (2006) establish criteria specific to interpretivist research and add ecological validity to the list of criteria, where the researcher should critically study the impact of their field roles on the research. The qualitative researcher needs to reflect and critically examine any influence he may have, due to his organisational role, on the data collection and findings, and reduce “sources of contamination”. This has been addressed in section 6.3.

5.3 Participant Observation

The studied organisation was chosen based on theoretical sampling – the project management system being deployed in the organisation is considered unique in the industry and is worth studying, making it a persuasive case study which allows researchers to gain certain insights that other organisations may not be able to provide (Siggelkow, 2007). Due to the competitive nature of business, where project management performance of one organisation can often provide a significant business advantage, it was not possible for the researcher to involve participants from other parts of the industry into the data-gathering process while fulfilling a management role in the researcher’s current organisation. For this research effort, participant-observation research has been chosen as the method for data collection because this allowed the researcher access to data and people from within the organisation, while still maintaining the required business privacy. This also helped solve for one of the

largest challenges of ethnographic participant-observation research viz gaining access to the social setting (Bell et al, 2018) (Maanen and Kolb, 1982) (Ritchie and Lewis, 2013) (Alvesson, 2003). Care has been taken to ensure that the key characteristics of the method (Eden and Huxham, 1996) – generality and theory generation, are strictly adhered to, as already discussed in previous sections. Also, since the phenomenon the researcher is studying vis the application of CPM methods to MRO projects, is either widely considered non-existent, or at least not recognized in academic or industry literature (as demonstrated by the Systematic Literature Review), the participant-observation methodology for studying teams that are employing these methods is an apt method for research.

As outlined by Bell et al (2018), participant-observation is one of the best-known methods for qualitative data collection in business and management research. It requires the researcher to be immersed in the social, business and organisational situation of the studied group, setting or management arrangement, in order to better understand its workings in a rich and meaningful way (Gold, 1958). Bell et al (2018) also mention how this can be considered ethnographic research, which has helped researchers better understand organisational culture, and also look at work organisations as cultural entities. The boundaries between ethnography and participant-observation research are blurred, as both involve immersive, time-intensive study of behaviour; ethnography is a broader term and does not limit itself to observation alone.

Gans (1968) classifies the participant-observer as either a researcher-participant or a total participant. This classification helps with the ability to shift roles during the research effort, based on the need of the data gathering setting. In the current research effort's observation data collection phase, the researcher took on the role of a total participant, wherein he was involved in the situation and then resumed the research stance and took notes after the events of the situation had unfolded. During the interview and scope-analysis phases, the researcher took on a researcher-participant role and was able to fully function as a researcher during the interaction.

5.4 The researcher's role in the organisation

As outlined by Spradley and McCurdy (1972), researching within one's own place of work can help in ethnographic research due to the ease of access and incumbent relationships with various stakeholders and members of the organisation. The researcher is in a leadership role in the company, and therefore his position of power within the organisation needed to be managed within the research context. This was done by clearly explaining to the participants that the research is a personal academic endeavour aimed at improvement of project management practices within the industry, and therefore the participants' participation in the research effort has no direct or indirect effect on their employment within the organisation, their work relationship with me, or with others in the organisation. The researcher communicated clearly that this is a process improvement project and their participation in co-creating the improvements will be sought as part of the ethnographic participant-observation methodology. This was validated when participants' feedback to the questions in the interviews were candid, and they were not hesitant to critique the organisational setup and identify the pros and cons of the approach. They seemed to be enjoying the opportunity to think deeply about their own approach to things at work and introspect on what works and what doesn't quite deliver the outcomes they are looking for. They freely reminisced about previous jobs and past experiences, and the researcher left the

interviews quite comfortable with the belief that his organisational role did not affect the interview feedback.

Pasmore et al (2008) say that organisational research needs to be rigorous (reliable across settings), relevant (practical and re-applicable), and reflective (a trigger for continuous dialogue). Specific to the project management context, Coghlan et al (2023) build out what good action research would like on those lines. While the current work is not action research, the guidelines by Coghlan et al (2023) provided food for thought and valuable context and validation that the research effort is indeed rigorous (collaboratively and rigorously generated, collected and analysed data), relevant (discussion of past experiences that have led to the building of the studied project management plan), and reflective (the research design has business as well as academic relevance).

Alvesson (2003) uses the term self-ethnography for research in which the researcher is intimately familiar with the research setting and argues that this offers advantages in terms of access, cultural understanding and time-management for the research effort, yet admits that it is very rare where academics study the 'lived reality' of their organisations. Brannick and Coghlan (2007) share similar views but call it 'insider research'. Rosen (1991) considers this organisational ethnography, drawing on the differences between the goal-oriented activities at work and regular social settings and interactions.

The studied organisation being the researcher's place of work also increased the risk of the researcher having pre-formed or biased opinions about the organisation's culture, rules or settings (Spradley and McCurdy 1972). Yet, as outlined by Alvesson (2003), personal involvement should not rule out enquiry and could lead to a better way to combine theory and practice. He succinctly differentiates between ethnography and self-ethnography: "*While conventional ethnography is basically a matter of the stranger entering a setting and "breaking in", trying to create knowledge through understanding the natives from their point of view or their reading of acts, words and material used, self-ethnography is more of a struggle of "breaking out" from the taken for grantedness of a particular framework and of creating knowledge through trying to interpret the acts, words and material used by oneself and one's fellow organisational members from a certain distance*". He also argues that the researcher's deeper and more intense knowledge of the context the research setting, may lead to more profound theoretical development than when an outsider, despite best efforts, tries to learn the research setting from scratch.

The recommendations by Alvesson (2003) is to ensure that self-ethnographic research does not portray the research object in unfair ways or have biased results. Instead, even if there is a risk of being celebratory in nature, as long as the research delivers an engaging, rich, empirical and realistic account, the benefits are from the research method are considerable. Care must also be taken than dark topics and negative motivations (like office politics) do not affect the research.

The researcher, in designing and implementing this research effort, has attempted to follow the above guidelines and recommendations to the best of his ability. With a clear intention to improve the project management practices in the field of industrial MRO projects, ensuring that this research effort has academic rigour was a key deliverable in the researcher's mind to demonstrate the validity of the research to industry and thereby get the results to be taken seriously. Therefore, all attempts were made to stay clear of bias or personal afflictions, and all interviews and case observations were made in line with the Ethics approval received from the University.

5.5 Engaged Scholarship

As the researcher was undertaking a research mode where he was both researching a complex problem in an organisational setting, whilst at the same time potentially working within and effecting change in that organisation, the researcher decided to take the approach of Engaged Scholarship (Van de Ven, 2007) to validate his work as a scholar-practitioner. The concept of Engaged Scholarship promotes the participation and feedback from multiple stakeholders to produce research that is more insightful and useful to organisations and practice, as against more individualistic research where industry, peer-group and other key-stakeholder feedback is not sought or incorporated into the research design (Anderson et al, 2015). Tekic et al (2022) show how engaged scholarship in project management research has high potential and has spanned studies in execution methodology, the understanding of projects as an organisational concept, and conceptually establishing projects as a theoretical framework. They also emphasize the need for more engaged scholarship to bridge the gap between academia and practice and generate more collaborative research volume.

To evaluate the proposed research on these lines, the researcher used Van De Ven's diamond model (Fig 11) as the guiding framework. Accordingly, a review of how well the proposed research plan meets the criteria of each component of the diamond model was carried out.

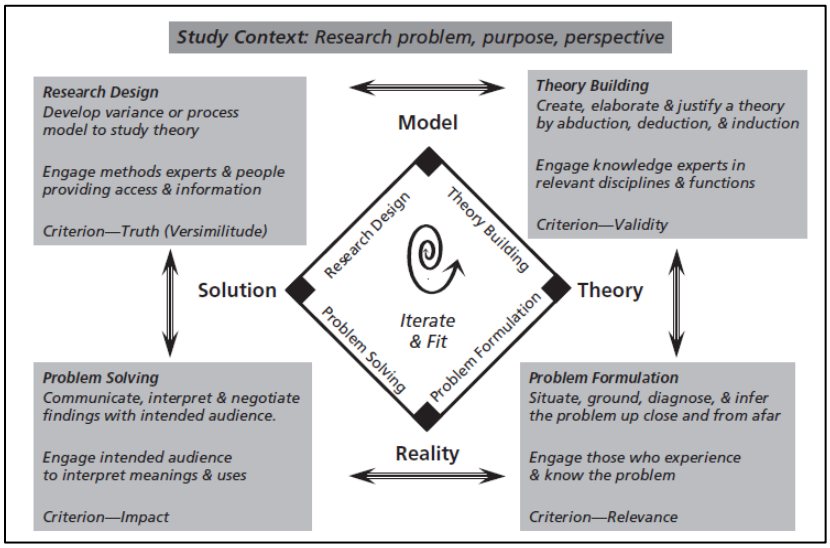


Fig 11. Diamond Model (Van de Ven, 2007)

- Problem Formulation
  - *i. Situate, ground, diagnose, & infer the problem up close and from afar*
    The Interviews with organisational leadership cater to this criterion, as they help to ground the research question in the project management landscape and challenges envisioned by industry practitioners and researchers.
  - *ii. Engage those who experience & know the problem*
    The interviews with the project teams of the case study organisation's projects cater to this criterion, as the research effort is grounded in evaluating the need, and subsequently the applicability of CPM techniques to MRO project management in the real world, based on feedback from practitioners.
- Theory Building
  - *i. Create, elaborate & justify a theory by abduction, deduction, & induction*

Using Complex Adaptive Systems as the theoretical link between MRO projects and CPM provides the foundational theory for this research effort.

ii. *Engage knowledge experts in relevant disciplines & functions*
The research plan was a collaborative one, with multiple interviews and observation-based research method and was not being done in isolation away from industry engagement.

- Research Design
  i. *Develop variance or process model to study theory*
  Ven de Ven links the 'What' component of the research to variance models dealing with input-output type observations, and the 'How' component to process models dealing with the mechanisms causing the input to lead to the output. The current research effort studies the applicability of using CPM techniques in MRO projects, and therefore uses a complementary mix of process (how CPM practices can be modified to fit MRO project requirements) and variance (whether CPM implementation was cohesive and useful) models.
  ii. *Engage methods experts & people providing access & information*
  The research plan is grounded in information and feedback received from industry practitioners using multiple communication and data collection techniques.
- Problem Solving
  i. *Communicate, interpret & negotiate findings with intended audience; Engage intended audience to interpret meanings & uses*
  The research is perfectly aligned with this step of the engaged scholarship model, since the entire research method is based on industry practices, practical application, case study, and empirically observed observations. Practitioners of MRO project management will see how the proposed process steps were adapted to the requirements of the type of projects they are concerned with, and if these adaptations provided favourable results for the participants.

5.6 Research design

Having proposed a conceptual framework, the data collection and analysis methodology is designed to test and validate this conceptual framework. This was done with the help of two different data collection methods that complimented each other to paint the full picture of MRO project management in the studied organisation. As Mason (2002) notes, qualitative research should be strategically conducted, yet flexible and contextual. The mixed-methods meets those criteria because it not only allows for qualitative management feedback from practitioners but also tests their feedback in the context of actual project execution. Both data collection methods were utilised for the same case study organisation.

1. Interviews: Interviews with the leadership team of the case study organisation and project teams discussed how they understand the dynamics of the industry, the role of project management and MRO projects in the business landscape, and their views on various aspects of MRO project management in the industry and in the studied organisation. This data was then analysed for compatibility with the conceptual framework.
2. Case Study organisation's projects: While the interviews provided vital information in how practitioners and leaders in the organisation viewed project management, it was necessary to

ascertain if their views actually translated to action on the ground, and if the projects were indeed being managed in the way stated by the interviewees. So, 2 projects were selected for data collection. The data was collected in 2 ways, chronologically:

a. Observations: Observations were carried out during meetings, walkarounds and unplanned discussions. These were noted and analysed against the conceptual framework as well as the interview data. This helped link the interview data to the site data.
b. Scope of work analysis: The scope of work analysis served two purposes: firstly, it helped validate if the MRO projects being studied had the required complexity to align with the literature review and conceptual framework. Secondly, it helped to gain a holistic view of the projects' scope of work, the changes in them, and how they were managed.

The research design/overview has been summarized in Figure 1.

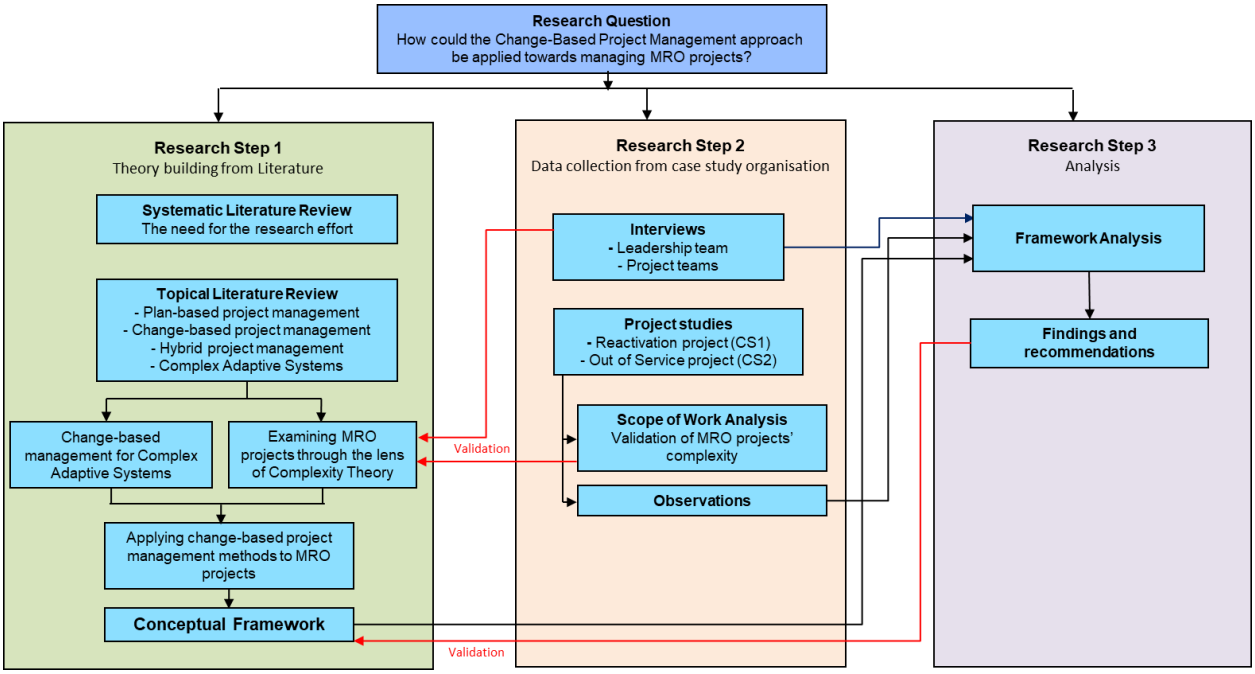


Fig 1. Research Overview

5.7 Type of Data collection

When it comes to data collection, several methodologies were evaluated and the most relevant and apt ones chosen. Focus groups were considered as a possible choice for the data gathering method but rejected because the key benefits of focus groups over individual interviews – the ability to reach a large number of participants in one go, and the additional insights from group interaction (Tracy, 2020) are both rendered ineffective due to the small project teams used in the drilling contract project setting. Essentially the entire project team would be the focus group, and due to the emphasis on communication and adaptive change-management, there are plentiful team interaction observation opportunities available outside of a formal focus group setting.

Surveys were considered and rejected as a possible choice because of multiple reasons – primarily because the methodology being studied is not prevalent in the industry, and so a survey would only serve to check the awareness of practitioners of the concepts of CPM, and not the application. Secondly, as the aim of the research is to study the applicability of these methods in MRO projects, this is best done by observing the project(s) where this is being implemented, an aim that is not served by the survey method.

Secondary data was considered and was deemed irrelevant because through the interviews, the participant's experiences and views were already being assimilated.

The case-study for the research effort was the studied organisation, and the actual MRO projects being carried out by their project teams, and qualify as a bounded, instrumental case as defined by Creswell et al (2018) and Stake (1995). Access was taken for interviewing and observing relevant personnel during the planning, execution and close-out phases of the projects. Therefore, the Unit of Analysis (Bell et al, 2018) for this research effort are the projects embedded within the studied organisation. Two different project studies are carried out with cross-study analysis (in lieu of cross-case analysis) used to better understand the empirical landscape. The limitation of this approach is that this data cannot be compared to other projects in other organisations, however the case study method used helps in achieving analytical generalization (Eisenhardt, 1989) which is discussed further in section 6.9.

5.8 Interviews

Interviews provide a meaningful source of qualitative information, rich in depth and anecdotal color from the participants' motivations, experiences, and opinions (Lindlof and Taylor, 2011) (Mason, 2002). Interviews were conducted with chosen participants in the project management team, and the organisation's corporate management team.

Purposive sampling (Bell et al, 2018) (Ritchie and Lewis, 2013) was used to select the interviewees, based on their impact on the organisation's management setup, and their involvement in the management of individual projects (. (Glaser and Strauss, 1967). While purposive sampling does not allow generalization to a population, it was critical to ensure that this does not become a convenience sample either. In line with the principles of purposive sampling, different project team members were interviewed in order to ensure variety yet maintain the relevance to the research question.

The list of interview candidates (in no particular order) was:

Corporate Organisation Leadership:

- Chief Operating Officer (COO)
- Executive Vice President (EVP)
- Vice President – Technical Services (VPT)
- Director – Engineering (DIE)
- Manager – Projects Supply Chain (SCM)

Project Teams:

- Project Manager Y (PM1)

- Project Manager R (PM3)
- Project Manager G (PM2)
- Construction Superintendent 1 (CS1)
- Construction Superintendent 2 (CS2)
- Electrical Superintendent 1 (ES1)
- Electrical Superintendent 2 (ES2)
- Mechanical Superintendent 1 (MS1)
- Mechanical Superintendent 2 (MS2)
- Rig Manager 1 (RM1)
- Rig Manager 2 (RM2)

An interview questionnaire/guide was developed and is presented in Appendix 3. A semi-structured approach was taken in order to get quality input (Symon et al, 2012) (Mason, 2002) which follows a set line of questioning, but allows the interview to digress if an insightful input is attainable by 'mining' (Kvale, 1996) (Ritchie and Lewis, 2013). The guidelines given by Kvale (1996) were used to set up the interview process, along with guidance from Yin (2003) for setting up levels of questions. While the participants were not exposed to the conceptual framework (Chapter 4), and the flow of the interview was organic and flexible (going from personal background, to views on project management in the industry, to views on project management in the organisation, to some hypothetical questions), care was taken that all aspects of the conceptual framework were incorporated and verified during the interviews.

Guba and Lincoln (1989) outlined confirmability as a key criterion for assessing the quality of naturalistic research and that the researcher needs to be able to clearly demonstrate where the data came from and how it was transformed into the findings. The interview data for the current research effort was collected via recordings of the interviews (using a phone recorder for in-person interviews and Microsoft Teams' recording function for online interviews), which were stored on the University server in line with the approved Ethics application for this research. Subsequently, the data was transcribed using Microsoft Word's transcription feature. Due to the variety of accents of the interviewed personnel, there were several errors in the transcriptions, which were corrected manually by the researcher. This proved to be the biggest challenge in the transcription process, because for some interviews, mainly due to the accent of the interviewee and their proficiency in English, the number of transcription errors were making the transcription almost incomprehensible. For such situations, during the indexing process (as discussed during the Framework analysis process later in this chapter), the researcher had to listen to the recordings while reading the transcripts, and a lot of the comments in the interview data chapter had to be re-written for clarity, brevity, and correcting grammar.

5.9 Interview Data analysis – Framework Analysis

For selecting the data analysis methodology, it was key to ensure that the central research objective was met (Crabtree and Miller, 2009). As Smith and Firth (2011), outline, qualitative data analysis can be divided into three categories:

1. Socio-linguistic methods that explore the use and meaning of language such as discourse and conversation analysis;
2. Methods that focus on developing theory, typified by grounded theory;

3. Methods that describe and interpret participants' views such as content and thematic analysis.

Because this research effort focuses on the practice of project management and the participants' views on the project management setup in their organisation, content and thematic analysis was the appropriate method. Morse and Richards (2002) outline that for qualitative interview data, a common set of principles apply for the data interpretation: transcribing, immersion into the data, developing a coding system, and then then linking data to codes to develop theory. Two popular methods (Smith and Firth, 2011) that apply these principles are the framework approach (Ritchie and Lewis 2003) and thematic networks (Attride-Stirling 2001). While the latter is an interpretive process (Tesch,1990) where data is searched for themes and can be used for testing or expanding theory (Smith and Firth, 2011)(Braun and Clarke, 2006), it has been criticized for being subjective and lacking transparency in the development of themes (Attride-Stirling 2001).

The framework analysis approach was first developed in the 1980s and has shown potential as an analytical approach with multi-disciplinary significance (O'Keeffe et al, 2015). Although quite similar to the thematic approach in the early stages of analysis, the framework approach helps provide more transparency due to the rigour required to go through the five-stage process of the framework and makes the researcher's interpretation of the participants' experience more transparent (Ritchie and Lewis, 2003), mitigating one of the common criticisms of qualitative research that it is subjective. Framework analysis also helps deal with cross-sectional descriptive data, where various themes and aspects could be gleaned from the same data set (Ritchie and Lewis, 2003) (Smith and Firth, 2011). Framework analysis is also considered an effective means to assess management system tools and practices from the perspectives of the people they affect (Srivastava & Thomson, 2009), which is appropriate for this study that uses practitioners for the data. Therefore, Framework analysis was chosen as this qualitative research effort had specific objective and a predefined sample of professionals and practitioners (Sweetman and Conboy, 2018).

Ritchie and Spencer (1994) outline four types of research questions that they believe framework analysis can help address:

- Contextual: identifying the form and nature of what exists
- Diagnostic: examining the reasons for, or causes of, what exists
- Evaluative: appraising the effectiveness of what exists
- Strategic: identifying new theories, policies, plans or actions

The researcher believes that the current research effort fits very well under the categories of Contextual (MRO projects and their challenges) and Evaluative (how change driven methods allow the management setup to work like a Complex Adaptive System). Despite being quite time consuming and labour-intensive (O'Keeffe et al, 2015), the framework analysis method was the best fit for this research effort.

As outlined by Richie and Spencer (1994), Framework analysis comprises of five steps:

1. Familiarization: Often known as 'immersion', this step involves listening carefully to the interviews and reading the transcripts carefully. While Srivastava & Thomson (2009) point out that it is not necessary to review all the material at this stage, the researcher did a

complete review at this stage of all the interview recordings and transcripts. The interviews had been conducted using an audio recorder and were later transcribed using Microsoft Word's speech to text feature. As the interviewees had a variety of accents and some of them were not very good at spoken English, a significant amount of manual correction was required in the system generated transcripts, which were carried out by listening to the audio recording while reading and correcting the transcript. In several areas, the comments were compressed manually into a coherent sentence due to speech idiosyncrasies and grammatical errors by the interviewee, as well as for brevity.

Below is an example of the original transcript from the audio with PM2:

Question: *"What role does project schedules or project plans play in your management?"*

Transcript from audio: *"This one is I've been normally on top of the schedule myself and doing the progress update. Uh, normally twice a week for all catch up and then based on that one talking to the PC and then that's where it's happening before the the Tuesday work Friday. And then we stick to that one and that will be addressed. If the critical path or timeline, any changes need to be informed. The management for sure"*

Simplified transcript as part of familiarization step: *I update the schedule twice a week to see how things are going. No baselines are created, but if the overall timeline and critical path is changing, management is informed.*

2. Identifying a framework: Ritchie and Spencer (1994) suggest that framework categories (sometimes called thematic categories (Wood et al, 2010)) are developed from both by a priori concerns as well as emergent issues arising from the immersion. For the current research effort, the a priori themes were the seven management aspects from the conceptual framework identified in the previous chapter:
    - Planning process
    - Change management.
    - The role of the customer
    - The role of leadership
    - Communication
    - Team setup
    - Documentation

    The emergent themes developed were:
    - Drilling Industry insights
    - Hybrid project management

3. Indexing: This step involves applying the thematic framework to the data and organising the data as per the themes. Against each thematic category from Step 2, relevant comments and observations from each interview were collated for qualitative completeness and richness of context. Interesting learnings were noted for discussion and as recommendations for further study. Some comments had multiple themes addressed in the same comment, in which case that comment was coded against each of the addressed themes.

Below is an example of a comment that was coded against different themes. The question posed to the COO was:

Question: *"What are your thoughts on changes in MRO projects?"*

Transcript from audio: *"If you plan that there are going to be changes then that will help you address what you have to. You have to go into the project knowing that there's the opportunity that there's going to be changes in the scope of work."*

The above comment was coded against Planning, Role of Leadership, and Change Management.

4. Charting: In this step, the data from the indexing phase is summarized in a tabular or chart form. As Mason (2002) notes, qualitative research should produce explanations or arguments. The purpose of data gathering in this research is to explain how the management system proposed in the conceptual framework can be applied.
   For each thematic category from the conceptual framework, sub-themes were charted and generated in a tabular form (Table 9). Each of these sub-themes are discussed in more detail in chapter 7. Each of the sub-themes had several aspects within them, that were further categorized and broken down in the first draft of the study. In the second draft, they were consolidated for conciseness and the final list is the one presented in Chapter 7.

Table 10 – Conceptual Framework Themes and Sub-themes

Conceptual framework themes	**Sub-Themes**
Planning Process	The role of planning
	Team setup for planning
	Responsibilities
	Types of Scope planning
	Stage Gate
	The role of project plans
Change Management	Management system
	Change management process
The role of the customer	Customer engagement
	Acceptance process
The role of leadership	Organisational setup and culture
	Empowerment
Communication	Meetings
	Flexibility
Team Setup	Team size
	Individuality
	The role of the Project Manager and self-organising behaviour
	Multi-skilled workforce
Documentation	Type of documentation
	Process
	Resource Adequacy
Emergent themes	**Sub-Themes**
Drilling Industry insights	Dynamic industry and time pressure
	Newbuilds vs MRO
	Complexity and change in MRO projects.
	Industry performance in projects
Hybrid project management	Balance
	Regimented aspects
	Flexible aspects

5. Mapping and interpretation: In this step, the assimilated data is understood and interpreted. For carrying this out, the author interpreted the analysed data from each of the thematic categories and their sub-themes against the theoretical expectations from the conceptual framework and the associated literature that had helped create the conceptual framework. The outputs from this step were commentary evaluating the application of the conceptual framework in the studied organisation, and recommendations for practitioners and researchers. This is covered in the Discussion chapter.

5.10 Case Study

The case study method, while popular in management research with ample academic backing, continues to raise questions regarding methodological rigour viz validity and reliability (Gibbert et al, 2008) (Miles, 1979). While all research methods are subject to the challenge of academic rigour (Bell et al 2018), management case study research needs to claim its relevance (Scandura and Williams, 2000) despite its typically interpretivist ontological position and the close interaction with practitioners as they deal with real management situations in the particular context of the case study. As Ketokivi and Choi (2014) put it, case research rigor is determined by attention to idiosyncrasy and transparency of reasoning. While case studies do not usually lend themselves to statistical generalization (Yin, 2003), there is a case to use them to generate analytical generalization as a means of external validity (Eisenhardt, 1989). Reliability of the results, while still constrained by the idiosyncrasies of the cases, should lead subsequent researchers to get to the same conclusions if they were to observe the same information and follow the same steps (Gibbert et al, 2008).

Siggelkow (2007), robust qualitative case research should firstly comprise of a key conceptual insight (the conceptual framework from Chapter 4), and then deploy case research for motivation, inspiration and illustration. In the case of the current research, the studied organisation's project management methodology motivated the research question, the immersion of the author into the theoretical and case research inspired new ideas and the conceptualization using Complex Adaptive Systems, and the data from the cases was used for illustrating the conceptual framework generated earlier.

A case study organisation that helped answer the research question (Bell et al, 2018) i.e. MRO projects being managed using Change-Based Project Management, was selected for the data collection, using a nested approach (Yin, 2003) for conducting multiple project studies within the same case-study organisation. Ontological integration (Mason, 2002) between the interview data and the project/observation data was sought. Multiple projects were sought as guided by Yin (2003) for theoretical replication of the validation of the conceptual framework being analysed.

- Project Study 1 (Reactivation): Project Study 1 was a project where the studied organisation had recently purchased a rig which was cold-stacked (idle for a prolonged period with no maintenance or upkeep being carried out). The rig was awarded a contract with a large National Oil Company in the Middle East, and the project was approved for a complete reactivation, recertification, contract specific upgrades and customer acceptance process to be carried out. This type of project is the most intense type of MRO project in the industry because there is little to no historical data available on the rig's condition, all aspects of the rig need to be worked on, there is a high degree of complexity and unpredictability in the individual scopes, and due to the extent of work being carried out, there is a very high amount of inter-connectivity between the scopes. Further, the situation is exacerbated by the customer being a very demanding one, with very specific requirements and acceptance criteria. The overall project duration, from approval to delivery, was 7 months.
- Project Study 2 (Planned Out Of Service): A planned Out Of Service (OOS) project is one where a rig is taken out of service for maintenance and upgrades before returning to work for the same or a different customer. Project Study 2 was a project where a rig completed a contract with an operator in the Middle East, came into a shipyard for the project, before mobilizing to India for

its next contract. The scope of work included major scheduled maintenance, major corrective maintenance, preventative maintenance, and contract preparation for the next contract. Planned OOS projects are typically less complex that reactivation projects because the rig's equipment history is available within the organisation, the rig's crew is able to highlight issues and challenges during the project planning process, and procurement for known scopes can be planned in advance. However, major maintenance scopes come with inherent scope risk because the condition of the equipment is not known till the equipment is stripped in the shipyard, thereby leading to complexity when multiple such scopes are being carried out at the same time. While a reactivation project (Project study 1) is the most intense case for testing the conceptual framework, a planned OOS (Project study 2) makes for a more typical case which the industry carries out multiple times in a year.

Between the 2 selected projects, the spectrum of MRO projects (discussed in Chapter 2) was well covered, and these provided good representation of MRO projects in the industry. Of course, both projects have their own unique scopes of work, and apart from the study of management style, there is limited capacity for the findings from the actual scopes of work to be generalized. However, as Yin (2003) points out, case studies in interpretivist research should be compared to positivist experimental research and not statistical analyses of large populations, with the aim of having analytic generalization as opposed to statistical generalization.

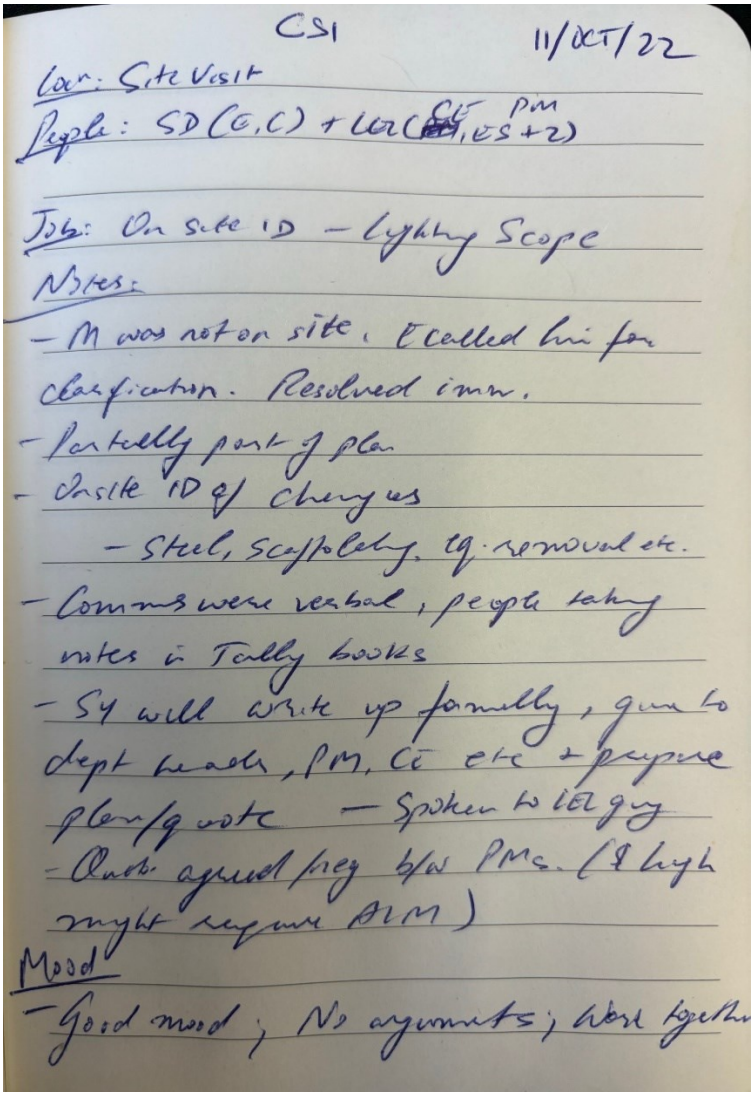
5.10.1 Observations data – Framework Analysis

During the project study observation sessions, a shadowing technique (Bell et al, 2018) was used, where notes were taken in a notebook without disturbing the meetings/interactions being observed. Field notes were taken in line with the guidelines by Bell et al (2018). An opportunistic method for the observations (Buchanan et al, 1988) was deployed to ensure relevant and insightful observations were carried out.

Framework analysis was applied to the observation data as well. Specific to the observation data, the five-step process (Richie and Spencer, 1994), comprised of:

(1) Familiarization: In this stage, the researcher did a complete review of the observation notes and transcribed them from the observation diary shorthand to structured notes. The complete set of structured transcribed observation notes are available in Appendix 1

As an example, below are the field observation notes from the 2nd observation of Project study 1:


CS1 11/OCT/22

Loc: Site Visit

People: SD (C, C) + Loc (SE, PM, ES + 2)

Job: On site ID – Lighting Scope

Notes:

- M was not on site. E called him for clarification. Resolved imm.
- Partially part of plan
- On site ID of changes
  - Steel, scaffolding, eg. removal etc.
- Comms were verbal, people taking notes in Tally books
- SY will write up formally, give to dept heads, PM, CE etc + prepare plan/quote – Spoken to Loc guy
- Quick agreed beg b/w PMs. (If high might require BIM)

Mood

- Good mood; No arguments; Work together

Fig 12. Project Study observation notes example

These were subsequently transcribed and structured as below:

Observation Code: C1_2

Location: *On board the rig.*

Observation type: *Site walkaround to discuss lighting scope of work.*

Attendees: *CS2, ES1, Shipyard Project Manager, Shipyard Electrical supervisor, Shipyard commercial estimator*

Notes:

- *Walk around the rig to identify lighting scopes of work for remedial as well as upgrades for contractual requirements.*
- *Mechanical Superintendent was not part of the walkaround. At one location his feedback and alignment were required to agree on the lighting plan. ES1*

called him immediately on the phone to reach an agreement and conclude the discussion.

- *Part of this scope was in the initial project plan, but several locations were site-specific and changes to the original plan. Many required steelwork, scaffolding, removal of other equipment in the way etc. As the group moved from one location to the next, verbal instructions were given by the project team, with responsibility on the shipyard to write up the full scope for final agreement.*
- *The shipyard team's plan was to write down the details of this scope and then give these details to the other department heads and Shipyard Project Manager, who will give manpower and material estimate to the commercial lead to finalize the quote.*
- *Once the quote is finalized, the Shipyard project manager and PM1 will negotiate and finalize the variation order. Depending on the commercial value, PM1 might need upper management approval before proceeding.*

Demeanour/Mood: *Collaborative meeting focussed on finalizing lighting locations and agreeing on the scope of work at each location.*

(2) Identifying a framework: The same framework established in the interview stage was used and notes from each observation session were extracted and categorized. However, since the observations were made during the project implementation phase, 3 of the emergent themes were dropped from this analysis as they were not relevant to the observation data. The themes employed were:
   - Planning process
   - Change management.
   - The role of the customer
   - The role of leadership
   - Communication
   - Team setup
   - Documentation
   - Hybrid project management

(3) Indexing and charting: For the project study data, these 2 steps were carried out in a combined manner using the themes and sub-themes identified while analysing the interview data (Table X). Observations were coded against the relevant themes/sub-themes and descriptive details were added in the Analysis chapter for qualitative richness.

   As an example, to continue from the previous data point of observation C1_2, this observation was coded to:
   - Communication > Flexibility
   - Communication > Rig team, shipyard, and project team interactions
   - Team Setup > The role of the Project Manager and self-organising behaviour

(4) Mapping and interpretation: In this step, the assimilated data is understood and interpreted. Key insights gained were interpreted using the thematic categories and their sub-themes against the theoretical expectations from the conceptual framework and the associated literature that had helped create the conceptual framework. The observations were also discussed and compared to the interview insights for validation and compatibility. This helped analyse if the observational data aligned with the interview data i.e. if people are actually doing what they claim they are doing in interviews, and if what people think is happening during the projects is actually happening. The outputs from this step were commentary evaluating the application of the conceptual framework in the studied organisation, and recommendations for practitioners and researchers. This is covered in the Discussion chapter.

5.10.2 Scope of Work analysis

The scope of work analysis was carried out together with the project manager for each of the studied projects once the projects had been completed. The Work Breakdown Structure, a tool used by the studied organisation to collate and track the scope of work, was reviewed in detail and each scope line item was discussed in a retrospective way. Each of the classification categories and coding system were discussed with the project managers, and then feedback sought on each scope item against these categories. As the projects were recently concluded, the project managers performed most of the classification from memory but had to occasionally refer to emails and notes when they weren't sure about something.

For each scope line item, the nature of the scope, the presence and impact of changes during the project, and the change management process was discussed and noted. This helped paint a picture of the 2 studied projects in terms of complexity and management style. This helped in analysing the requirement for the Change-Based Project Management approach for these types of projects and the applicability of the conceptual framework to them.

The following columns were used for the Scope of Work Analysis breakdown:

1. WBS: This is the tracking number for the scope under the WBS system. The main WBS categories are:
    1. For CS1
        i. WBS 1 – Steel and Hull
        ii. WBS 2 – OEM (Original Equipment Manufacturer) Equipment
        iii. WBS 3 – Inspections and Certifications
        iv. WBS 4 – System Integration and contractual upgrades
    2. For CS2
        i. WBS 1 – Steel and Hull
        ii. WBS 2 – OEM (Original Equipment Manufacturer) Equipment

iii. WBS 3 – Inspections and Certifications
iv. WBS 4 – System Integrity
v. WBS 5 – Contractual Upgrades

2. Brief description of the scope/equipment/system

3. Pre-inspection possible (only for C2, as pre-inspection was not possible in C1):
    i. Yes: A scope where an inspection was possible during operations to identify the requirements
    ii. No: A scope where an inspection was not possible during operations
    iii. Periodic: A scope that is based on a maintenance schedule and is not based on inspection or known issues
    iv. NA: where pre-inspection is not required (typically procurement scopes that do not require any installation).

4. Type: Classification of the scope into the following categories:
    1. Shipyard: Scopes involving steel, piping, painting and other works executed exclusively by the shipyard. Scopes are defined by the project team, and quality control measures are verified by the project team as well.
    2. Procurement: Scopes that exclusively for procurement of loose items that do not need to be installed e.g. tools.
    3. Procurement/Installation: Scopes that involve procurement of an item which also needs to be installed on the rig.
    4. Overhaul: Scopes that involve strip-down of a large equipment for inspection, remediation (as required), rebuild and commissioning.
    5. Upgrade: Scopes that involve adding new equipment or systems to the rig which it did not have before.
    6. Maintenance: Scopes that involve maintenance of equipment around the rig as per known issues or based on periodic maintenance schedule.
    7. Inspection/Remedial: Scopes that involve inspection of an equipment, system, structure etc and associated remedial work based on the inspection. This type also covers safety and compliance inspections around the rig.

5. Change Encountered: If a change was encountered during the execution of the scope (Yes/No)

6. Change Classification: Only for scope items marked Yes under Change Encountered
    1. Low impact on plan and resources. No effect on other plans
    2. Medium impact on plan and resources. No change in schedule
    3. High impact on plan and resources. Critical path potentially gets affected.
    4. Critical impact on plan and resources. Critical path changes for sure

7. Change connectivity: If the change in the scope had connectivity i.e. affected the timelines, plans, resources or technical requirements for one or more other scopes.

8. Change resolution: Only for scope items marked Yes under Change Encountered
    1. Resolved by project team using existing resources.
    2. Resolved by project team with additional resources and assistance from shipyard/vendors.
    3. Resolved by project team after escalation to senior management within the organisation and/or with vendor organisation.
    4. Not resolved adequately.

The complete tabular Scope of Work analysis data is available at Appendix 2.

As an example, for the Scope of Work analysis exercise, let's review the inputs for CS1, WBS 2.01 – Mud Pumps. The following steps were followed:

a. WBS number: 2.01 (from project WBS)
b. Brief Description: Mud Pumps (from project WBS) – this is the name of the equipment being worked on
c. Type: Overhaul (from Project Manager feedback) – the scope of work for this line was an API-Cat-4 inspection and remedial workscope, commonly known as an overhaul.
d. Changes Encountered: Yes (from Project Manager feedback) – when the equipment was inspected, several components failed inspection and had to be replaced.
e. Change classification: 2 (from Project Manager feedback) – the parts that failed inspection were available with the OEM and the studied organisation's spares warehouse. Additional resources were required to mobilize and install those parts, as compared to if the incumbent parts had passed inspections.
f. Change connectivity: Yes (from Project Manager feedback) – the mud pumps are part of the rig's fluid circulation system, and if they are not ready, the entire system cannot be tested, nor can the endurance test be carried out.
g. Change resolution: 2 (from Project Manager feedback) – as spare parts were available, even if their replacement was unplanned, the project team was able to complete the scope without involving senior management. However, additional manpower and logistics resources were required to complete the task.

5.11 Feedback

Since the primary purpose of the empirical study was a validation of the conceptual framework for Change-Based Project Management approach for managing MRO projects, it was important to not limit the study to points of validation, but to also note any differences that provided feedback to the conceptual framework and could lead to its betterment. Since the conceptual framework was developed from theory and the empirical data was gathered from an organisation that had intuitively developed their project management method without theoretical study feeding its design, this study was a comparison of practiced actuality of the project management approach to the theoretical expectations

from research. This offered an invaluable opportunity to use data from the field to help improve a theoretical conceptual framework, hopefully making it more relevant for both practitioners and researchers.

Chapter 8 covers this feedback loop, where interesting deviations of practice from the conceptual framework are noted, discussed, and incorporated, with the conceptual framework revised into its final form.

5.12 Summary

In this chapter, the research methodology was outlined along with justifications for each decision taken. The researcher's role in the organisation was considered and built into the research design, the larger plan for interviews and project studies was outlined, before discussing in detail the process by which the data collection and analysis was carried out. This chapter is intended to provide context and answer any questions on the 'why' of every step in the research method, while the following chapters dive straight into the content of the steps.

6. Research Setting: Case Study Projects

6.1 Overview

As discussed in the Methodology chapter (Section 5.1), a case study organisation that fits the research question (Bell et al, 2018) was selected for the data collection, using a nested approach (Yin, 2003) for conducting multiple studies within the same organisation. Ontological integration (Mason, 2002) between the interview data and the case-study/observation data was sought. Multiple cases were sought as guided by Yin (2003) for theoretical replication of the validation of the conceptual framework being analysed via the cases.

This chapter introduces the 2 studied projects, before presenting the data gathered from the 2 project studies via Scope of Work analysis. While a reactivation project (Project study 1) is the most intense case for testing the conceptual framework, a planned OOS (Project study 2) makes for a more typical case which the industry carries out multiple times in a year. Between the 2 selected cases, the spectrum of MRO projects is well covered, and these cases provided good representation of MRO projects in the industry. Of course, both projects have their own unique scopes of work, and apart from the study of management style, there is limited capacity for the findings from the actual scopes of work to be generalized. However, as Yin (2003) points out, case studies in interpretivist research should be compared to positivist experimental research and not statistical analyses of large populations, with the aim of having analytic generalization as opposed to statistical generalization.

The analysis of the Scope of Work for both studied projects helps to validate the complexity of MRO projects which was earlier derived from literature. It is also an important validation step for the interview data as it helps understand if the MRO projects being studied fit the assertion of complexity by the interviewees.

The scope of work analysis was carried out together with the project manager for each of the studied projects once the projects had been completed. The categorical breakdown and data collection process was discussed in the Methodology chapter. Because Project study 1 is a reactivation project and Project study 2 is a planned Out Of Service project, this will help analyse the project setup not only for the 2 main types of MRO projects in the industry, but also help compare the differences between these 2 types of projects

6.2 Project study 1

6.2.1 Project details

Project study 1 was a project where the studied organisation had recently purchased a rig which was cold-stacked (industry term for a rig that is idle for a prolonged period with no maintenance or upkeep being carried out). The rig was awarded a contract with a large national oil company in the Middle East, and the project was approved for a scope comprising of:

- Complete reactivation: This includes getting the hull, equipment, living quarters, and all other parts of the asset into good working condition and verified/certified as per industry standards and requirements.
- Recertification of major equipment: Major drilling and well control equipment is required to be maintained as per certain industry standards (typically outlined by the

American Petroleum Institute) and Original Equipment Manufacturer (OEM) guidelines. This scope involves a complete strip-down of the equipment, typically in a workshop, followed by inspection, rectification and rebuild. The equipment is then brought back to the rig, installed, and commissioned as per OEM guidelines.

- Contract specific upgrades: the customer is widely known in the industry to have one of the most stringent, specific, and extensive requirements for rigs that are contracted to work for them. The requirements are outlined as per 3 documents: the contract equipment specifications, the customer's Health Safety and Environment (HSE) manual, and the customer's Well Control requirements manual.
- Customer acceptance process to be carried out: the customer's typical modus operandi is to give the drilling contractor a set amount of time to get the rig ready after the contract is awarded (typically 180-210 days). These readiness projects are typically carried out outside the area of operations because of a lack of good shipyards there. Near the end of the project, the customer sometimes sends a small team for a preliminary inspection, but the main customer acceptance and intake process is carried out when the rig is mobilized to the country of operations. At that time, a large team from the customers' rig acceptance department boards the rig and goes through all the requirements and certifications and raises a deficiency punch-list for non-compliant items. The deficiencies typically need to be closed prior to contract startup.

Project study 1 was a reactivation project. This type of project is the most intense type of MRO project in the industry because:

- there is little to no historical data available on the rig's condition because the rig has only recently been purchased, and often via resellers or banks who have taken control of the asset, making the transfer of previous operating and maintenance history impossible. Further, there is no real inspection or planning period prior to project kick-off, so any advantages of planning via detailed inspection are lost.
- all components of the rig need to be worked on because during a cold-stack, the rig is not kept in good condition. So, none of the equipment can be expected to reliably function, and statutory requirements involve retesting all systems.
- there is a high degree of complexity and unpredictability in the individual scopes due to above 2 points, because everything is being worked on and the underlying condition is unknown.
- due to the extent of work being carried out, there is a very high amount of inter-connectivity between the scopes, and slippage in one can often cause a cascading effect across different equipment/system scopes.

6.2.2. Project study 1: Timeline

- Cold stacked rig acquisition: July 2022
- Contract awarded by customer: August 2022 (start of project)
- Completion of shipyard scope and departure from UAE: March 2023
- On contract after mobilization and acceptance: April 2023

6.2.3. Project study 1: Project performance

- The project was delivered in line with the promised timeline to the customer.
- The project was completed at 2% more than the budgeted cost.
- The customer acceptance timeline was the shortest in the organisation's history, proving the quality of the work done and the thoroughness of the scope definition and execution.
- The project was considered a success by the company and the customer.

6.2.4. Project study 1 - Project Organisation Chart

The project team organisation chart for Project study 1 was as per Figure 13. The chart, regardless of project size, is similar across projects. Also clear from the organisation chart is the flat hierarchal structure within the organisation as there are only 2 layers between project manager and the CEO.

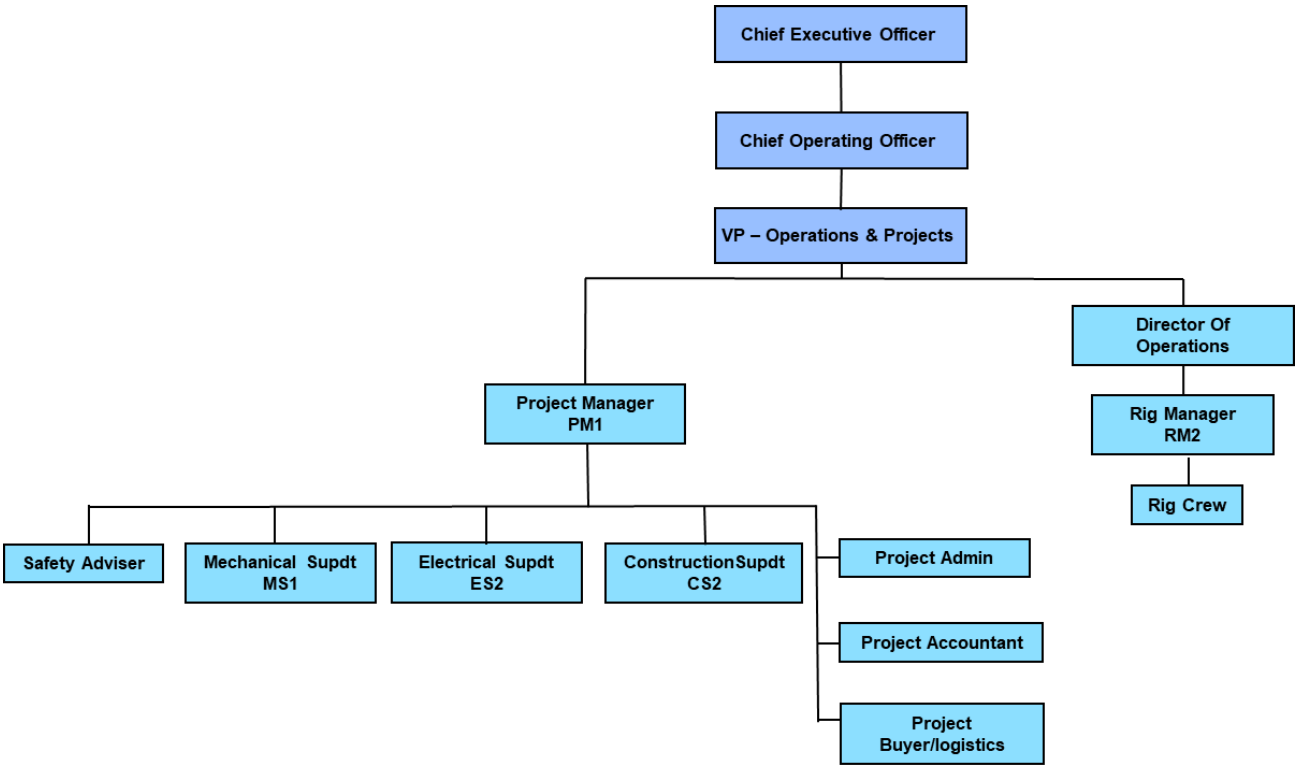


Figure 13. Project study 1 Project Team Organisation Chart

The trade superintendents (mechanical, electrical etc) report to the Project Manager, who in turn reports to the VP- Operations and Projects.

On the operations side, the Rig Manager leads the rig team and is the manager for the rig during drilling operations. During shipyard projects, he works closely with the project manager to support the project and continues to remain accountable for management of rig crew, standard rig maintenance, rig-level budgets etc. He reports to the Director of Operations of the geographical region where the rig will

be carrying out drilling operations (not necessarily the shipyard location), who in turn reports to the VP-Operations and Projects.

As is also mentioned in the interviews, there is typically friction between operations and project teams on the ground. The project teams are naturally inclined towards finishing their scope and getting the rig out of the shipyard while meeting their deliverables of cost and time, while the operations team typically want as much work to be done in the shipyard to make their lives easier offshore. This potential misalignment of priorities can be problematic if not managed properly, and the company's leadership has a role to play in exacerbating or ameliorating the problem. Having both Operations and Projects under the same leader helps the organisation manage this efficiently.

6.2.5. Project study 1 - Scope of Work Analysis

After the successful completion of the project, the Scope of Work was discussed with the project manager (as outlined in the Methodology chapter). Below is analysis of the data along with noteworthy observations:

6.2.5.1. Scope of work type

The scope of work breakdown into types is as per below. The scope was quite well balanced between the work types, with around ½ the scope being contract related upgrades and procurement/installation, and the other half being asset maintenance related (inspections, remedial, shipyard and overhaul scopes).

Table 11. Project study 1 Breakdown by Scope of Work type

Shipyard	Overhaul	Maintenance	Inspection/Remedial	Procurement	Procurement/Install	Upgrade	Total
8	18	0	32	15	14	25	**112**
7.1%	16.1%	0.0%	28.6%	13.4%	12.5%	22.3%	

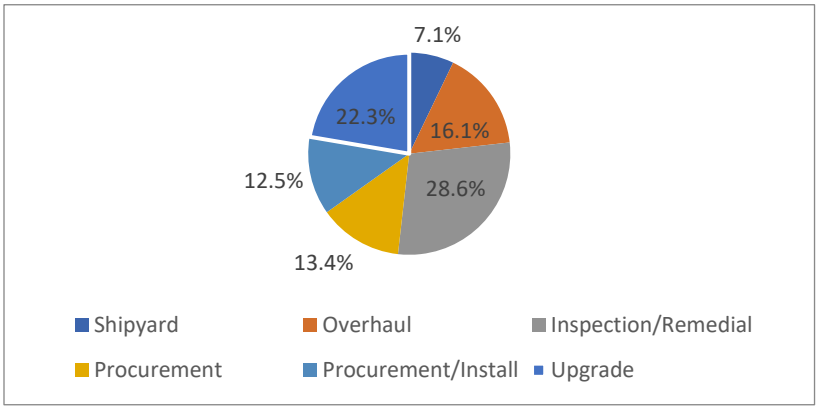


Fig 14. Project study 1 Breakdown by Scope of Work type (Pie Chart)

6.2.5.2. Changes

Next, we look at which of the project scopes experienced changes. The breakdown is as per below.

Table 12. Project study 1 Breakdown of Scopes experiencing changes

Changes	Shipyard	Overhaul	Inspection/Remedial	Procurement	Procurement/Install	Upgrade	Total
Yes	4	12	14	0	6	19	**49%**
No	4	6	18	15	8	6	**51%**

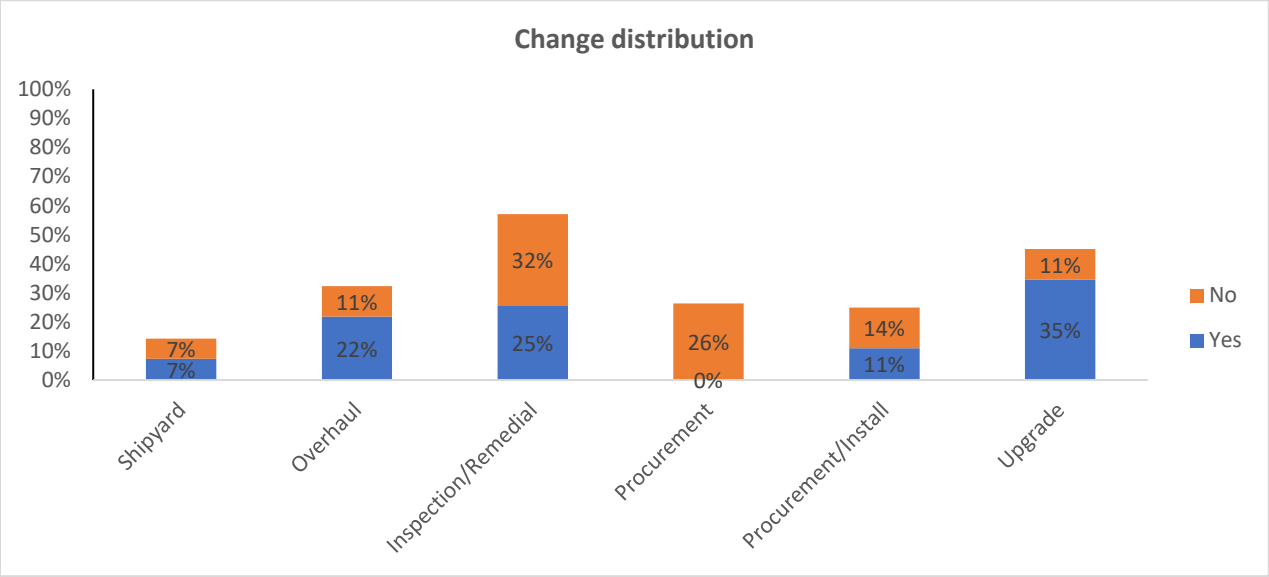


Fig 15. Project study 1 Change Distribution

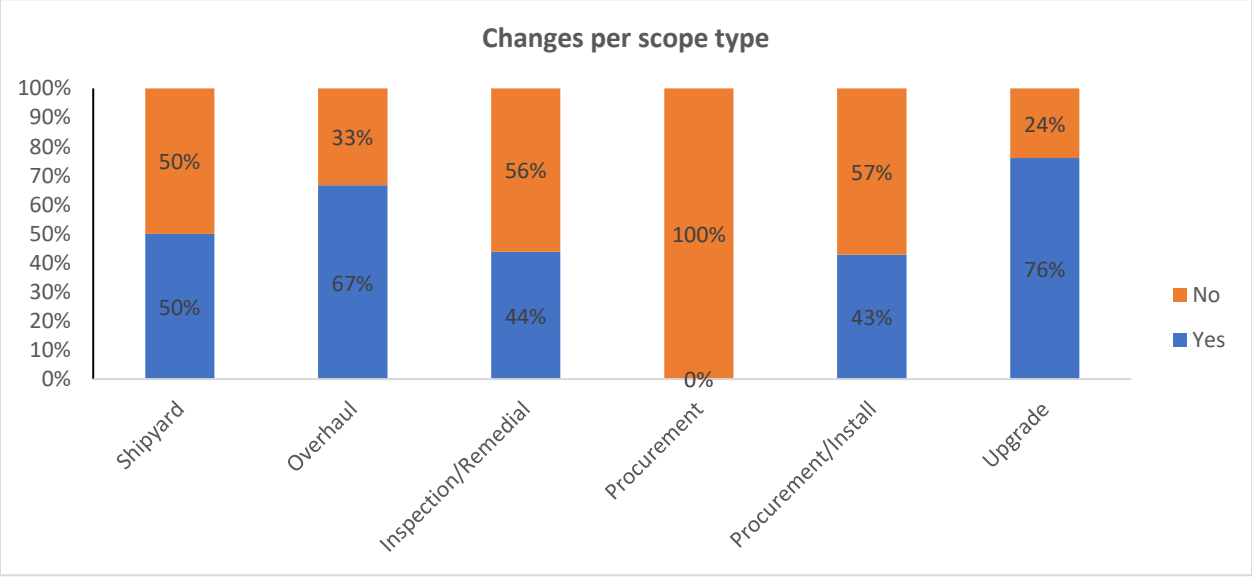


Fig 16. Project study 1 Changes per scope type

Noteworthy observations from this data:

1. Changes were observed in almost 50% of all scopes. This shows how MRO projects have a high degree of changes observed during the project.
2. 55% of all changes observed were in the maintenance related scopes and 45% in contract related scopes. This showed that the chances of experiencing a change were quite high, regardless of scope type.
3. 100% of all changes observed had connectivity i.e. each change affected at least one other scope, and often multiple. This shows how MRO projects have high complexity due to the high connectivity between the scopes, a large number of which are experiencing changes.
4. Pure procurement scopes did not experience any changes. This shows the team did a good job in identifying the specifications of the material that needed to be ordered. Further, since the material did not need to be installed, the chances of on-site changes was nil.
5. Maintenance scopes (Shipyard, overhaul, inspection/remedial) had 52% scopes experiencing changes, while contract related scopes (procurement/install and upgrade) had 46% scopes experiencing changes. This showed that there was no significant difference in the source of the scope – the chances of changes were quite high in all of them.

6.2.5.3. Change classification

The change classification was carried out only for scope items marked Yes under Change Encountered. The coding was based on the below criteria for the encountered change:

1. Low impact on plan and resources. No effect on other plans
2. Medium impact on plan and resources. No change in schedule
3. High impact on plan and resources. Critical path potentially gets affected.
4. Critical impact on plan and resources. Critical path changes for sure

Table 13. Project study 1 Change Classification

Classification	Shipyard	Overhaul	Inspection/Remedial	Procurement	Procurement/Install	Upgrade	
1	1	2	8	0	1	5	31%
2	2	3	5	0	4	5	35%
3	1	3	1	0	0	4	16%
4	0	4	0	0	1	5	18%

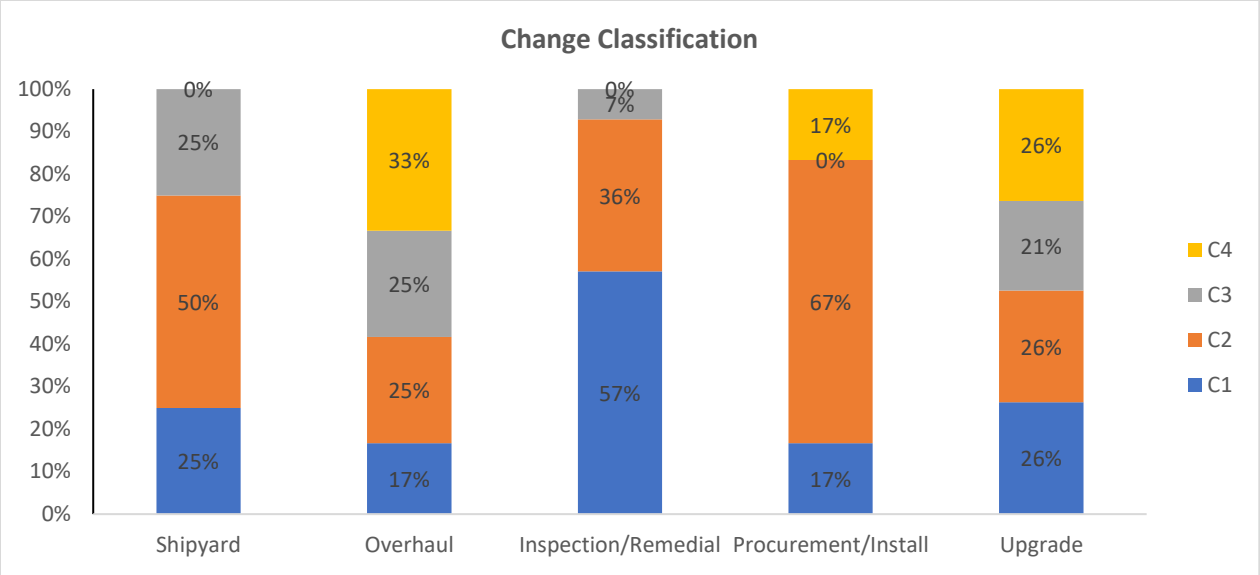


Fig 17. Project study 1 Change Classification

Noteworthy observations from this data:

1. 66% of the changes encountered fell within Categories 1 and 2, and were relatively easy to manage with the company's change management setup.
2. 16% of the changes had the potential to impact the critical path, but the change management method deployed ensured that it did not.
3. 18% of the changes affected the critical path and the change management efforts were designed to minimize that impact.
4. From the above points, it is clear that when almost half of the project's scopes experience changes, all the changes have connectivity, and more than 1/3 of the changes have a potential impact on the critical path, the project's complexity is very high.
5. Overhaul scopes had the highest ratio of Cat 3 and Cat 4 changes, which reinforces the challenges associated with equipment overhauls with the real condition of the equipment only discovered during the project execution, leading to changes.
6. Change types in Upgrade scopes were balanced across all categories and difficulty levels.
7. Shipyard, inspection/remedial and Procurement/install scopes had a large majority of changes that were easy to manage.

6.2.5.4. Change Resolution

The change resolution classification was carried out only for scope items marked Yes under Change Encountered. The coding was based on the below criteria for the resolution of the encountered change:

1. Resolved by project team using existing resources.
2. Resolved by project team with additional resources and assistance from shipyard/vendors.

3. Resolved by project team after escalation to senior management within the organisation and/or with vendor organisation.
4. Not resolved adequately

Table 14. Project study 1 Change Resolution

Resolution	Shipyard	Overhaul	Inspection/Remedial	Procurement/Install	Upgrade	
1	0	4	6	3	3	29%
2	4	3	8	2	12	53%
3	0	5	0	0	4	16%
4	0	0	0	1	0	2%

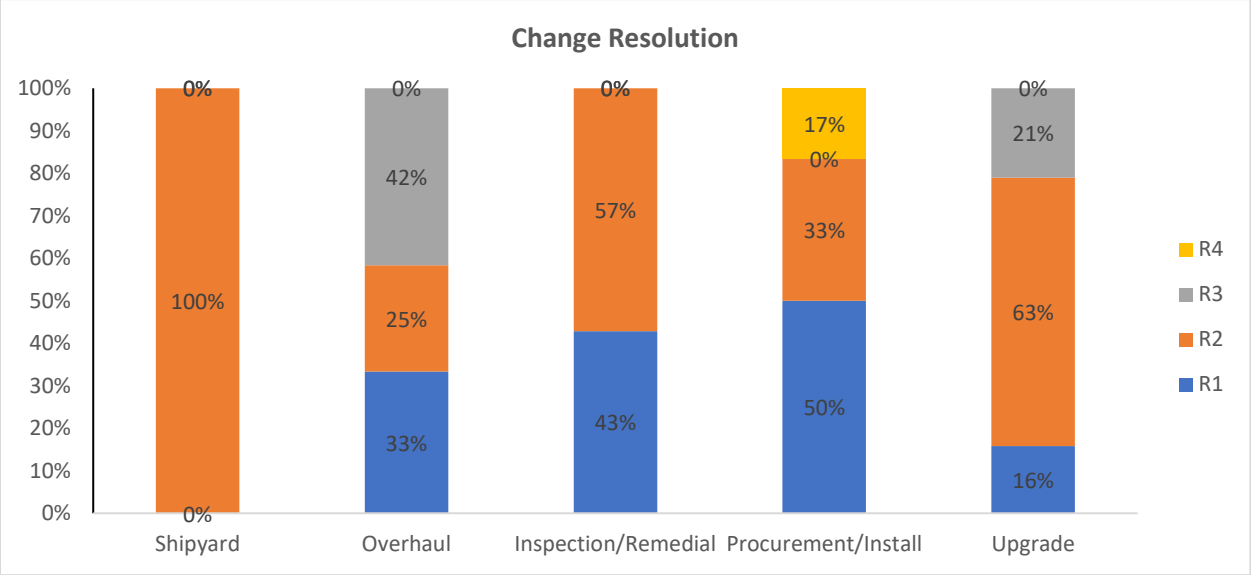


Fig 18. Project study 1 Change Resolution

Noteworthy observations:

1. 29% of the changes encountered were successfully managed with existing resources by the team, using the change management process outlined in the data.
2. 53% of the changes encountered were successfully managed but required additional resources from the shipyard or external vendors. These were managed at the project team level.
3. 16% of the changes encountered required an escalation to senior management (VP-Projects) within the studied organisation, subsequent to which senior management at a vendor and/or shipyard was involved to prioritize, assign resources, or expedite the requirements of those scopes. All of these changes were successfully managed.
4. Only 1 scope was not managed adequately. In this scope, the vendor continued to provide insufficient or erroneous details for the supplied equipment (new installation for the contract),

and these issues persisted till the end of the project and even during the startup phase of the rig in operations. Subsequently, management engagement was carried out with the vendor and long-term plans put in place with the organisation's corporate supply chain team to look for alternate vendors and have a higher quality control due diligence if this vendor needed to be used again.

5. 100% of shipyard scope changes were managed as Cat 2, which typically means that the shipyard has adequate resources available to throw at a problem.
6. Overhaul and Upgrades scopes had all of the Cat 3 resolutions, which meant that they were difficult problems to solve and required management intervention to manage. This is observed typically in the industry because issues in overhauls typically revolve around parts availability, and issues in upgrades typically revolve around vendor engineering, which eventually leads to parts lead time issues if the engineering takes too long. This is what was observed in this project as well.

6.3 Project study 2

6.3.1. Project details

Project study 2 was a project which is called a planned Out Of Service (OOS) project in the industry. In this type of project, an operating rig is taken out of service for maintenance and upgrades before returning to work for the same or a different customer. Project study 2 was a project where a rig completed a contract with an operator in the Middle East, came into a shipyard in UAE for the OOS project, before mobilizing to India for its next contract. The scope of work comprised of:

- Major scheduled maintenance and recertification: As with project C1, major drilling and well control equipment was required to be maintained as per API and OEM guidelines. This scope involves a complete strip-down of the equipment, typically in a workshop, followed by inspection, rectification and rebuild. The equipment is then brought back to the rig, installed, and commissioned as per OEM guidelines.
- Corrective maintenance: Because the rig was an operating unit, a comprehensive list of known issues and defects was known. Plans were made to correct these during the project.
- Contract specific upgrades: for operating with the customer in India, the drilling contractor needs to comply with specific requirements, some of which are just procurement, and others involve installation of new equipment and upgrades on the rig. The requirements are specified in the contract, as well as the regulations from India regulatory bodies.
- Customer acceptance process to be carried out: the customer's typical modus operandi is to give the drilling contractor a set amount of time to get the rig ready after the contract is awarded (180). These readiness projects are typically carried out outside the area of operations because of a lack of good shipyards there. Also, the project for this customer, due to fewer requirements, do not usually need 180 days, and so the rig is usually kept operating with other customers even after the India contract is awarded (as

is the case with C2). Near the end of the project, the customer sends a third-party team (hired for carrying out acceptance) to go through all the requirements and certifications. These inspectors raise a deficiency punch-list for non-compliant items. The deficiencies typically need to be closed prior to contract startup.

Planned OOS projects are typically less complex that reactivation projects because:

- the rig's equipment history is available within the organisation since the rig has been operating within the organisational framework. This history is typically stored within the rig's maintenance system, which is server/cloud based. Further, key equipment maintenance schedules and certification status is closely tracked within the organisation and the dates and timelines are well known.
- the rig's crew can highlight issues and challenges during the project planning process, which reduces the number of surprises found during the project. As mentioned earlier, reactivation projects suffer from the lack of crew knowledge and intimacy with the equipment condition, issues and niggles. Some of the key corrective maintenance scope items (e.g. crane replacement) were scoped out based on crew feedback.
- the procurement for known scopes can be planned in advance because the contract requirements are known, the rig's OOS timeline is known, and the procurement can start before the rig arrives in the yard. This helps in better planning of the scope of work as the rig is not waiting on parts and long lead deliveries do not exacerbate complexity.

However, major maintenance scopes come with inherent scope risk because the condition of the equipment is not known till the equipment is stripped in the shipyard, thereby leading to complexity when multiple such scopes are being carried out at the same time.

6.3.2. Project study 2: Timeline

- Completion of contract with Middle east customer: December 2022
- Mobilization to shipyard: 15 days
- Project timeline: 75 days, with departure in March 2023
- On contract after mobilization and acceptance: May 2023

6.3.3. Project study 2: Project performance

- The project was delivered in line with the promised timeline to the customer.
- The project was completed at 4% less than the budgeted cost.
- The customer acceptance process was smooth with no critical path time spent in India (customer acceptance was carried out during project execution in UAE), proving the quality of the work done and the thoroughness of the scope definition and execution.
- The project was considered a success by the company and the customer.

6.3.4. Project study 2 - Project Organisation Chart

The project team organisation chart for Project study 2 was as per Figure 19. The similarity in the organisation chart between the 2 studied projects is obvious, showing the case study organisation's commitment to the flat management structure and what they believe is the ideal project team setup.

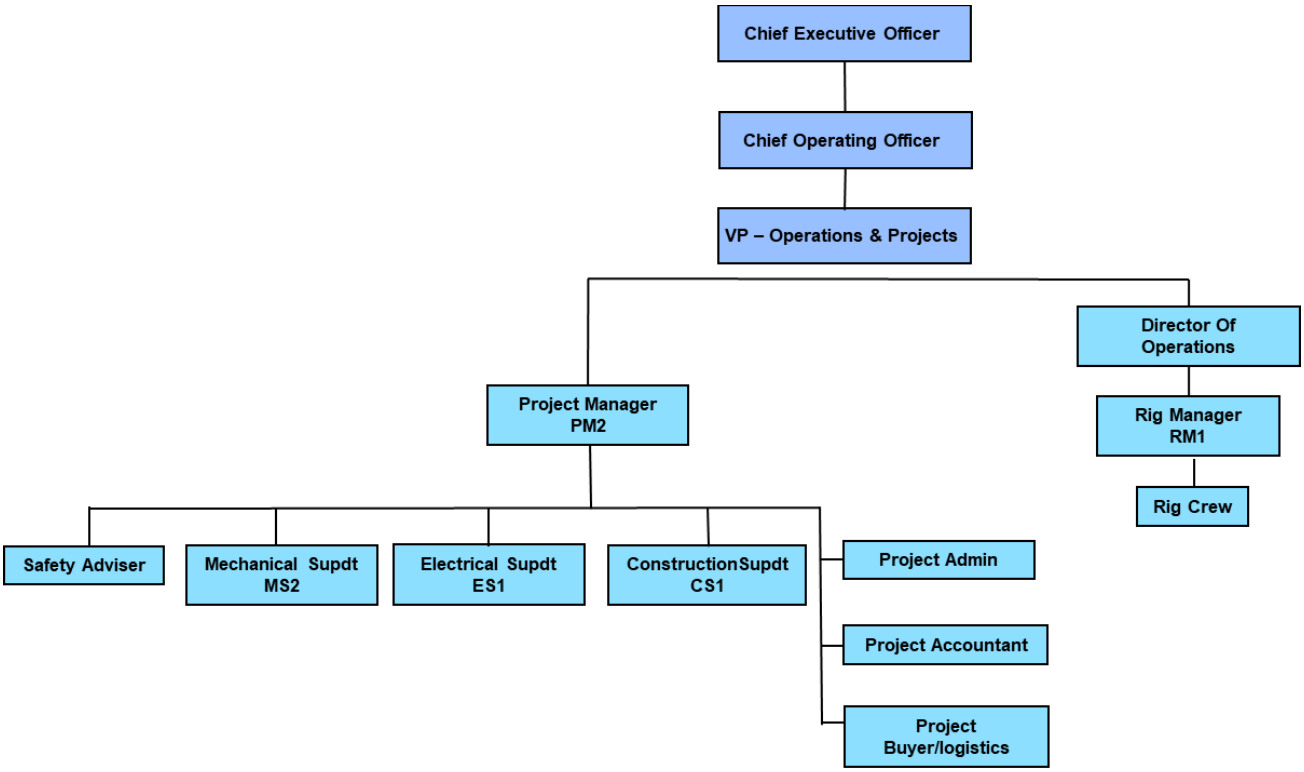


Fig 19. Project study 2 Project Team Organisation Chart

6.3.5. Project study 2 – Scope of Work analysis

After the successful completion of the project, the Scope of Work was discussed with the project manager (as outlined in the Methodology chapter). Below is analysis of the data along with noteworthy observations:

6.3.5.1. Scope of work type

The scope of work breakdown into types is as per below. The scope was focused more on maintenance, with around 1/3rd of the scope being contract related upgrades and procurement/installation, and 2/3rd being asset maintenance related (inspection/remedial, maintenance, shipyard and overhaul scopes).

Table 15. Project study 2 Breakdown by Scope of Work type

Shipyard	Overhaul	Maintenance	Inspection/Remedial	Procurement	Upgrade	Total
5	26	3	41	26	10	**111**
4.5%	23.4%	2.7%	36.9%	23.4%	9.0%	

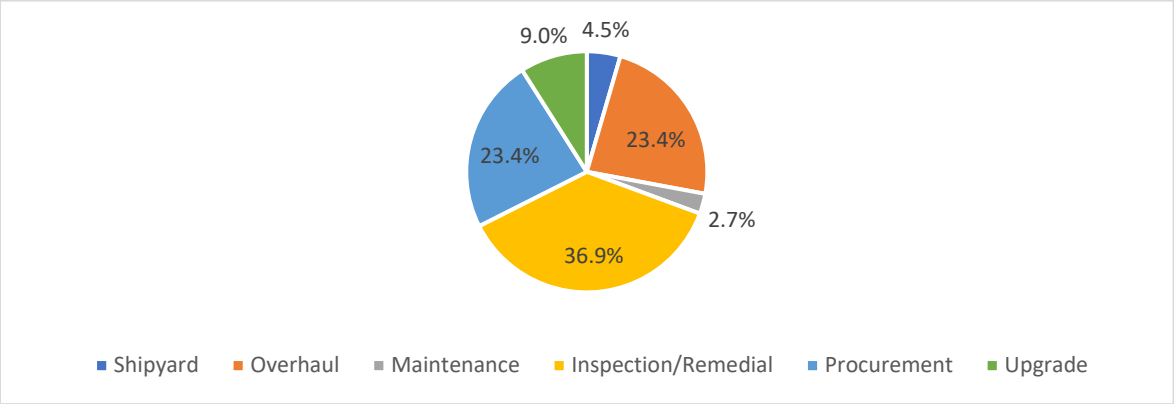


Fig 20. Project study 2 Breakdown by Scope of Work type (Pie Chart)

6.3.5.2. Pre-inspection Possible?

Because C2 was a planned project, an analysis category called 'Pre-inspection possible?' was included to gauge how much of the scope can be pre-planned based on inspections, and how much of the scope can not be pre-inspected due to access issues (e.g. equipment that cannot be opened during operations for inspection). The periodic category was for scopes which were based on a maintenance schedule (usage or calendar based) and not on condition or inspection findings. The NA category was for procurement scopes that did not depend on a schedule or inspection, and could be ordered regardless of them.

Table 16. Project study 2 Pre-inspection possibility

Pre-inspection	Shipyard	Overhaul	Maintenance	Inspection/Remedial	Procurement	Upgrade	
Yes	4	3	1	30	0	8	41%
No	1	16	2	10	0	2	28%
Periodic	0	7	0	1	0	0	7%
NA	0	0	0	0	26	0	23%

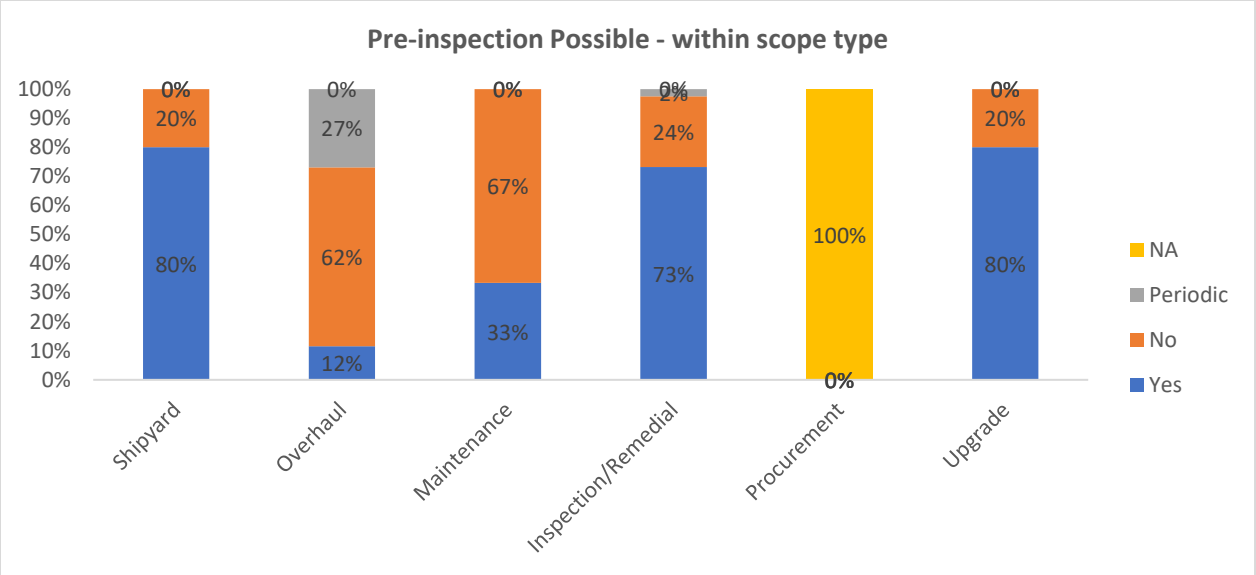


Fig 21. Project study 2 Pre-inspection possibility

Noteworthy observations from this data:

- 41% of the scope could be pre-inspected, 23% did not require any inspections, and 7% was based on periodic maintenance schedules. This meant that 28% of the scope could not be pre-inspected and had a likelihood for causing changes during the project. The fact that even in a planned project around 1/3rd of the scope cannot be pre-inspected, shows how MRO projects have a high susceptibility to scope changes.
- Shipyard, Inspection/Remedial and Upgrade scopes had a high chance of pre-inspection, which reduced the change susceptibility for those scopes.
- Overhaul and maintenance scopes, largely due to access during operations, had a low chance of pre-inspection, and therefore had a higher susceptibility to change and unknowns when the equipment/system was actually inspected during the project.

6.3.5.3. Changes

Next, we look at which of the project scopes experienced changes. The breakdown is as per below

Table 17. Project study 2 Breakdown of Scopes experiencing changes

Changes	Shipyard	Overhaul	Maintenance	Inspection/Remedial	Procurement	Upgrade	
Yes	3	13	2	7	0	0	**23%**
No	2	13	1	34	26	10	**77%**

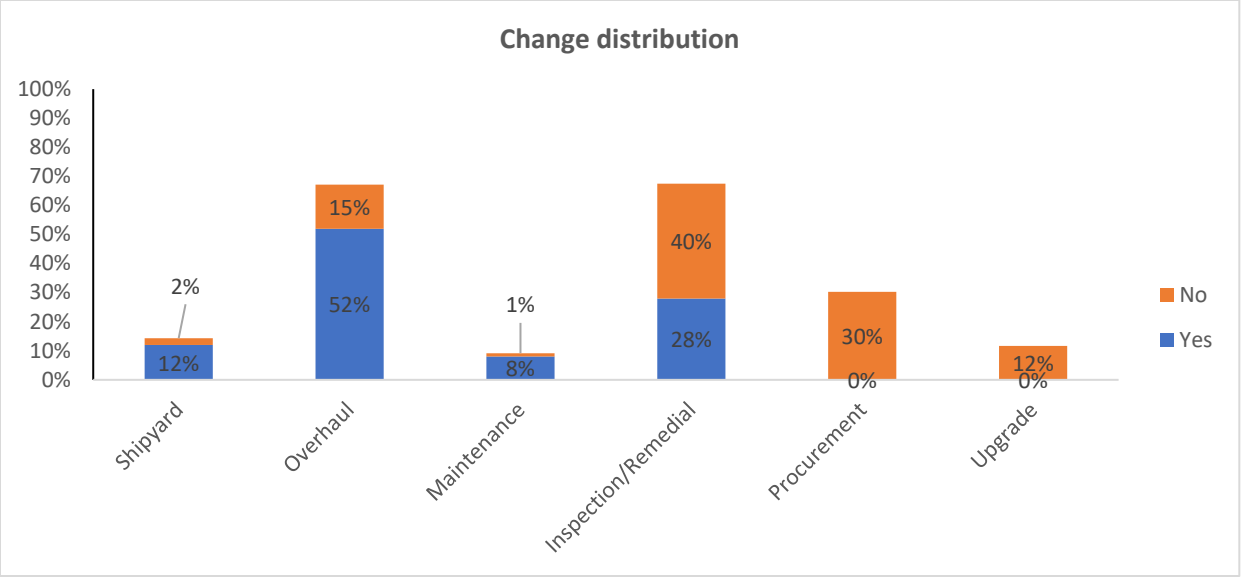


Fig 22. Project study 2 Change Distribution

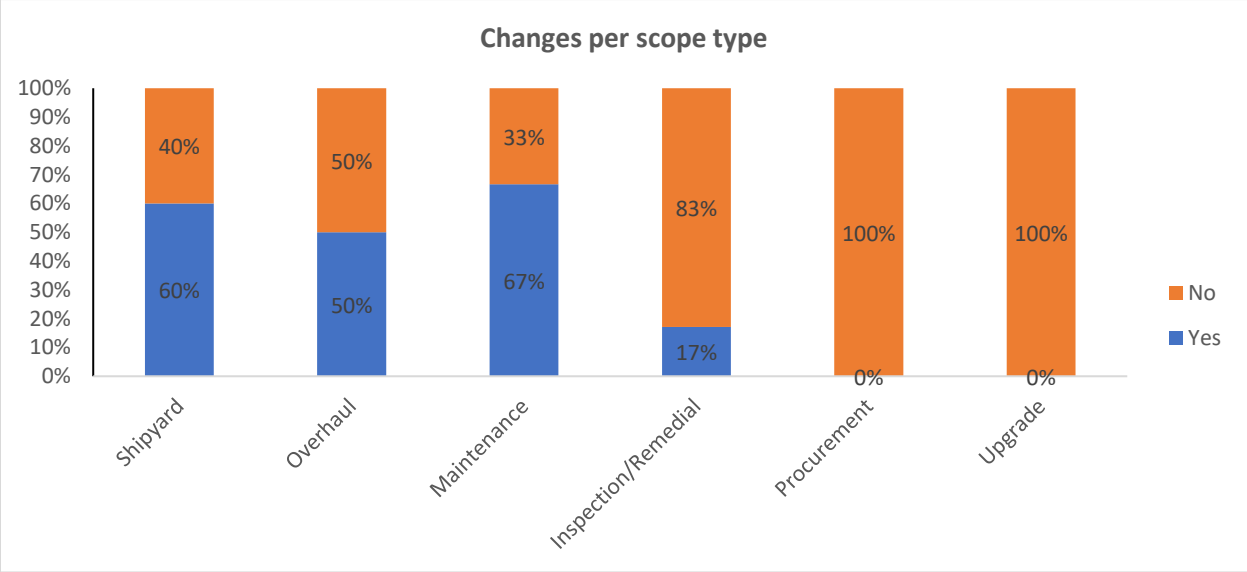


Fig 23. Project study 2 Change per scope type

Noteworthy observations from this data:

1. Changes were observed in 23% of all scopes. This shows how MRO projects have a high degree of changes observed during the project. However, this also shows that the project being a planned one helps reduce the % of changes (C1 was at 49%).
2. 52% of all changes observed were in the overhaul scopes, showing how the inability to have intrusive inspections during the planning period can lead to overhauls experiencing high susceptibility to change.

3. 100% of all changes observed had connectivity i.e. each change affected at least one other scope, and often multiple. This shows how MRO projects have high complexity due to the high connectivity between the scopes, a large number of which are experiencing changes.
4. Contract preparation upgrade scopes experienced zero changes, which shows that upgrades are easier execute as per the plan if the team has the time to plan them properly (unlike C1).
5. Maintenance related scopes had 100% of the changes experienced during the project, which shows that despite inspections and planning, these scopes have a high susceptibility to change due to their very nature.
6. Pure procurement scopes did not experience any changes. This shows the team did a good job in identifying the specifications of the material that needed to be ordered. Further, since the material did not need to be installed, the chances of on-site changes was nil.
7. 15% of the scopes that could be inspected experienced changes, which shows that pre-inspection, where possible, has a dramatic effect in scope definition and reduction of changes during the project.

6.3.5.4. Change classification

The change classification was carried out only for scope items marked Yes under Change Encountered. The coding was based on the below criteria for the encountered change:

1. Low impact on plan and resources. No effect on other plans
2. Medium impact on plan and resources. No change in schedule
3. High impact on plan and resources. Critical path potentially gets affected.
4. Critical impact on plan and resources. Critical path changes for sure

Table 18. Project study 2 Change Classification

Classification	Shipyard	Overhaul	Maintenance	Inspection/Remedial	Procurement	Upgrade	
1	1	2	2	5	0	0	**40%**
2	2	7	0	1	0	0	**40%**
3	0	2	0	1	0	0	**12%**
4	0	2	0	0	0	0	**8%**

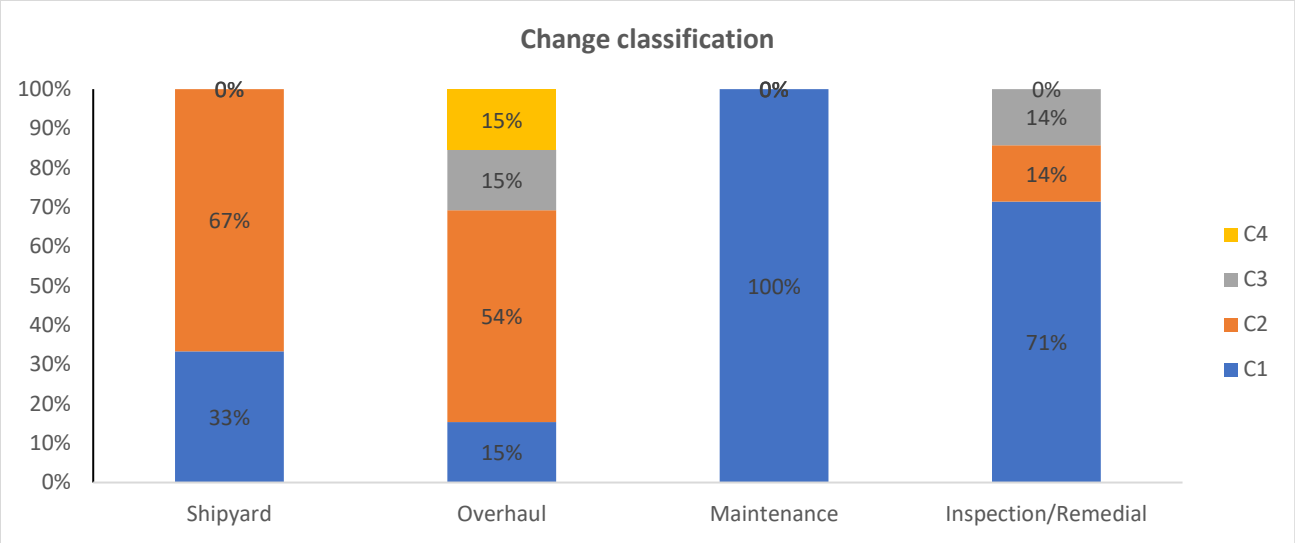


Fig 24. Project study 2 Change Classification

Noteworthy observations from this data:

1. 80% of the changes encountered fell within Categories 1 and 2 and were relatively easy to manage with the company's change management setup. This was better than C1 (66%), showing that even when there were changes, in pre-planned projects being run using CBPM, these can be largely handled easily.
2. 12% of the changes had the potential to impact the critical path, but the change management method deployed ensured that it did not.
3. 8% of the changes affected the critical path and the change management efforts were designed to minimize that impact.
4. From the above points, it is clear that even in planned MRO projects, project's scopes experience changes, all the changes have connectivity, and 20% of the changes have a potential impact on the critical path, the project's complexity is quite high, though less than C1 which was not planned.
5. Overhaul scopes had the highest ratio of Cat 3 and Cat 4 changes, which reinforces the challenges associated with equipment overhauls with the real condition of the equipment only discovered during the project execution, leading to changes.

6.3.5.5. Change Resolution

The change resolution classification was carried out only for scope items marked Yes under Change Encountered. The coding was based on the below criteria for the resolution of the encountered change:

1. Resolved by project team using existing resources.
2. Resolved by project team with additional resources and assistance from shipyard/vendors.

3. Resolved by project team after escalation to senior management within the organisation and/or with vendor organisation.
4. Not resolved adequately

Table 19. Project study 2 Change Resolution

Resolution	Shipyard	Overhaul	Maintenance	Inspection/Remedial	Procurement	Upgrade	
1	0	5	2	3	0	0	**40%**
2	3	6	0	4	0	0	**52%**
3	0	1	0	0	0	0	**4%**
4	0	1	0	0	0	0	**4%**

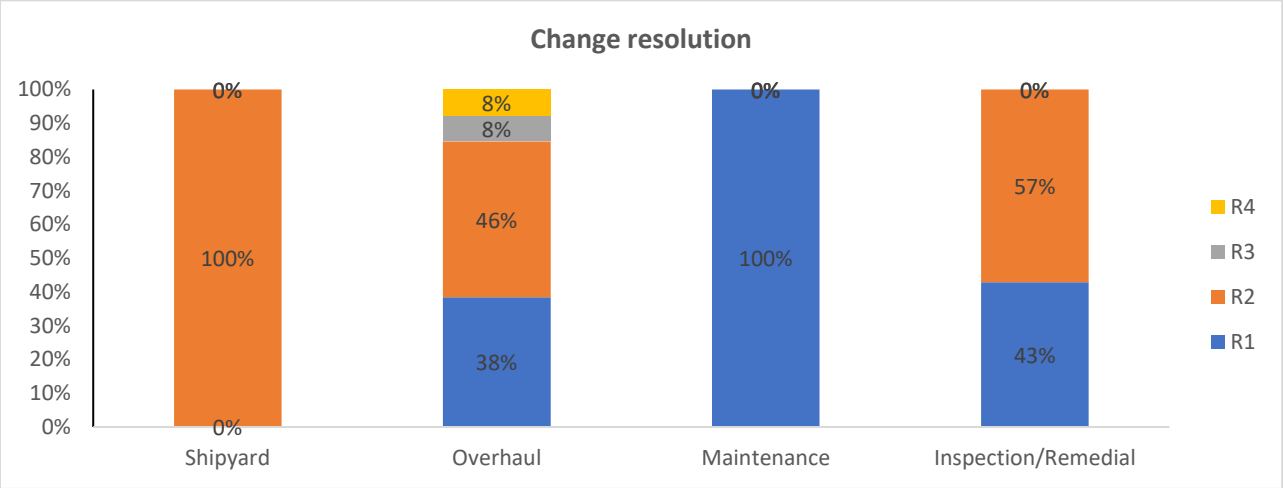


Fig 25. Project study 2 Change Resolution

Noteworthy observations:

1. 40% of the changes encountered were successfully managed with existing resources by the team, using the change management process outlined in the data.
2. 52% of the changes encountered were successfully managed but required additional resources from the shipyard or external vendors. These were managed at the project team level.
3. Only 1 scope (4% of the changes encountered) required an escalation to senior management (VP-Projects) within the studied organisation, subsequent to which senior management at a vendor and/or shipyard was involved to prioritize, assign resources, or expedite the requirements of those scopes. This one change related to the Drawworks and the availability of parts. Management had to get involved for a discussion with the OEM to allow the use of non-OEM parts, which was agreed and the change managed successfully.
4. Only 1 scope (4% of the changes encountered) was not managed adequately. In this scope, 2 of the rig's engines failed catastrophically during the mobilization to India, due to incorrect

lubricant usage (human error). Using the organisation's agility in response and fleet spares program, replacement engines were shipped immediately to the rig, but the installation was done during operations. This is why this scope is marked as inadequately managed.

5. 100% of shipyard scope changes were managed as Cat 2, which typically means that the shipyard has adequate resources available to throw at a problem.
6. Overhaul scopes had all of the Cat 3 and Cat 4 resolutions, which meant that they were difficult problems to solve and required management intervention to manage. This is observed typically in the industry because issues in overhauls typically revolve around parts availability. This is what was observed in this project as well.

6.4 Summary

This chapter provided an overview of the 2 project studies that were used for this research effort, and the data gathered from them via Scope of Work analysis. From this analysis, several inferences can be drawn.

Firstly, the data and analysis of the Scope of Work for both studied projects helps to validate the complexity of MRO projects and shows their alignment to the definitions of complexity from literature. It is also an important validation step for the interview and observation data because the meaningfulness of that data is predicated on the MRO projects being executed in the organisation as complex. Therefore, the data validates that the MRO projects being studied fit the assertion of complexity by the interviewees.

Secondly, the findings from the data show that despite the significant differences in the 2 MRO projects being studied, there is enough evidence to provide analytic generalization (Yin, 2003) towards the applicability of these projects to this research effort. By using these to test the conceptual framework, not only are the two extremes in MRO project types in the industry being used for their differences, but it also helps identify the management principles being used to treat them similarly at an organisation level.

7. Data Analysis

As discussed in the Methodology chapter, for the qualitative data from the interviews and studied projects' observations, content and thematic analysis was deemed the appropriate method for data analysis in the current research effort. A common set of principles (Morse and Richards, 2002) for qualitative interview and observational data are: transcribing, immersion into the data, developing a coding system, and then then linking data to codes to develop theory. Two popular methods (Smith and Firth, 2011) were considered: framework approach (Ritchie and Lewis 2003) and thematic networks (Attride-Stirling 2001), and framework approach was chosen as this qualitative research effort had specific objective and a predefined sample of professionals and practitioners (Sweetman and Conboy, 2018) and due to its inherent advantages in rigour, transparency and ability to deal with cross-sectional descriptive data (O'Keeffe et al, 2015) (Ritchie and Lewis, 2003) (Smith and Firth, 2011). Framework analysis is also considered an effective means to assess management system tools and practices from the perspectives of the people they affect (Srivastava & Thomson, 2009), which is appropriate for this study that uses practitioners for the data.

7.1 Framework Analysis

This chapter will focus on Steps 3 and 4, Indexing and Charting, of the Framework analysis, as outlined in the Methodology chapter. In Chapter 4, the conceptual framework was developed that focussed on key aspects of MRO project management and how complexity theory could be used to map out the Change-Based Project Management approach towards such projects (Table 9)

Table 9: Conceptual framework for managing MRO projects using Change-Based Project Management

MRO Projects Management aspect	Change-Based Project Management Approach	Complex Adaptive Systems
Planning Process	Continuous Planning mentality; Suitable for projects where scope breakdown into iterations is not possible; Accountability of the team is continuous from the planning to execution to closeout phases.	Agents with schemata; Non-linear emergent behaviour;
Change Management	Change is inevitable; swift and nimble change management; Adaptive management style	Adaptiveness, Anticipation and co-evolution
The role of the customer	Customer engagement and active participation throughout the project lifecycle and at all levels	Feedback and connectivity; Adaptiveness, Anticipation and co-evolution
The role of leadership	Leadership buy-in towards the approach; Autonomy of the project team.	Feedback and connectivity; Self-Organisation
Communication	Communication over processes (Stand-up Meetings, retrospective meetings, co-location). High-frequency informal communication to facilitate self-organising behaviour	Feedback and connectivity; Self organisation; Non-linear emergent behaviour
Team Setup	Smaller teams with varied skillsets spread across multiple scopes; Ability to be multiskilled; Project manager as a mentor and guide; Self-organising behaviour	Non-linear emergent behaviour; Variety, Feedback and connectivity; Self organisation
Documentation	Decentralized decision making, leading to low documentation emphasis; Extent of documentation driven by final project deliverables	Agents with Schemata

Subsequently, using Framework Analysis, for each MRO project thematic category from the conceptual framework, sub-themes were charted and generated in a tabular form (Table 9). Each of these sub-themes are discussed in more detail later in this chapter. As each sub-theme is explored and elaborated, illustrative quotes and observations will be provided from the interview and studied projects data – these will cover both commonalities as well as discrepancies.

Table 10 Conceptual Framework Themes and Sub-themes

Conceptual framework themes	**Sub-Themes**
Planning Process	The role of planning
	Team setup for planning
	Responsibilities
	Types of Scope planning
	Stage Gate
	The role of project plans
Change Management	Management system
	Change management process
The role of the customer	Customer engagement
	Acceptance process
The role of leadership	Organisational setup and culture
	Empowerment
Communication	Meetings
	Flexibility
Team Setup	Organisational arrangement
	Team size
	Individuality
	The role of the Project Manager and self-organising behaviour
	Multi-skilled workforce
Documentation	Type of documentation
	Process
	Resource Adequacy
Emergent themes	**Sub-Themes**
Drilling Industry insights	Dynamic industry and time pressure
	Newbuilds vs MRO
	Complexity and change in MRO projects.
	Industry performance in projects
Hybrid project management	Balance
	Regimented aspects
	Flexible aspects

The following sections have the analysis of the findings against each theme and sub-theme. Relevant quotes from interviews, and observations from the studied projects are mentioned against each sub-theme to provide richness of context.

7.2 Planning Process

The discussion and observations related to the planning process were a key element to the research effort. As developed in the Conceptual framework in Chapter 4, the conceptual link between MRO projects, CAS and CBPM specific to Planning was:

Part of Table 9: Conceptual framework for managing MRO projects using Change-Based Project Management

MRO Projects Management aspect	Change-Based Project Management Approach	Complex Adaptive Systems
Planning Process	Continuous Planning mentality; Suitable for projects where scope breakdown into iterations is not possible; Accountability of the team is continuous from the planning to execution to closeout phases.	Agents with schemata; Non-linear emergent behaviour;

While this framework was developed at a first principles level, it was important to understand the ideology and working methods of the studied organisation when it comes to Planning. Using the data, sub-themes were identified (Table 9). Within each sub-theme, there were several interesting and relevant data points that are elaborated, with examples, in this section. The tabular arrangement of the Planning Process theme is presented in Table 20

Table 20. Planning Process: Themes, Sub-themes and Key Aspects

Conceptual framework themes	Sub-Themes	Key Aspects
Planning Process	The role of planning	The importance of Planning
		Balance
		Continuous Planning
		Flexibility
	Team setup for planning	Resource allocation
		Accountability
	Responsibilities	Joint ownership
	Types of Scope planning	Inspections
		Procurement
		Contingency Planning
	Stage Gate	Stage Gate not deemed necessary
	The role of project plans	Retrospective diagnostic tool
		Flexibility

7.2.2. The role of planning

7.2.1.1. The importance of planning

It was evident from the interviewees' comments that planning is critical to the success of the project. The earlier the planning starts, the better. This was in line with literature on change-based project management methods as well (Koskella and Abrahamsson, 2004). As per the interviewees, typical MRO project planning starts 6 months in advance, apart from very long lead items which can sometimes be ordered years in advance. However, this was not observed to be consistent across the board, with some projects (like reactivation) getting less planning time due to organisational circumstances. Project study 1, a reactivation project, had almost no planning time prior to project commencement as the company bought the rig and commenced the project immediately. Project study 2 was a planned Out Of Service project, and therefore had planning time where inspections were carried out and material ordered prior to project commencement. The type of planning was an interesting observation and was split into 3 main types – inspections, procurement, and contingency planning. These are explored as separate sub-themes under Planning.

PM1: The most important for MRO projects is the planning stage. If you make a good planning stage for your project, your project will go very easy and very smooth.

ES1: Some projects are easier than others because they are better planned. For example, when a rig comes out of service, there is planning in advance. You know basically what the scope is going to be and you have plenty of time to plan and by the point the project starts, you can have all the material on hand.

7.2.1.2. Balance

It was also commented that there was marginal utility for planning beyond a point, and the cost of the planning team needs to be considered. Too much planning was also considered to come at the expense of flexibility and interviewees were wary about losing the flexibility of the project management approach by setting up a planning system for a no-change scenario.

PM2 and MS2 felt that in the current organisation, sometimes the required amount of planning time is not available, but PM2 also acknowledged that there needs to be a balance between having sufficient time to plan yet still maintaining a lean team that can work in an agile manner.

PM2: "Inadequate time for planning is one of the downsides of the company's project management model, and I would like to see more time spent on that".

PM2: "However, if you create too big a team from the planning stage, then it leads to poor execution focus and you lose agility in decision making, like I saw with my previous employer".

MS2: "Would like to see a longer preparation and planning period due to lead time of parts and material."

7.2.1.3. Continuous Planning

Team members believed that they follow a continuous planning process. Plans were reviewed and developed at a high frequency. As long as the boundary conditions, typically the critical path, was unchanged, management was not informed when the team reworked the plan.

PM1: "We follow continuous planning process and the requirement to stick to an initial plan is not there. Planning is done on a daily, weekly, monthly basis." "On longer projects (reactivations), the schedule is updated and reviewed every 2 weeks. On shorter ones, its weekly"

PM2: "I update the schedule twice a week to see how things are going. No baselines are created, but if the overall timeline and critical path is changing, management is informed."

PM3: "Planning is a continuous process. Once you have the base plan where you have the start date and the end date, then the project managers and the project team know what exactly is to be done. If we are falling behind, we can plan something to mitigate that."

MS1: "The project plan is looked at once a week."

7.2.1.4. Flexibility

There were differences observed between the styles of different project managers – while one preferred a more documented approach (in terms of creating detailed work-packs which outlined the scope, requirements, specifications etc) for the shipyard scope discussion, the other preferred to have a more inspection-based approach (where the shipyard was given a high level guidance, and entrusted to submit a detailed scope of work after inspections were done). Both styles fit into the overall management style of the organisation and also showed how the flexibility in the overall management approach allowed people to fine tune processes specific to their preferences and requirements.

ES1: "The planning process also depends on which project manager you're working with. Some project managers are not big on the paperwork. But are big on other things and some project managers are big on the paperwork and the planning and work scopes. I mean for example PM2 makes work packs for everything before every project - there's a work pack for every single job that the shipyard's doing. PM1 is not strict on this - his work packs are a very basic instruction to the shipyard, more on a verbal side. But if you're going to prepare work packs then you need to be in attendance in the office, maybe a month or two before the project even starts. I can see pros and cons for both - I can see advantages to planning it in detail and I can see advantages to just doing it on the fly."

7.2.3. Team setup for planning

7.2.2.1 Resource allocation:

The company has a pool of resources and experts. During the planning phase, the project manager works with the VP-Projects to finalize the requirement (based on the scope and size of the project) for the team composition and then resources are allocated and

mobilized. Within the project teams, the superintendents estimate their resource requirements and discuss/agree the same with the project manager.

PM1: "I have freedom from the management to justify or optimize the project team. I just have to notify my boss that I need some more resources."

MS1: "Depending on the project scope, I request the number of resources required from the project manager."

MS2: "I decide how much resources I need and negotiate that with the project manager."

7.2.2.2 Accountability:

There was no need felt for a project planning engineer or a dedicated resource for planning of MRO projects because the execution team was assigned to the planning as well. So, the same team moves from planning phase to execution phase to the commissioning/testing/acceptance and handover phase. This eliminates the need for handover and leads to better accountability as the planning team is also the executing team. For longer Newbuild projects, a planning engineer was deemed to be potentially useful.

VPT: "The difference between (Studied Organisation) projects and others is that there is accountability before and, more importantly, after the projects, because there is enough integration that happens during planning, of course, during execution and more importantly post when the project has been delivered so that makes us pretty unique"

PM3: "For longer projects (Newbuilds), a planning engineer might be a useful asset for workload management. Not required for shorter projects (MRO)"

PM2: "There is no value in having a dedicated project planner. Maybe only for very long projects, but even then, they get information from all the project team supervisors, so it doesn't really add value."

7.2.4. Responsibilities

7.2.4.1. Joint Ownership

The project manager, key supervisors, the rig team, and the larger support organisation all collectively work on the planning for the project. Each project supervisor takes responsibility for certain scopes and discusses and finalizes with the operations team before consolidating this information with the project manager, who is developing the Work Breakdown Structure (WBS).

For new contract requirements, identifying what the scope entails and how it interfaces with the rig (if at all – some contract deficiencies are just procurement items) is done by the supervisory team during the planning phase.

CS1: "During the planning phase, I focus on understanding the scope, and look at the engineering, procurement and resource requirements for that"

ES1: "I'm a lot more involved in actually planning the job - getting quotes, assisting to issue the Purchase Orders, and working to a budget. So, I'm given a budget sometimes and told that's the amount that you have."

MS1: "During the planning phase, we try to assess the equipment and get feedback from the rig crew. We try and find out what issues they are having so you can order parts for those issues."

PM3: "For contract preparation projects, the contract is the Bible. So, the planning process starts with the team reviewing the contract thoroughly and identifying deficiencies. Responsibilities are distributed for various scopes between the team members."

VPT: "I don't think the planning process is largely driven by the project manager. I think he is the guy who has to consolidate a whole lot of things and some project managers do it better than the others, but he is not the only driver"

7.2.5. Types of scope planning

7.2.5.1. Inspections

Time spent by the team on board the asset during the planning phase was considered to be very useful and helped with a detailed identification of the scope and a reduction in the number of changes experienced during the project. After the inspections are completed, the final scope (WBS) is discussed and agreed by all parties. Based on this WBS, the next steps (procurement, engineering, discussion with experts, shipyard interface etc.) commence.

One of the big sources of changes and risk was identified as rig scopes that the rig team did not inform the project team about during the planning phase. A rig inspection and detailed interaction with the rig team, along with alignment on the final scope after the inspection, was considered an important step towards reducing this risk.

It was deemed that a careful and thorough inspection on the structural and piping scopes can lead to a much lower chance of changes during the project, as compared to equipment scopes where the equipment condition will only be known when the equipment is stripped down during the project.

MS1: "During the planning phase, we try to assess the equipment and get feedback from the rig crew. We try and find out what issues they are having so you can order parts for those issues."

PM2: "During the planning phase, scopes are divided to the mechanical, electrical and construction side to create parts lists, get quotes and create workpacks for the shipyard."

RM2: "As a rig manager, I mainly get involved in the contract and customer specific requirements, but the maintenance and upgrade scopes and the WBS are planned by the project manager and project team. It is beneficial for operations to get involved at an early stage because it can help"

CS1: "On the structural side, changes can be minimized based on planning and surveying in advance."

7.2.5.2. Procurement:

Long lead procurement was considered an essential aspect of the planning phase. Drilling contractors typically do not manufacture any of the equipment or hull materials and are reliant on a vendor base for these. Accordingly, when a project is being scoped out, getting quotes for the material required is a key step in being prepared for the commencement of the project.

The procurement process usually consists of vendor procurement, done using Purchase Orders (PO) and the shipyard scope of work, done using a Shipyard contract.

After the WBS is created, the team works on getting quotes for various procurement items and creating workpacks for the shipyard scope of work. The execution cost is estimated and commercial approvals for the complete project are sought. After this, the POs can be released the shipyard contract can be negotiated and executed.

SCM: "It is very beneficial that we start long lead procurement in the early stages, including contingency planning, and have an established pipeline of projects which helps avoid last minute scrambling".

"This is a more streamlined approach compared to previous employers where projects would come last minute, and the clock was already ticking while you are not ready."

7.2.5.3. Contingency planning

Due to the complex and unpredictable nature of the projects, where equipment condition is often only known once the rig is in the shipyard, it was deemed to be important to have contingency planning for parts that might be required, instead of only procuring parts that will surely be required.

The company also exercised Organisation-level contingency planning. Having a pipeline of projects and a lookahead at future projects helps in this regard, as significant contingency procurement for 1 project alone is problematic due to excessive cost and the potential of being left with a large surplus of expensive parts if they are not required. By having an available lookahead of future projects, contingency parts can be ordered as a fleet reserve with a higher probability of being used over a multiple project lifecycle.

VPT: "Having required contingencies in place, both high and low dollar, is the key to successful change management, aided by quick decision making. Having a focused asset base helps in this regard."

7.2.6. Stage Gate

7.2.6.1. Not deemed necessary

Apart from CS1, interviewees who were familiar with Stage Gate processes did not support their use in the drilling rig MRO project management context. Especially in the studied organisation, it was noted that due to the flat management structure, a Stage Gate process would not add value as the key people are already aware of the main challenges and milestones in a project. The Stage Gate process was considered a bureaucratic process needed for organisations which were not flat.

CS1, who had recently joined the studied organisation from another company, had an interesting perspective towards the Stage Gate process. He wished for a Stage Gate process to be implemented in the planning phase of the project, so that various planning deliverables could be better tracked. This was in use in his previous organisation and he liked that setup. It is interesting to note that his previous employer was the same company where most of the other interviewees worked earlier and had negative views on their project management setup. This illustrates that the studied organisation's system, due to its uniqueness in the industry, is not easy to adapt to. It could also be imagined that an organisation looking to change their plan-based management system to a change-based one could face challenges and resistance from their teams. This was also visible in literature around agile implementation challenges (Williams and Cockburn (2003)(Rigby et al, 2018)

VPT: "When you talk about stage gate processes at the PMI method, it's a great project management tool. It's a great project management setup, but I'm not very sure if it is actually applicable to the industry that we're talking about. I mean, it is a generic tool"

DIE: "I think because we are so flat, I don't think there is a whole lot of need for stage-gating because most of the people are aware of whatever is going on and whatever needs to be achieved, so I'm not sure what the stage gate will really achieve. Stage gating wouldn't change what we are doing - it probably would impede more than help because it is really bureaucratic."

CS1: "I would like to see that implemented again because like each stage would have its own deliverables and these deliverables. Then we're finished. We finished that. Stage we've done. We've done material order whatever changes we have to deal with. We can deal with, but major again studies, major engineering, major material delivery, long lead. All that we've done. Then we can focus"

7.2.7. The role of project plans

7.2.7.1. Retrospective diagnostic tool

In the studied organisation, the project schedule was observed to be used as a tool initially for planning the overall timeline and priorities of the project. But during the execution phase, it is used as a retrospective diagnostic tool to see where the project is falling behind, and which scopes need more attention, resources, or intervention. On longer projects (reactivations), the schedule is updated and reviewed every 2 weeks. On

shorter ones, it was typically reviewed weekly. The reviews are a retrospective process with a forward-looking view that help the team plan the next steps better. Thus, project schedules are used as a diagnostic tool and not in terms of baselines and slippages. In fact, baselines are not really made or tracked. But if the overall timeline and critical path is changing, management is informed. It was deemed that the baseline (PMI) model was better suited to Newbuild projects and not MRO projects.

The project manager is the keeper of the schedule, and he updates it periodically based on feedback from various team members. This process of updating not only helps with the holistic picture of the project but also gives the individual supervisors an opportunity to reflect on the status of their scopes and where they need to focus their attention.

Apart from the interview data, this was also evident in Observation C1_4, which was an action-oriented meeting with a brainstorming atmosphere where the team was trying to solve for a lot of moving parts while still maintaining overall timeline compliance.

MS1: "The project plan is looked at once a week. The plan is updated by the project manager based on feedback from us. We look at the project plan to see what is falling behind or left out and needs to be focused on."

PM3: The project schedule is important for every project. However, the project schedule is not used as per the PMI model with established baselines, re-baselining etc. It is updated on a periodic (usually weekly) basis by the Project Manager based on the latest updates"

PM3: "The schedule is updated every week. Obviously, I will be looking behind what went wrong so that it doesn't get carried on into the next phase of the project. It is like a forward-thinking tool."

PM1: "On longer projects (reactivations), the schedule is updated and reviewed every 2 weeks. On shorter ones, its weekly"

7.2.7.2. Flexibility

ES2 preferred not to use a project schedule at all and track their scopes on an MSExcel sheet based on their personal preference. He still provided the PM with the required updates and participate in the larger meetings and discussions. This showed the inherent flexibility in the process in the studied organisation.

ES2: "I don't rely on a project plan and have my own tracker. If it's there, it's useful because it keeps you aware of the timelines. Usually, the project manager keeps it updated every couple of weeks."

7.3 Change Management

As developed in the Conceptual framework in Chapter 4, the conceptual link between MRO projects, CAS and CBPM specific to Change Management was:

Part of Table 9: Conceptual framework for managing MRO projects using Change-Based Project Management

MRO Projects Management aspect	Change-based Project Management Approach	Complex Adaptive Systems
Change Management	Change is inevitable; swift and nimble change management; Adaptive management style	Adaptiveness, Anticipation and co-evolution

While this framework was developed at a first principles level, it was important to understand the ideology and working methods of the studied organisation when it comes to Change Management. Using the data, sub-themes were identified (Table 9). Within each sub-theme, there were several interesting and relevant data points that are elaborated, with examples, in this section. The tabular arrangement of the Change Management theme is presented in Table 21

Table 21. Change Management: Themes, Sub-themes and Key Aspects

Conceptual framework themes	Sub-Themes	Key Aspects
Change Management	Management system	Flat Organisation
		People Over processes
		Contingency Planning
	Change management process	Managing within set boundaries
		Active change management
		No MOC Documentation

7.3.1 Management system

7.3.1.1 Flat organisation

The management team felt that because changes in MRO projects are a given, the organisation has been setup to deal with them efficiently and expeditiously.

The flatness of the organisation (figures 13 and 19 in Chapter 6) leading to quicker and more efficient decision making toward change management was a common theme in responses. The smaller organisational hierarchy allows people to communicate directly, or in groups, and reach decisions faster, as compared to management system with more formal change management processes where multiple layers of justifications and presentations might be required before an approval is received.

> *COO: "If you plan that there are going to be changes then that will help you address what you have to. You have to go into the project knowing that there's the opportunity that there's going to be changes in the scope of work."*

EVP: "We deal with unknowns, as the 'nature of the beast' for MRO projects. So, we're going to do an overhaul on our Drawworks brake, and you're going to dismantle the Drawworks. You have no clue what's inside. And so we're constantly dealing with unknowns."

SCM: "MRO projects are full of changes. Decision making is very fast in (the studied organisation) due to a flat structure."

PM3: "Decision making in (the studied organisation) is very fast, which is very different than other organisations I have worked for"

CS2: "The studied organisation has a very simple organisation, so the decision making is very good, which really helps on the project since most of the time we are expecting some changes"

RM2: "One of the advantages of the current company is that we don't have multiple layers of management that we need to go through to in order to make a change. If a change is encountered, there is a direct route form the project manager or rig manager to the VP-Projects, and it is very streamlined and very beneficial."

7.3.1.2 People over processes

It was mentioned that because the equipment types on rigs don't allow for comprehensive knowledge of the equipment condition without stripping down the equipment (which is only done during the project), a regimented approach towards project management is bound to fail. Instead, the management system relies on people to manage the changes and solve problems instead of processes. So, the organisation is more focused on making the right decisions, and not necessarily the process by which that decision was made.

EVP: "For the regimented approach to work, in my view, it would seem to be much more practical where it's a whole series of defined knowns that you're working with. And you've got proper documentation on exactly the condition of this bearing and exactly the condition of that before you start a piece of work, because then it's just, you know, stepping through the process. But because we tend to be dealing with a whole bunch of unknowns and a bunch of assumptions, you really have to rely on people to then manage your way through that"

VPT: "We are not hung up on the process of getting to the right decision, we focus on the right decision first. There is not a whole lot of layers within the organisation which keep on asking questions to justify a particular outcome, but it is easier for us to make a decision and move on with it by huddling in the room and proceeding rather than layers and layers of justifications which don't serve a whole lot of purpose"

ES2: "Decision making on changes is pretty fast. The entire process is pretty easy."

7.3.1.3 Contingency Planning

The organisation also committed to having a higher focus on high and low dollar contingencies to be able to react to these changes quicker. Having a focused asset base (Jack-Up rigs) helps with this contingency planning.

VPT: "Having required contingencies in place, both high and low dollar, is the key to successful change management, aided by quick decision making. Having a focused asset base helps in this regard."

MS2: "For managing major overhauls, it is important to have the must-use consumables. Then, it is useful to have major critical spares within the fleet spares. If you don't have those parts, then it can be problem with very long leads"

7.3.2 Change management process

7.3.2.1 Managing within set boundaries

The project managers felt empowered to manage changes without needing management approval as long as the changes had no impact on bottom line cost, overall project completion timeline or key scope deliverables.

When a change that may affect any of these is encountered, the first attempt is by the project team to find a solution to mitigate the impact – if such a solution is not found, then management escalation is done to keep management (Vice President -Projects) appraised of the problem, while the team engages with vendors, shipyard etc. to work on a solution.

There is a weekly or fortnightly review, done in person or over the phone/Teams, between the project manager and VP-Projects, where non-critical changes are discussed along with overall project updates. No formal approval is sought, but the issues are discussed, and guidance sought and sometimes the plans are changed based on the discussions. This is not a documented review. There is an Authority Limits Matrix in the studied organisation, where the VP-Projects decision making authority is also defined. As long as the bottom-line deliverables/schedule/cost are within his ALM level, the VP-Projects can approve the changes requested by the Project Manager.

Apart from the review meeting, for major changes to project deliverables, the VP-Projects tacit approval is sought on an ad-hoc basis. This approval is not via a formal documented process step but is typically a phone call or email to discuss the issue and potential solutions.

PM2: "We don't do a formal change management process but inform the management (VP) while working with vendors and shipyard in parallel for quotes and cost estimates. Unless there is an issue during the intimation stage, you don't wait for formal approval."

PM1: "If the change is going to affect the time and the coast, I have to go to my management first to get the Approval due to this going to affect the cost or affect the schedule but and I have to discuss it and get approval. But if it is not affecting the schedules and not affecting the money, I can take a verbal approval or just notification to my management."

7.3.2.2 Active change management

While most of the equipment scopes have a high risk of change, structural, piping and painting scopes were identified as areas where changes can be minimized to a large extent based on accurate and detailed surveys, which are possible while the rig is operating.

On the equipment side, the supervisors attempt to identify problems and potential changes as early as possible in the project by carrying out equipment health checks, and strip-down of key equipment is front-loaded in the project schedule. Once a change is found, the supervisor will first study it for criticality, need, redundancy etc. Then he will typically discuss it with the project manager after which they will collectively contact shipyard/vendor/engineering to look for solutions. The solutions sometime require a re-shuffling of the work plan and resource allocation, all of which is done via discussions between the project team, rig team, vendors and shipyard in a self-organising manner.

As the projects progress, the focus of morning meetings was seen to shift towards more active change management.

In C1_7, it was observed that there were more change-management discussions than previous meetings (because the project was at a much more advanced stage than the previous observation meetings). Commercial and technical plans were made during the meeting (cost numbers were not discussed but agreements made based on previously submitted quotes or contractual unit rates). A few things decided to be taken 'offline' due to commercials in the way of technical execution. However, on the ground the work continued due to the ballpark levels being correct and due to unit rate agreement in place as a backup.

> *MS1: "Once you find a change, you go speak to the project manager and advise him of the change. We sit together and make a plan on how to manage that change, what caused the issue, how it will affect the other scopes, and potential solutions"*

> *CS1: "Changes are discussed and a plan created by the team together with the project manager. Once a plan is agreed, the team, we organise to manage the scope from there"*

> *ES1: "Once I find a change, I will discuss this with the project manager and get hold of vendors or get hold of specialists in that field, if required, and plan it, and sometimes you have to reshuffle the way that you're doing the job. So, for example, if you find something wrong with a piece of equipment that you'd plan to, in your schedule, to have repaired by a certain date, you then have to reorganise and possibly leave that piece of equipment until the parts come and move on to something else". "Now in that decision, you have to discuss this with the mechanical team, with the guys on the rig, with the project manager, possibly even the structural team. Depending on the severity, you know depending on what it is. But this is the kind of thing that needs the input from most people from operations. And then, in a few occasions it requires some feedback from Technical Support services in the office as well."*

7.3.2.3 No MOC documentation

There is no formal Management of Change documentation requirement in the organisation for project scope changes. This contributes to the fast decision making in the organisation, which was a unanimous comment from the interviewees.

There was opposition to formal change management processes by the interviewees because it would lead to too much paperwork and slow down the speed of response significantly.

PM2: "We don't do a formal change management process but inform the management (VP) while working with vendors and shipyard in parallel for quotes and cost estimates. Unless there is an issue during the intimation stage, you don't wait for formal approval."

PM1: "Accordingly, there is no formal process or form or paper(work) for Management of Change. It is done informally over email based on criticality. This allows flexibility and speed and reduced paper(work) and meetings. If there is cost impact, we follow ALM"

PM3: "(Does PMI style change management process work for your projects?): No, absolutely not. It's good for an ideal project where you have 10 years to plan, five years to execute and all those things. So for short term projects like what we do, it is completely unachievable and for me it doesn't make sense just because of the administration of it or of the change management process. The change management process has to go through different levels. It has to go up to the stakeholders to get all these things done, which doesn't work on a day-to-day project and within a short time frame."

PM2: "For jack-up projects, stage gate process or other formal change management processes don't add value. Too much management involvement is detrimental to project execution."

7.4 The role of the customer

As developed in the Conceptual framework in Chapter 4, the conceptual link between MRO projects, CAS and CBPM specific to the role of the Customer was:

Part of Table 9: Conceptual framework for managing MRO projects using Change-Based Project Management

MRO Projects Management aspect	Change-based Project Management Approach	Complex Adaptive Systems
The role of the customer	Customer engagement and active participation throughout the project lifecycle and at all levels	Feedback and connectivity; Adaptiveness, Anticipation and co-evolution

While this framework was developed at a first principles level, it was important to understand the ideology and working methods of the studied organisation when it comes to the role of the Customer. Using the data, sub-themes were identified (Table 9). Within each sub-theme, there were several interesting and relevant data points that are elaborated, with examples, in this section. The tabular arrangement of the Customer theme is presented in Table 22

Table 22. The role of the customer: Themes, Sub-themes and Key Aspects

Conceptual framework themes	Sub-Themes	Key Aspects
The role of the customer	Customer engagement	Proactive customer participation
		Scope management
	Acceptance process	Joint effort
		Benefits of early engagement

7.4.1. Customer engagement

7.4.1.1. Proactive customer participation

Interviewees mentioned that the typical model within the industry is that the drilling contractor executes the project without customer involvement till a very late stage of the project, at which time the customer is invited to carry out an acceptance and testing process. This was because drilling contractors often consider customers a distraction, or fear that their presence would lead to additional scopes or them harping on incomplete scopes without knowing the full remedial plan.

Interviewees mentioned that the studied organisation's approach is different that they seek and encourage customer participation in the planning, scope of work creation, and execution stages of the project. This enables the customer to have ownership in the project and they become part of the team instead of considering themselves to be an auditor of completed work. This is akin to the principles behind the Agile methodology, where customer participation is sought throughout the project.

There were also comments that customers, when there isn't enough trust in the drilling contractor's capabilities, do not entertain an early engagement in the project as it could end up being a waste of resource and cost. Because the studied organisation has a history of strong project performance, customers are more willing to engage early in the project lifecycle.

There are some customers that do not prefer to have any early engagement in the project, regardless of the drilling contractor's invitation. For such projects, there is no option but to deal with the acceptance process near the end of the project. Typically, the project team will send them periodic updates during the project so that the customer can be aware of what is being done in the project.

There were a few views when dealing with reactivation projects, where interviewees preferred the customer does not come too early as the rig could look in disarray because various equipment is stripped down, and this could lead to a negative first impression with the customer. It is still good that they stay engaged with the scope from the start, but it takes a lot of effort to keep them focused on that and not let morale drop due to the optical situation of the rig in the early days of the project, and unnecessary punches created for work that is underway. Either way, the interviewees believed transparency with the customer was very important to them, regardless of the level of site engagement.

COO: "The other thing that the other thing that we do a lot differently, is we include our customer in the project planning, the scope of work and then actual execution at the shipyard and that's very, very different from what most drilling contractors do" "The customers involved from day one, the customer we believe feels that they have ownership in the project as well, and that they actually become part of our project team. So, it's much more of a A-Team friendly spirit than at the end of the project, it becomes decisive and arguing over this or that. So it's certainly, I believe, and I think we believe as an organisation, that having the customer involved with us is definitely a benefit to project execution."

EVP: "I think most people at the project level would like to see customers involved early on. In the game. I think where we manage better than others is through reputation and the fact that we've done it in the past and we've been able to demonstrate performance. Then the customers trust us and there's a belief in what we do. And so that respect and trust in what we do is probably allowing people to come with us when we ask them to come on board early."

PM3: "Personally prefer the customer comes near the end of the project because sometimes the rig is not in good shape at the start and a bad customer visit can bring the entire morale down…It is good from a scope-engagement perspective that they come early, but then a lot of work is needed to ensure that they remain focused not on what they see in front of them but what the end product will be…Transparency is important to customers, regardless of their engagement level on site"

CS1: "Unfortunately, most customers tend to come at the end, but having them involved as early as possible helps a lot…Ideally have at least one customer rep in the shipyard who can be a focal point with the customer organisation."

CS2: "While it is good to have the customer involved in the project from the start, sometimes they just create new punch items in the early days of the project when we already have a plan to fix those things"

7.4.1.2. Scope Management

It was also mentioned that early customer engagement helps reduce scope creep, because the customer is aware of the plans from the very beginning and gets answers to his questions at an early stage, versus questioning completed work during an acceptance process which can often lead to re-work.

It is also important to have a clear understanding of the customer's standards, policies and requirements, so that there are lower chances of discrepancies during the acceptance process.

COO: "Most drilling contractors do not want their customer looking over their shoulder, if you will, while they're actually executing the project, they think it's more of a distraction than a benefit. But we look at it as a pure benefit. There's no surprises at delivery."

DIE: "Can scope creep be mitigated - I think if there is enough time spent on making sure that all the stakeholders are aware of what needs to be done and then keeping various entities i.e., customer and class and everybody in the loop, I think you can certainly mitigate most of it." "I think we do a great job because the project team is mostly aligned with the customers' expectations. I mean like that's how we have been delivering all these many successful projects otherwise it's not possible."

ES1: "The earlier a customer joins the project, the better because you can have difficult discussions and get to know their pet peeves early. They are also more accommodating when they see what work has been planned and going on, and are aware of how you are fighting challenges, instead of just coming in at the end and expecting everything to be perfect"

7.4.2. Acceptance process

7.4.2.1. Joint effort

The final acceptance process is managed hand in hand by the operations and project team. The operations team typically takes the lead in engagement, as they are the holders of the long-term operations contract, while the project team typically focuses on the audit, testing and remediation aspects, which are more technical in nature.

Most of the project team gets involved during the acceptance phase, dealing with the deficiency punch-list like they deal with any other project scopes. Some of them interact directly with the customer, and some let the project manager take care of that interaction – it seems to depend on how large the customer contingent is. If they have departmental leads, they interact with corresponding departmental supervisors. If it's just a few multi-skilled inspectors, they typically interact via the project manager.

Observation C1_10 was at a customer acceptance punch-list meeting where the customer was not present. In that project, the customer acceptance team visited the rig briefly and gave a deficiency punch-list to the team before leaving. The final acceptance and verification of the punch-list closure would only be done when the rig was mobilized to Saudi Arabia. It was an action-oriented meeting with a brainstorming atmosphere where the team was trying to solve for the punch-list while still maintaining overall timeline compliance. Good communication, self-organising behaviour and cross-discipline interaction was observed.

VPT: "The engagement with the customer on what the final deliverable is, while it needs to happen through the operations team, I think the project team takes a pretty forward approach on it in a very, very collaborative manner with the Operations guys to stand in front of the customer and explain what is it that was asked and what is it being delivered."

CS2: "My main job is mainly to support the operations team to meet the customer's requirements. Because our crew rotates, sometimes we are the ones that help with continuity in the process with the customer"

7.4.2.2. Benefits of early engagement

For projects done within the country of operations, the customer often leaves a representative on board, which helps a lot when it comes to scope planning, execution and acceptance.

Observation C2_5 was also a customer acceptance punch-list meeting, but the difference was that the customer representatives were actually present during project C2. The advantage of that, as compared to C1, was quite evident because the customer representatives clarified many punch items, and participated in the plan for closing the others, and even closed some during the meeting. Their collaboration with the team seemed to lead to fewer and clearer action items for the team. This approach continued in C2_6, which was a site walkaround to close punch items. It was obvious that there was a good working relationship between the project team and the inspector(s) courtesy of time spent together at the shipyard.

RM1: "For projects done in Saudi, Aramco often leaves the company man on board, which is very helpful for planning, execution and acceptance"

PM2: "It is critical to have customer or their acceptance team's involvement through the project from the scoping to the execution and commissioning stage. It makes for a smooth acceptance process and there are no fights at the end."

RM2: "When a customer is not involved, you carry out your project based on your understanding of their requirements. However, at the time of customer acceptance, it can happen that the expectation what you think you have needed to do to get the rig to work or go to work for the customer completely changes in the space of a week and you'll have a very short time to change it"

7.5 The role of leadership

As developed in the Conceptual framework in Chapter 4, the conceptual link between MRO projects, CAS and CBPM specific to the role of leadership was:

Part of Table 9: Conceptual framework for managing MRO projects using Change-Based Project Management

MRO Projects Management aspect	Change-based Project Management Approach	Complex Adaptive Systems
The role of leadership	Leadership buy-in towards the approach; Autonomy of the project team.	Feedback and connectivity; Self-Organisation

While this framework was developed at a first principles level, it was important to understand the ideology and working methods of the studied organisation when it comes to the role of leadership. Using the data, sub-themes were identified (Table 9). Within each sub-theme, there were several interesting and relevant data points that are elaborated, with examples, in this section. The tabular arrangement of the Leadership theme is presented in Table 23

Table 23. The role of leadership: Themes, Sub-themes and Key Aspects

Conceptual framework themes	Sub-Themes	Key Aspects
The role of leadership	Organisational setup and culture	Leadership buy-in
		Accountability
	Empowerment	Managing within set boundaries

7.5.1 Organisational setup and culture

7.5.1.1. Leadership buy-in

Acknowledgement that an MRO project cannot be managed without changes was consistent across all interviewees, which showed how the company's leadership has accepted that as a fact and have set themselves up to manage projects based on that reality (Change-Based Project Management) instead of setting up to fight that reality (plan driven project management). A flat management structure and empowerment of the team were two key aspects of this management setup.

Agility in response and speed of decision making was a common theme in all responses, and the fact that this management aspect is highly valued and coveted by the team was clear. This is not easy, because typically organisations setup to be process and plan driven and adopting change-based management systems that embrace complexity and adaptation, as literature shows, is not a common model.

Support from the leadership team was visible in observations C1_6, C1_8, and C2_2, where the leadership (VP-Projects) engaged actively with the project team to assist in finding solutions to problems. The interaction was real-time and did not require formal meeting invites, presentations, or emails.

COO: "The entire organisation that's involved with the project they need to understand before we undergo one of these, you know, big huge capital projects that there's more than likely going to be change and that helps us as a management team deal with change once it comes our way, because typically if we're doing a management of change on a certain line item or scope of work then it's going to have to go through an approval process. Maybe we're going to have to ask, ask for more money on the on the project. So the organisation needs to be set up so they can make those decisions quickly, not sit there and rub their hands and pass it around to another person."

EVP: "For projects to succeed in dynamic environments, you need to have the right people managing it, and people that you can trust to be able to make that happen. But then there needs to be the ability to flex resources and staffing when things change. And so, it's that ability for the

organisation to adapt and move as the needs change become important. So flexibility extends beyond just the project team - the entire organisation needs to start having that mindset there."

DIE: "I think our culture is the key thing there. I think we give enough freedom to people to do what they need to do and at the same time, I think we hold them responsible enough to make sure that they deliver what they are supposed to deliver. I think both goes hand in hand - freedom and responsibilities. So, people know that, hey, you once we give you a job or once you are responsible for something, you are required to deliver and do whatever you need to do. Nobody's coming in the way or stopping you from achieving that. So, reach out to whoever you need to reach out and get it done."

SCM: "Flat management organisation has helped a lot in projects at (the studied organisation) as compared to a more hierarchal structure with previous employers, where approval processes would take a long time"

PM2: "A big difference between (the current organisation) and (my previous employers) is that the speed of decision making is much faster here. This is due to a flat organisation, and giving the project manager more authority and freedom to make decisions than other organisations, leading to fewer escalation events"

ES1: "The entire company needs to buy into an approach. If the VP asks PM1 for a lot of extra information and presentations and everything else, then that will trickle down to the team and we will not get the decisions at the speed we need to execute and keep up with the schedule. Because the senior people have given that amount of trust to PM1, enables him to allow us the freedom to do our thing and get on with it"

7.5.1.2. Accountability

Accountability of the project team from the planning till the closeout of the project was a common theme in the senior leadership's view of the setup and was aided by integration of the project with the rig operations to ensure smooth transitions, vs a parachute model where a project team just comes in for a project and then hands over the rig back to operations with little accountability once the project has been completed.

EVP: "The DNA of the organisation is line with the lean and mean approach, and giving small teams big responsibility and holding them accountable to the bottom line."

VPT: "The difference between shelf drilling projects and others is that there is accountability before and, more importantly, after the projects, because there is enough integration that happens during planning, of course, during execution and more importantly post when the project has been delivered so that makes us pretty unique"

RM2: "The system is setup for projects and operations to work well together. In my previous company, there was always friction between the two and the project team did not have accountability once the project was complete. In the current company, it is like a family where you help each other out."

7.5.2 Empowerment

7.5.2.1. Managing within set boundaries

The empowerment of the project team and their support functions to manage changes and make decisions as long as certain set criteria are not violated (typically project cost and timeline) helped in the team having ownership of the outcomes.

Observations C1_6 and C2_2 (cost review meeting between the PM and VP-Projects) showed how the project manager was empowered to make commercial decisions and trade-offs between scopes and costs as long as bottom-line deliverables were met. The meeting was done in a brainstorming pattern, where problems and opportunities were assessed and solutions for both were discussed for possible implementation. Some difficult decisions were also discussed, and agreements reached on how to move forward.

The team feels that they have been given the tools and freedom to get the job done, and therefore feel motivated towards achieving the desired outcome, instead of losing ownership due to micro-management and extensive approval requirements which essentially make key decisions someone else's.

RM3: "The leadership's support via quick decision making and making the project manager feel empowered is working well. In previous jobs, I felt shackled by not having the authority to manage changes, make decisions or having overly restrictive approval requirements. Sometimes my decision were cancelled or shutdown by management in previous companies as well….In the studied organisation, there is no micro-management of the decision making process from the leadership, giving the project manager greater ability to move quickly to lock in better prices/resources/parts instead of waiting for a prolonged period for approval"

CS2: "In my previous company, in order to get a change approved, I needed to through various steps to raise to different levels of management. In (the studied organisation), it is a pretty straightforward system, where the Project Manager can approach leadership anytime to take a particular decision regardless of the time. Like, for a change on Friday, we don't need to wait for Monday to get the confirmation. So how the team is working on the ground is the same way leadership is supporting the project."

7.6 Communication

As developed in the Conceptual framework in Chapter 4, the conceptual link between MRO projects, CAS and CBPM specific to Communication was:

Part of Table 9: Conceptual framework for managing MRO projects using Change-Based Project Management

MRO Projects Management aspect	Change-based Project Management Approach	Complex Adaptive Systems
Communication	Communication over processes (Stand-up Meetings, retrospective meetings, co-location). High-frequency informal communication to facilitate self-organising behaviour	Feedback and connectivity; Self organisation; Non-linear emergent behaviour

While this framework was developed at a first principles level, it was important to understand the ideology and working methods of the studied organisation when it comes to Communication. Using the data, sub-themes were identified (Table 9). Within each sub-theme, there were several interesting and relevant data points that are elaborated, with examples, in this section. The tabular arrangement of the Communication theme is presented in Table 24

Table 24. Communication: Themes, Sub-themes and Key Aspects

Conceptual framework themes	Sub-Themes	Key Aspects
Communication	Meetings	Scheduled meetings
		Retrospective meetings
	Flexibility	Informal communication
		Self-organising behaviour

7.6.1 Meetings

7.6.1.1. Scheduled Meetings

Every morning, there is a meeting with key stakeholders (project team, operations team, shipyard team and key third parties) in which the team reviews the previous day's progress, discusses the plan for the current day, and addresses clashes or simultaneous operations.

On project C1, the project-rig and project-shipyard meetings were held separately one after the other as a single group would have become too large due to project size, while on project C2, it was a combined morning meeting.

On reactivation projects, there is also an internal audit team for operational readiness. There is a meeting with this team once a week, with key project and operations team members present.

In line with the flexible approach towards other management aspects, the project manager involvement in these meetings was also observed to be different as a central process was not mandated. PM1 and PM2 liked to be part of the morning meeting and were the primary facilitator of the discussion. PM2 did not prefer to join the morning meetings and preferred to have a one-on-one meeting with the rig manager and shipyard project manager later in the day.

During observation C1_1 and C1_3, it was observed that the meetings were taking place in line with the principles outlined by the interviewees, and were collaborative, with the project manager (PM1) guiding the meeting agenda while the team self-organised as scopes and plans were discussed. Observation C2_4 noted a meeting similar in format and principles as in project C1, but without PM2's presence.

Schedule review meetings were held fortnightly in both projects, with the project schedule updated collaboratively and used as discussed under the planning section 8.2 above.

PM3: "During the execution phase, there is a morning meeting with all stakeholders…Project team, shipyard, operations team, vendors… where the tasks for the day, issues and clashes etc are discussed and the forward plan agreed"

PM2: "My preference is to do meetings in small groups vs tying up large groups for 1-2 hours of meetings in a day…I have a meeting with the key team members at the end of the day, looking at the jobs that need to be done the next day…I don't do morning meetings as that wastes productive time…I don't prefer to meet the full shipyard team. Instead, I sit one on one with the shipyard project manager and review progress and targets."

7.6.1.2. Retrospective Meetings

It could be observed that regular scheduled meetings, even though not being formally labeled as retrospective, involved a significant amount of retrospective review and tweaking of forward-looking plans accordingly.

For PM1's project, a fortnightly or weekly (depending on project duration and size) meeting is held with all key project team members, where the schedule is used as a diagnostic tool to combine the updates from all team members, realign priorities, resources and third-party instructions. This meeting combines a retrospective review as well as forward looking projections to create micro-plans for the next review cycle/iteration. On project C1, this was being done weekly.

PM3 preferred to do an evening meeting with a smaller group that looks back at the day and plans any course-corrections for the night shift and the next day. This is a retrospective meeting. Preference is to have that daily instead of weekly.

PM2 preferred to have a meeting with the key team members at the end of the day, looking at the jobs that need to be done the next day. He didn't prefer to do morning meetings as that wastes productive time.

On project C2, the team had a progress review (retrospective) and lookahead meeting twice a week – on Tuesday and Friday. They look back at what was achieved or missed, and where course corrections may be required, and plan for the upcoming days. They then review the progress against this plan in the next meeting and so on. Observation C2_3 verified this.

Retrospective meetings were almost unanimously sought, but execution of formal retrospective meetings was not unanimously being done.

There was desire expressed by management that a retrospective meeting at the midway point and after project completion would help capture lessons learnt and identify themes that could be useful for future projects.

DIE: "Would like to see a retrospective meeting during and at the end of the project to assimilate and share lessons learnt. I think it might even help get a good feel of where we are as a team and who is holding up or where there is more need for attention and to make sure that nothing is getting ignored or forgotten. And bringing everybody back together and aligning the goals again."

PM3: "I like to have an evening meeting with a smaller group that looks back at the day and plans any course-corrections for the night shift and the next day. This is a retrospective meeting. Preference is to have that daily instead of weekly."

PM2: "We have a progress review (retrospective) and lookahead meeting twice a week – on Tuesday and Friday. We look back at what was achieved or missed, and where course corrections may be required, and plan for the upcoming days. Then we review the progress against this plan in the next meeting and so on"

CS1: "Also implemented a lookahead planning meeting, where we also do a look-back of where we are behind and what we need to kick off if it hasn't been started."

ES1: "When I have the weekly meeting with the project manager, that's when we look back at what happened the previous week. There is benefit in doing a formal retrospective weekly meeting with a select group of people."

ES2: "We have a Saturday meeting with our project team. And then we discuss what the shipyard is doing, what we're doing, and how everything is going. We look backwards and look forward. I like that meeting because I'm one of the few who wanted to have that done, because we didn't have anything before that, and I see that it benefits everyone, but it benefits the lesser experienced people more, because then it gets them more comfortable with the scopes on them. Otherwise, some of them were pretty unsure about the big picture."

PM1: "A formal retrospective meeting is definitely something that could add value and should be considered going forward"

7.6.2 Flexibility

7.6.2.1. Informal communication

The flexibility in communication style amongst the project team and between the project team and management was clear and evident and was considered one of the strengths of the management system. Formal emails, presentations or documentation were not mandated apart from project weekly reports, or safety incident reports and investigations.

DIE: "I think we are super agile. I think we can change fast. Our communications is great - we are only a phone call away. We don't want to wait on people. I don't think anybody is waiting on anybody thinking I'll send an e-mail and now my job is over. I think that's what makes us different, right? We are always communicating…. I think there is enough communication in the current system, without being overly formal or over-communication…The weekly project report provides the necessary amount of information for the most part."

7.6.2.2. Self-organising behaviour

Apart from the planned meetings, because the team is co-located, there are several impromptu meetings that are called whenever something important needs to be discussed, if there is a change that needs to be managed, a new scope that needs to be studied, or an unforeseen clash between activities.

Observation C1_2 covered a walkaround to discuss lighting scopes on project C1, which was a collaborative meeting focussed on finalizing lighting locations and agreeing on the scope of work at each location. The self-organising approach and collaboration between parties was evident during the observation.

It was considered vitally important for the project team to maintain good communication with and involve the operations team in the project planning and execution, as they are the end users of the rig and often know the equipment and rig better and can assist with a lot of things.

After the morning meeting, project and rig supervisors typically went for a walk around the rig to check on various work sites and discuss, in ad-hoc meetings, certain scopes in smaller groups, discuss resource requirements, and also manage changes that had come up. This was observed in C1_2 and C1_8, where various stakeholders got together on site to work their way through changes and create real-time plans and action items. People attended the meetings with a problem-solving mindset and engaged actively in the problem statement and potential solutions.

Observation C2_7 was a handover meeting at the end of the project, where the project team summarized all completed scopes, and discussed all outstanding scopes and associated responsibilities. It was a good handshake between projects and operations, with congratulatory discussions but also a clear focus on making sure the rig is ready to commence operations on arrival at the destination.

It was also mentioned that there is significant interaction between project teams working on various projects, and often material and manpower plans were jointly created or modified based on various projects' needs.

PM1: "The different thing about the project organisation in the studied company is that across project teams, there is teamwork. Lessons learnt, material, resources and assistance is shared across projects, and the project teams are in good communication with each other across geographies to make this happen… Very important to maintain good communication with the operations team and get their feedback. It's their rig and they usually know it better and can help if you take them along"

CS2: "there aren't many planned meetings, but we are a small team and we meet ad-hoc 3-4 times a day to discuss various scopes, issues and plans. We all sit close by and it isn't like someone is sitting in a cabin and is unapproachable. Communication is as-needed and doesn't really need to be planned as such"

7.7 Team setup

As developed in the Conceptual framework in Chapter 4, the conceptual link between MRO projects, CAS and CBPM specific to Team Setup was:

Part of Table 9: Conceptual framework for managing MRO projects using Change-Based Project Management

MRO Projects Management aspect	Change-based Project Management Approach	Complex Adaptive Systems
Team Setup	Smaller teams with varied skillsets spread across multiple scopes; Ability to be multiskilled; Project manager as a mentor and guide; Self-organising behaviour	Non-linear emergent behaviour; Variety, Feedback and connectivity; Self organisation

While this framework was developed at a first principles level, it was important to understand the ideology and working methods of the studied organisation when it comes to Team Setup. Using the data, sub-themes were identified (Table 9). Within each sub-theme, there were several interesting and relevant data points that are elaborated, with examples, in this section. The tabular arrangement of the Team Setup theme is presented in Table 25

Table 25. Team Setup: Themes, Sub-themes and Key Aspects

Conceptual framework themes	Sub-Themes	Key Aspects
Team Setup	Team size	Small, accountable teams
		Resource pool
	Individuality	Reliance on individual abilities
	The role of the Project Manager and self-organising behaviour	Guiding, not directing
		Accountability
		Cost management
	Multi-skilled workforce	Basic requirement, not advanced

7.7.1 Team size

7.7.1.1. Small, accountable teams

Interviewees believed that the studied company's project teams were much smaller than industry peers, and that helped with clear responsibilities, quicker decision making, and clear accountability amongst the team.

The company's project management method takes accountability and responsibility away from individual lines and making the team accountable for the overall outcome. This is different than the industry and improves performance.

Having the same team members working on the planning as well as the execution of the projects was a key factor for the interviewees. This enabled not only familiarity with the scope, but also helped maintain accountability and responsibility across the project lifecycle.

One pitfall mentioned was that due to the small size of the team, there was very little contingency workforce available if any of the team members were to become unavailable.

COO: "If you look at my past experience, if you looked at a $50 million MRO out of service type project. You might have a total project team of 40 to 60 people with no accountability, decision making all over the board. While on a (studied organisation) 40 to $50 million MRO type out of service project, we probably have 11-15 Shelf drilling employees, we'll have another handful of contractors that come and go as we as we need them, but it is a very, very lean, efficient team and that allows for pure accountability. You know what person is responsible for what part of the scope and our management team up to our CEO level understands that as well."

EVP: "The company's project management method takes a different view on accountability and responsibility, by taking it away from individual lines and making the team accountable for the overall outcome. This is different than the industry and improves performance….The project team is much smaller than the competition, through which you get greater accountability."

DIE: "Our team setup is suitable for purpose because we have assigned PICs for different disciplines, and I think that's a great way. People know their responsibilities and most of them are experienced enough to do what the project requires them to do…It's a very effective organisation without having too many layers and a lot of people that kind of step on others' toes. There is clear definition of their responsibilities and deliverables, so it works well."

VPT: "Hypothetically speaking, if 50% of our project team key guys leave, then we would not be able to run the projects the way we run them right now because the process framework just doesn't exist"

7.7.1.2. Resource pool

The company has a pool of resources and experts. Each project typically has a project manager, PICs for electrical, mechanical and structural scopes, a safety officer, buyer, logistics coordinator and administrator (refer project org charts in Chapter 6. Additional resources, if required, are discussed and agreed between the project manager and Vice President-Projects. Sometimes, during the project, a need for additional team members is identified. If this is within the existing budget approval for the project, the project manager feels empowered to add the resource (with just information shared with VP - Projects). However, if bottom line cost is affected, formal approval is sought.

PM3: "The company has a pool of resources and experts. During the planning phase, the project manager works with the VP-Projects to finalize the requirement (based on the scope) for the team composition and then resources are allocated and mobilized."

PM2: "Team size is decided during the planning phase, depending on the size and scope of the project. Project manager proposes and is typically approved."

PM1: "Sometimes, during the project, a need for additional team members is identified. If this is within the existing budget for the project, I feel empowered to add the resource with just information shared with VP-Projects. However, if bottom line cost is affected, formal approval is needed."

7.7.2 Individuality

7.7.2.1. Reliance on individual abilities

There were mixed responses on whether the project management setup in the studied organisation relied too heavily on individual brilliance, experience, and ability. Some people believed that the process-light setup only worked with very experienced people and the organisation would struggle if the same projects had to be done with different or new people. On other hand, several project team members claimed that as long as an individual doing these jobs was familiar and experienced with the type of work, which he should be at a supervisory level, then individual brilliance was just a nice to have and not essential.

Mediocrity or lack of knowledge/experience was considered hard to manage when there is no fat in the team. Interviewees believe that new personnel should be given an adequate amount of time training under senior personnel to gain experience and knowledge, before being entrusted with a supervisory role.

It was mentioned that when you have a competent and skilled team, a high level of autonomy can be given to the team to make decisions and run with them. For big changes and major scopes, they will bring their recommendations back to the project manager for discussion.

VPT: "The con of this approach is that it is very individual driven. You are relying on the knowledge, the resilience of the people involved (and) there needs to be some kind of a process framework which is agile enough, which I today I don't see."

CS2: "The setup is robust enough that we don't rely on superstars. Having good people will always help, but the company's processes are simple and strong enough to support whoever is doing the job."

ES1: "I think it's a balance we are not a team of superstars. And I'm sure that there are people that could come in and just take over, but not it wouldn't be easy if I put myself in a situation to take over this job if I wasn't involved in it before, like suddenly at this stage, it would be very difficult."

SCM: "Having small teams and flat organisation requires the project supply chain team to be experienced and good at their jobs. Mediocrity or lack of knowledge/experience is hard to

manage when there is no fat in the team. New personnel should be given an adequate amount of time training under senior personnel to gain experience and knowledge."

7.7.3 The role of the Project Manager and self-organising behaviour

7.7.3.1. Guiding, not directing

During the execution phase, the Project manager guides, sets deadlines, monitors and asks for course corrections where required. As long as things are going to plan, the team self-organises between them, and the project manager does not micro-manage.

In terms of autonomy, the project team has autonomy over most of their daily tasks/decisions/planning and self-organise for the same, and the remaining is coordinated/guided by the project manager. Overall, the project manager guides and coordinates, instead of directing. If there are some inexperienced team members, they may require more coaching or guidance, compared to experienced members.

Team members are encouraged to work together and solve problems, while only keeping the project manager or asking for guidance. Only if they are unable to solve the problem optimally is the issues raised to the project manager for active assistance.

Project managers and team members unanimously felt empowered in their jobs.

Observation C1_5 displayed the robustness of the system because PM1 was away and ES1 almost seamlessly took over the project manager's role for the meetings and interactions. A simple discussion to review the day was carried out between ES1 and PM1 when PM1 returned, displaying a non-dictatorial role of the project manager.

PM1: "The project team has autonomy over around 75% of their daily tasks/decisions/planning and self-organise for the same, and the remaining is coordinated/guided by the project manager. Overall, the project manager guides and coordinates, instead of directing. If there are some inexperienced team members, they may require more coaching or guidance, compared to experienced members."

PM3: "During the execution phase, the Project manager guides, sets deadlines, monitors and asks for course corrections where required. As long as things are going to plan, the team self-organises between them."

PM2: "I don't micro-manage but it is important to stay on top of the progress of each job, so that if any PIC is struggling or not performing, we can course correct."

CS2: "Most of the project team supervisors have been working together for a long time. We are aware of each other's scope and priorities and adjust our work accordingly. So we self-organise and ensure proper coordination amongst ourselves"

CS1: "The PICs self-organise for most scopes as long as things are going largely to plan. If there are significant deviations or if things are going wrong, the project manager is involved."

ES1: "I think a lot of our work is self-organised between the individual team members. If I want something from Structure, I won't necessarily go to the PM directly for it unless it's something big. Yeah, I might mention something that he has that he wants priority on, sure, but other than that he generally leaves us to our own devices, and to the plan that we have for the day. Obviously, if he's not happy with the plan, he's going voice his opinion about it, but he generally leaves us to our own devices."

7.7.3.2. Cost control

The Project Manager is mainly responsible for cost control at the project level, though other members often contribute information and details specific to their scopes (change in costs, ideas for potential cost reduction, optimization etc).

Observations C1_6 and C2_2 also validated this, where the project manager discussed the project cost outlook in detail, using a cost-tracker sheet that other project supervisors do not contribute directly to. The sheet has a summary tab that is finalized every month between the project accountant and project manager and then shared with the VP-Projects for approval. Once approved, the numbers are shared with the larger finance group and reported to the Board during the monthly management reporting (Projects is an important part of the Board reports at the company).

Observation C1_2 also confirmed that the commercial implications of a changed scope would be discussed by the shipyard with the project manager, and the cost numbers were not discussed on site. However, the extent of the scope (that feeds into the cost) were discussed at length during the site walkaround.

PM1: "Project Manager is mainly responsible for cost control at the project level, though other members often contribute information and details"

PM2: "Project manager manages the overall cost, but the PICs are managing individual scope costs, mainly for planning potential cost reduction and optimization"

ES1: "In my role work wise, I feel empowered enough. On the financial side it would be nice to just be able to spend as much money as I wanted to, but understandably that decision is made elsewhere. So, I don't feel 100% empowered financially on the project because I don't hold the purse strings. But it's very seldom that I request something, and it's turned down because of a financial reason. It sometimes takes a little bit of persuading, but generally I get what I want eventually"

CS2: "In terms of commercial responsibility, the project manager will usually take our opinion on quotes and we will work together to optimize the cost of scopes. We also play a role in validating the shipyard's costs vs the scope that they carried out"

7.7.4 Multi-skilled workforce

7.7.4.1 Basic requirement, not advanced

Having multi-skilled team members was considered essential at a basic knowledge level, but not critical at an advanced knowledge level because of the frequent communication and self-organising behaviour amongst the teams.

Where basic cross-functional knowledge was not present, training should be carried out.

CS2: "There is value in having multi-disciplinary knowledge, a lot of which comes with experience. I don't think too many people will be interested in taking detailed classes in other disciplines."

PM2: "Multi-skilled project team adds a lot of value. Where PICs don't understand the overall system, it creates weakness in the team"

PM1: "Because a high level of experience and competency required of team members, it is important to train and develop new hires for future projects"

ES1: "For me personally, I think I've picked up enough mechanical knowledge over the years from just being on a rig and having to work with mechanics for many years. In many cases I will give mechanical advice on equipment, just because I've been there and seen it before. I don't see value in training mechanics in electrical stuff. From my personal point of view, I don't see any value in it"

ES2: "Having multi-skilled teams: It is essential. Because it's so dynamic that sometimes people don't get it right all the time, right? So I think it's good cross training. Because I've never had any mechanical training, for instance right, but because of my involvement and my experience, it's beneficial, very beneficial."

7.8 Documentation

As developed in the Conceptual framework in Chapter 4, the conceptual link between MRO projects, CAS and CBPM specific to Documentation was:

Part of Table 9: Conceptual framework for managing MRO projects using Change-Based Project Management

MRO Projects Management aspect	Change-based Project Management Approach	Complex Adaptive Systems
Documentation	Decentralized decision making, leading to low documentation emphasis; Extent of documentation driven by final project deliverables	Agents with Schemata

While this framework was developed at a first principles level, it was important to understand the ideology and working methods of the studied organisation when it comes to Documentation. Using the data, sub-themes were identified (Table 9). Within each sub-theme, there were several interesting and relevant data points that are elaborated, with examples, in this section. The tabular arrangement of the Documentation theme is presented in Table 26

Table 26. Documentation: Themes, Sub-themes and Key Aspects

Conceptual framework themes	Sub-Themes	Key Aspects
Documentation	Type of documentation	Final product vs process documentation
	Process	Project specific
		Lack of standardization
	Resource Adequacy	Need for a document controller?

7.8.1 Type of documentation

7.8.1.1. Final product vs process documentation

A documentation package is generated at the end of the project, summarizing work done on equipment and the final certification for the same. The documentation is focused on the final product/deliverable and not on the process steps. This was because that was what was required for both internal and external consumption, and process documentation was deemed to not have any utility.

The exception to this was on the steel scopes, where process documentation is necessary for Classification society verification, and the shipyard is typically in-charge of furnishing this documentation as part of their documentation package.

Sometimes project managers who are involved with the same rig over multiple projects like to keep more process documentation for specific equipment in order to have better history for the next round of overhauls. But this is not a company or customer requirement.

VPT: "I think we do it fairly well. I have yet to see an issue with documentation when somebody six months later after the project has asked for a particular document and the project organisation has not been able to deliver that."

DIE: "Only end products are documented and not the process documents, which does not impact me at all. There isn't any value in retaining any process documents."

PM3: "Documentation is focused on the end product of each scope – for some it is an inspection report, for some it is a commissioning report, and others might require more process works, like welding jobs where the certification of the welders is part of the documentation requirements"

CS2: "On the construction side, the shipyard prepares most of the documentation and with major shipyards its usually not a problem. But if we are buying any material, we need to take care of that documentation…In our industry, most people are interested in the end-product documentation and not the process documentation. However, we do keep some process documentation in case there are questions about the final work done."

RM2: "We are usually only interested in the final documentation and not the process documentation"

7.8.2 Process

7.8.2.1. Project specific

Documentation starts during the planning phase of the project, with the creation of a Work Breakdown Structure. The skeleton of the structure is a company standard document (and excel sheet broken down by scope type), but the use and application of it is not controlled and the project team are free to morph it into what is useful for them.

Supervisors (PICs) are responsible for collecting documents specific to their scopes, and hand that over to the project manager throughout the project. The filling system is typically created by the project manager and is populated with the files sent by the supervisors.

Finally, the document folders are copied onto the portable drives and uploaded on the project server at the end of the project. Copies of the drives are handed over to relevant stakeholders in the operations, project and corporate teams.

PM2: "Documentation is the WBS during the planning phase, and then the final QC, commissioning and certification documentation collected during the project, either by the PICs or a dedicated project engineer if it is a large project. The filing structure is created by the project manager."

ES1: "Generally what I do is I will collect all the documentation in a separate folder on my computer - so as certification or manuals come in, I create a folder for each piece of equipment and document it all in there and then generally towards the final stages of the of the project, I will start forwarding all of this to the PM or in some cases we have a document controller. In this project we don't have one, so the project manager is taking care of this."

MS2: "For my scopes, I categorize and keep the files on computer - daily reports, certification, COCs - and then hand it over at the end to the Project manager who is compiling it"

7.8.2.2. Lack of standardization

There was no ERP based filing system observed across projects apart from the use of the WBS to create folder hierarchies saved on the projects server.

The lack of standardization was noted as an improvement area by some interviewees, while others were OK with the way things were done.

SCM: "A potential area of further improvement/simplification would be to have better ERP integration into Supply Chain processes, vs the current offline model. This would remove some of the fragility from the system as well, as details and documents are not lost with the PIC after the project is completed."

ES2: "Historical archives of record-keeping could have been better. Sometimes a struggle to find information"

RM2: "There is scope for improvement in the documentation as it is currently quite project manager specific. A more formal process would be good."

7.8.3 Resource Adequacy

7.8.3.1 Need for a document controller?

As the project manager takes the lead on documentation, the interviewees were of the opinion that a standalone documentation controller would only be required if the project manager is unable to handle this requirement, which was not observed in the studied organisation's MRO projects.

There were contradictory views on the types of projects where a document controller might be required. Some interviewees deemed that for Newbuild projects (that last >2 years), a document controller would add value, while others thought that its more required for short and intense projects for the project manager's workload management.

DIE: "The need for a document controller: If you have a good project manager who can assimilate everything and hand over at the end of the project, then really no need. If there was a dedicated person who was collecting and keeping track of it, to a certain degree I thought it's redundant."

PM3: "For shorter and more intense projects, a document controller would help with workload management"

ES1: "I feel that that's a little bit too much responsibility for him. To have a proper document package, I feel a document controller is a necessary evil. I think we could do slightly better on the documentation part. I think maybe it could be planned a lot better. There generally seems to be a mad rush at the end for everyone to gather the documentation and hand it all in and get it all synchronized into a package. I think if we spread this out more evenly throughout the project, we could avoid that last minute rush for documentation at the end."

7.9 Drilling Industry Insights

During the interviews, the wider landscape of the industry and the specific space the studied organisation filled in the industry was discussed. These discussions provided valuable insights about the views that industry practitioners and leaders hold about their business, where they feel project management fits and performs in their business setting, and the factors they felt affect project management in the upstream oil and gas industry specific. These themes, even though not part of the conceptual framework, have been discussed in this section as they provide richness of context to the more tactical project management aspects reviewed in previous sections. The data was divided into sub-themes (Table 26), showing how practitioners felt about the industry, how MRO projects, in the practitioners view, are different than Newbuild projects and are complex in nature with a high likelihood of changes during the project, and how the industry has struggled with execution of MRO projects (where the studied organisation feels they have done better than the industry, as discussed in Section 3.7, due to their change based management system).

Table 27. Drilling Industry Insights Themes and Sub-themes

Emergent themes	Sub-Themes
Drilling Industry insights	Dynamic industry and time pressure
	Newbuilds vs MRO
	Complexity and change in MRO projects.
	Industry performance in projects

7.9.1. Dynamic industry and time pressure

The dynamic and fast-paced nature of the industry was a common theme, with the focus on time a key reason for the same. This presumably stems from the business model of the industry, where the revenue is typically earned based on time worked and not a lump-sum or turnkey arrangement.

The global nature of the business was also deemed as something that adds to this dynamic nature, with companies spanning operations in multiple continents, and the rigs themselves being mobile and often marketed in various geographies.

The offshore operations of the rigs also add to the dynamic perception of the business, with a lot more planning to manpower and material required to get things done due to the remote location of the rig.

COO: "It's fast paced and constantly evolving. Very important to the world. Very cyclical"

DIE: "think offshore gives you a lot of challenges if you are up to it you can get an exciting career out of it. You get chances to do things that people can only dream of…Other industries are a lot more regimented. I mean like for example, if you are building a bridge, I don't know how much innovation you can do on a bridge. A bridge is a bridge, or a highway is a highway. I mean, like there is not that kind of challenges or opportunities to prove yourself any different."

SCM: "It is an industry that is international where operations and projects span the globe. Comes with its share of challenges."

ES1: "What makes the business different is availability of material. When you're working shore based, you can pop down to the store and buy stuff. With the oil and gas industry, especially with the projects offshore, you must plan a lot better material wise, and manpower wise. Obviously, time away from home makes a big difference. Not only for yourself, but for the people that work for you. So, you have to manage your team's absence from home. And travel is another. Normally if you're working on a shore-based job, guys can go home on the weekend. They go home every day. That's a big difference in this industry."

7.9.2. Very little standardization, high flexibility

A common theme from the organisational leadership, and less so from project team members, was that the industry follows very few standardized processes, procedures, practices, or rules and operates more flexibly than others.

Supply chain challenges, and the ability to manage procurement and planning of material movement was deemed a key aspect of the business. This was accentuated by the lack of standardization, rig-specific procurement requirements, and cyclicality of the industry which led to sudden changes in activity and 'firefighting'.

VPT: "It's an industry which is in disarray. The industry does not have standard practices, processes, procedures, and there's a lot of fat throughout."

EVP: "It tends to manage by the seat of its pants, and so your process is often an afterthought. But you know it's very much 'can do' attitude. The industry is full of firefighting. And so, we love being the hero and solving a problem. But generally, we could have avoided that problem with a little bit of preparation and so we recognise and reward firefighters, so we tend to reinforce the behaviour that we would like to otherwise not see."

SCM: "The industry is very dynamic and hard to standardize the requirements as the supply chain requirements are not very predictable."

7.9.3. Newbuilds vs MRO

The common theme from the interviews are the Newbuild projects (where a new rig is built from scratch) are significantly different than MRO projects. Newbuild projects were deemed easier to plan and execute due to more predictability, fewer surprises, and a longer project timeline which allowed for course correction.

There was a sense that there is a much larger sense of control in Newbuild projects because you are creating the asset, vs MRO projects where you are dealing with an incumbent asset that comes with surprises, unknowns and challenges.

DIE: "Aside from all the procurement and whatever other long lead items, I think an MRO project is certainly harder to achieve successfully and reach the end goal compared to a Newbuild because Newbuilds are a bit more predictable. An MRO project has so many variables because you are dealing with something that's already there and you are trying to do something to that asset, it's always impossible to know what you're going to get when you start on it; while Newbuild is like starting with a blank piece of paper. There is lot more control in a Newbuild that you can implement, or you at least know what you're working with versus an MRO is like you don't know what you're going to get, what what's going to happen when you open up a box of gear case or something. So there is a lot of uncertainty in an MRO project."

EVP: "Because if you look at people that build rigs successfully with a very documented well organised process. But then we take the same people generally and put them into a project organisation in the drilling site. And you end up with a very different outcome"

PM3: "Time is the big difference between Newbuilds and MRO projects, because in Newbuilds you have the time to plan and react to issues due to the extended build duration, where MRO projects are usually in a much more compressed time frame."

CS2: "Newbuild projects are different to MRO projects due to the timelines involved, budgets and the fact that you can give the complete Newbuild as a lump-sum to a shipyard. MRO projects are not that straightforward because surprises pop-up due to rig and equipment condition, and what you thought was the scope could grow during the project."

7.9.4. Complexity and change in MRO projects.

Interviewees were of the view that change in MRO projects is inevitable, and it is not possible to plan your way into a zero-change scenario.

The ability to recognize change and react to it in an efficient manner to come up with procurement or engineered solutions, and then getting these approved within the organisation expeditiously was considered a critical success factor by the interviewees.

Scope discovery during the project phase was considered exceptionally hard in rig MRO projects because of the inability to isolate the changed scope and get the rest of the system functional.

A common theme was the complexity of MRO projects due to the unknown condition of equipment until it is opened during the project. This leads to procurement, engineering, and service challenges. These can be mitigated by carrying out non-intrusive inspections in the planning stage and having contingency material available within the company to deal with any surprises.

Planning was considered one of the key ways to reduce project risk and unpredictability, but it was also reiterated that no amount of planning can lead to an MRO project without changes or surprises.

PM3: "The biggest challenge with MRO projects is the uncertainty in scope because when you open up an equipment during the project, you don't know what you will find inside"

PM2: "In MRO projects, because the rigs are old/working, when you open up the equipment during the project, there can be surprises. Till you open it up, you will not know the condition and how good or bad the project will be. Change is inevitable. 99% of scopes do not follow your plan. With the previous employer, there was a project that was planned for 6 months with a vision for no change orders – it did not work at all because once equipment was opened, everything changed."

VPT: "Scope discovery during the MRO project in the drilling and marine industries, while encountered in maintenance projects across industries, makes it harder for the drilling/marine business because you are unable to isolate a section and carry-on (like in a refinery) if you couldn't fix it in time, neither can a replacement asset be brought in for the time being (like in the aircraft industry)"

ES1: "There's always changes in MRO projects. A lot are unavoidable in any project because there's always nasty surprises. We know we have, you know, set maintenance to do on the equipment, but we don't know what surprises are in store for us - that maybe the rig crew have been hiding away from us. When we go and do the health checks, when we go and check the equipment, we're going to find stuff that's going to be a surprise to us. That's unplanned, and then we have to negate that and make a plan to come up with the parts and the manpower to repair it. You can plan this to death and it's never going to go according to that plan."

MS2: "Change is inevitable in MRO projects. There's always something that crops up that becomes a higher priority, you know, and everybody's focus gets shifts towards that."

7.9.5. Industry performance in projects

The recurrent theme in the interview responses was that the industry has a poor track record in project execution and delivery. This despite project performance being very critical for drilling contractors' business model.

There were also references to a typical industry model where a project management team is considered an external party that is parachuted in to execute the project, regardless of whether it is comprised of company employees or third-party employees. This leads to issues in ownership, accountability, consistency and creates complex change management processes for any deviations in the external project management team's scope.

COO: "The industry as a whole has not truly figured out how to manage a large capital Out of service project within the shipyards."

EVP: "The ability for drilling companies to be able to execute projects on time and on budget is very poor. And it's not just now, it's been historically the case."

VPT: "I think as an industry we have not done very well in projects I am yet to see or hear a lot of success stories."

DIE: Outside in the industry, what I see is that MRO projects are mostly either running late or there was a lot of blame culture. You have to figure out a way to justify why that project was over budget or delayed. That's how I saw them in the past. Most of the time, people would just look for a reason why that particular project was not finished on time and budget. I don't recall seeing any Project that was on budget or on time that I can think of in the past.

RM2: "The way that my previous employer approached projects was very different than the present company. It was largely outsourced to a third party, even though there was an internal projects group. Projects was the worst performing department for them, and the projects didn't seem to be well planned. Managing the scope was a problem – there would be a significant snowball effect where even though a scope was announced at the start, it would grow significantly along with the size of the project team. Money didn't seem to be an object for them, so it used to be a 'free for all'. I was involved in a project once where there were 8 project managers, which was not at all well-organised. "

7.10 Hybrid Project Management

While not a part of the proposed conceptual framework for CBPM, it became evident to the researcher during the research process that the studied organisation valued and deployed a hybrid project management system with aspects of traditional plan-based project management striking a balance with their change-based management philosophy. This hybrid approach was evident at the scope level, where some scopes were managed in a more plan based way, but also at the organisation level, where some responsibilities and actions of the project manager were more traditional while others were based on change-based methods. This hybrid approach was discussed and observed during the data gathering, and these themes (Table 28) are discussed in this section.

Table 28. Hybrid Project Management: Themes and Sub-themes

Emergent themes	Sub-Themes
Hybrid project management	Balance
	Regimented aspects
	Flexible aspects

7.10.1 Balance

A balance between flexibility and regimented project management aspects was sought by all interviewees and believed to be in place in the organisation's project management system. Making things too flexible could lead to scopes being missed, and making things too prescriptive could slow down reaction to change and adaptability. Having good plans and engineering on paper, but then allowing the team on the ground to quickly manage changes as they pop up was deemed to be the desirable setup.

There was also balance between which aspects are controlled. While the end boundaries of time, scope and cost are fixed, there is a lot of flexibility in how those are achieved on site.

Balance on the reporting front was on similar lines, where periodic reporting on the overall project progress was required, yet the management team did not require extensive change management approvals for every change the project team was encountering.

Balance in terms of documentation rigor was also observed. The organisation does not require extensive drawing approvals from multiple parties that can eat up a lot of time. A simple review and approval process for drawings, with flexible modifications based on site conditions, and feedback of 'as built' to the engineering team to finalize the documentation package is a good example of a hybrid engineering-installation process.

In terms of the project manager's role, a hybrid arrangement was evident. Certain aspects like cost tracking, management communication and reporting, and commercial negotiations were almost exclusively controlled by the project manager in a traditional project management style. Other aspects like team management, mentoring vs directing, communication, and flexibility around the team's self-organising behaviour were evidently in line with the change-based approach. This hybrid balance was managed quite smoothly by the project managers and project teams, even though it had not been formally defined by the organisation.

VPT: "Can they coexist in a hybrid environment: Totally. I mean the only way the only way they can exist successfully is coexistence. It's not possible to have a total agile approach to project management because otherwise you would probably miss some of the important gates, and if you go completely on the opposite side you will end up making it so prescriptive that there will be no room for any kind of innovation in that process. I think the (studied organisation) employs a hybrid method quite well."

DIE: "You have to make sure you get it right on a piece of paper, but once that piece of paper is handed over to someone who is doing project management, there is a lot of challenges that you still encounter because whatever you see on a piece of paper is just an idea and I think that still needs to be implemented and executed correctly, so it's kind of a mix of both - between front loaded an on-site management of challenges"

PM3: "Hybrid approach is required as a balance between flexibility and a more regimented workflow for major decisions and approvals. The system needs to be agile but still have the required controls…Flexibility does lead to more focus on individual capabilities, and a more regimented style might be required where personnel competencies are not high…Definitely lean more towards the flexibility side of the mix on the ground."
PM2: "There is a balance between freedom and rules, 70:30 in an ideal world…Finance and timeline should have clear and strict guidelines and involvement from management for approvals. Execution should be more flexible."

ES1: "I think some projects can be over-regimented with the document and the paperwork and the approval process. I think we're sitting in a good place. We don't harp too much on detailed engineering and review levels and that something has to be stamped by 10 or 15 people before it's reviewed. I think the simple approach we take to this, and the less strings attached approach that we take, allows us more time to concentrate on analytics. I've worked on projects before where you spend a lot more time in the office taking care of paperwork and drawings and

approvals, and I think that takes away from where a supervisor should be, and that's on site, making sure the job gets done"

7.10.2 Regimented aspects

It was deemed that a lot of experience has gone into creating the PMI model, so it should not be taken lightly. There are several aspects of the project that benefit from a plan-based approach, and there are benefits of this approach because all aspects of the project are covered at the expense of time and effort from the resource pool.

Steel, piping and paint scopes were identified as scopes where a regimented approach works well within the MRO space, because proper inspections and planning can significantly reduce changes and an initial plan can be followed through to completion. It also helps that the shipyards use traditional project planning methods, and their primary scope of work is typically the steel, paint and piping jobs. So, there can be alignment between the project team and the shipyard on this.

CS1: "There should be a 50-50 balance between the more regimented PMI approach and a flexible style of project management. A lot of experience has been put into creating the PMI model and we should not take it lightly… On the structural side, changes can be minimized based on planning and surveying in advance"

CS2: "Structural and piping changes are easier to avoid than on the equipment side, because equipment condition will only fully be known once the rig is in the shipyard and the equipment is opened up. On the structural side, we can do inspections and thickness checks to find out a majority of the scope"; "I mainly work with the shipyard schedule for construction work, and feed that information to the project manager for the overall scope schedule that he maintains. The shipyard construction schedule is typically reviewed once a week, and adjustments are made according to what's going ahead/behind schedule, challenges, clashes and so on."

7.10.3 Flexible aspects

Equipment scopes were deemed to require a flexible approach because equipment condition is only found out during the project, making a plan-based approach with a no-change mentality impossible to achieve. Contingency planning, inspections early into the project, and quick decision-making protocols were the main tools highlighted by the team to deal with these scopes. These were also discussed in the previous sections in this chapter.

EVP: "We deal with unknowns, as the 'nature of the beast' for MRO projects. So, we're going to do an overhaul on our Drawworks brake, and you're going to dismantle the Drawworks. You have no clue what's inside. And so we're constantly dealing with unknowns…For the regimented approach to work, in my view, it would seem to be much more practical where it's a whole series of defined knowns that you're working with. And you've got proper documentation on exactly the condition of this bearing and exactly the condition of that before you start a piece of work, because then it's just, you know, stepping through the process. But because we tend to be dealing

with a whole bunch of unknowns and a bunch of assumptions, you really have to rely on people to then manage your way through that."

7.11 Chapter Recap

In this chapter, the data from the case study interviews and projects was analysed against the conceptual framework. Using Framework Analysis, for each MRO project thematic category from the conceptual framework, sub-themes were explored and studied with quotes and examples from the cases. Fig 26 summarizes the development of the Conceptual framework specific to the studied organisation.

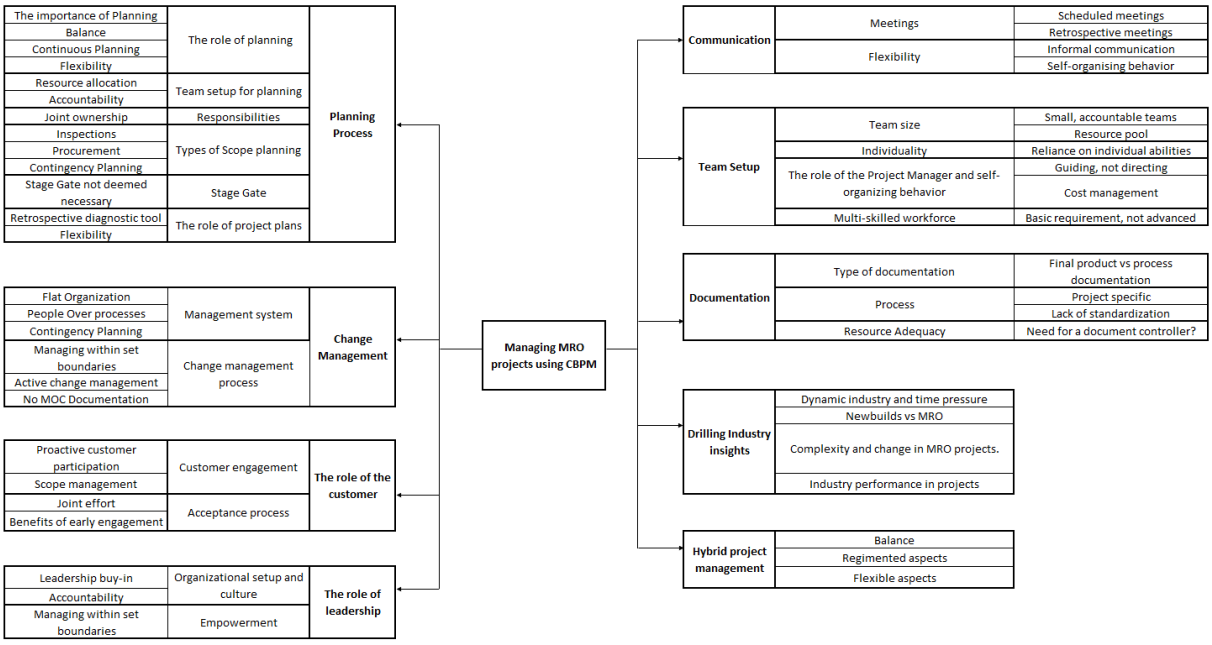


Fig 26. Development of the Conceptual framework specific to the studied organisation

8. Discussion

8.1 Overview

This chapter comprises of a summary of the research plan and its execution, a discussion on the key findings from the data collection and creates a feedback loop from empirical evidence to improve the conceptual framework (that had originally been created from theory) and present it in its final form.

8.2 Research Plan

The primary research question that was outlined was: How can complex, non-iterative projects be managed with acceptance rather than avoidance of inevitable change?

To answer the research question, the following steps were proposed to be taken:

1) *Theory building: Conceptualize Change-Based Project Management as the suitable approach for managing non-iterative complex projects in certain contexts and develop a conceptual link between MRO projects and Change-Based Project Management through the lens of Complex Adaptive Systems.*

   In order to accomplish this, the following steps were taken:

   - A literature review (Chapter 3) was conducted to individually study the history, tenets and current academic and industry research on prevalent project management methodologies and discourse.
   - Also in Chapter 3, literature on Complex Adaptive systems was studied to understand its theoretical underpinning.
   - In Chapter 4, Change Based Project Management was conceptualized as a project management approach for complex projects meeting certain contextual criteria. MRO projects were shown to meet these criteria.
   - Also in Chapter 4, the prevalent discourse on Hybrid Project Management was reviewed.

2) *Data collection: Qualitatively observe and study Upstream Oil and Gas MRO projects in a case study organisation where the Change-Based Project Management principles are being deployed, and interview key personnel in the organisation.*

   In order to accomplish this, the following data collection steps were taken:

   - Interviews were carried out with the corporate leadership team as well as the project teams of the studied organisation. The interviews discussed how they understand the dynamics of the industry, the role of project management and MRO projects in the business landscape, and their views on various aspects of MRO project management in the industry and in the studied organisation. This data was then analysed for compatibility with the conceptual framework.
   - Projects in the case study organisation were studied to ascertain if the views of the interviewees actually translated to action on the ground, and if the projects were indeed being managed in the way stated by the interviewees. 2 projects were selected, and data was collected in 2 ways:
     - Observations: Observations were carried out during meetings, walkarounds and unplanned discussions. These were noted and

analysed against the conceptual framework as well as the interview data. This helped link the interview data to the site data.

- Scope of work analysis: The scope of work analysis served two purposes: firstly, it helped validate if the MRO projects being studied had the required complexity to align with the literature review and conceptual framework. Secondly, it helped to gain a holistic view of the projects' scope of work, the changes in them, and how they were managed. This helped validate if the management of these projects aligned with the complex adaptive system view of project management and the management aspects that emerge from that in the conceptual framework.

3) *Analysis: Analyse the data to validate the conceptual framework showing how the Change-Based Project Management approach could be used to manage MRO projects.*

Analysis of the gathered data was carried out using Framework analysis. The conceptual framework was expanded specific to the cases and studied organisation, and the findings against each thematic element were summarised and recorded.

In the following section, the findings will be summarized to create a model of a management system along the same thematic elements identified in the conceptual framework, thereby answering the research question: How can complex, non-iterative projects be managed with acceptance rather than avoidance of inevitable change? For each thematic element, there will be a look back at what the theoretical expectations, based on literature review, from the conceptual framework were, and how the data performed against those expectations. There will also be a feedback loop to evaluate where the conceptual framework could be improved and/or modified based on the empirical evidence.

8.3 Discussion of findings: Are MRO Projects really complex?

In the early chapters of this research, the researcher presented his views on the drilling business and MRO projects in that business context. The key step in subsequently developing the conceptual framework was to draw a theoretical link between what, at that point in this thesis, were the researcher's views on MRO projects and the complexity that was claimed to be present in them. It was, therefore, necessary to observe the actual nature of the MRO projects from the case study data to validate this.

The interviews showed that practitioners, both at corporate and project team level, believed that MRO projects were much more difficult to control and manage than new construction projects. This complexity was attributed mainly to a high occurrence of changes once the project commences, and the connectivity between these changes. The inability to have detailed information about equipment condition before the project commencement was considered the main cause of changes Planning was considered one of the key ways to reduce project risk and unpredictability, but it was also reiterated that no amount of planning can lead to an MRO project without changes or surprises. Beyond a certain

degree, the problem could not be mitigated with better planning, but only with a different way of management.

The claims from the interviews were further validated with the Scope of Work analysis from the two studied projects. The selected projects covered the spectrum of MRO projects and provided good representation of MRO projects in the industry – one was a reactivation project with little to no planning time, and the other was a planned Out-Of-Service project where the team had sufficient time to plan the scope of work. Despite their inherent differences in scope, context, the ability to pre-inspect, and planning timelines, both projects experienced a high degree of changes during the project, albeit the planned project experiencing fewer changes, with no scopes isolated to an individual equipment – the way the drilling rigs are setup ensures that a change in one scope affects other scopes as well.

With the above data, the first step of the conceptual framework was validated, that MRO projects in the offshore drilling space are indeed complex business situations where traditional plan-based management systems would face a daunting challenge.

8.4 Discussion of findings: What did CBPM for MRO projects actually look like in real-world business conditions, and how did it compare to the conceptual framework?

Using framework analysis, all the management aspects under the conceptual framework (Table 9) were studied from the case study interview and project data. Each aspect is discussed (section 8.4.1-8.4.7) with the expectations from literature, findings from the data, and recommendations for practitioners and leaders looking to create an organisation implementing CBPM. This also leads to an improved version of the conceptual framework, which is discussed in Section 8.5.

During the case study interviews and observations, some emergent themes were also discovered, which are discussed (sections 9.4.8 - 9.4.9) as they are considered relevant to the purpose of the research effort.

8.4.1 The Planning Process

8.4.1.1 Expectations from Literature:

In traditional plan-based project management methods, attempts are made to minimize change through rigorous upfront scoping, analysis, planning, and design (Vinekar et al, 2006)(PMBOK, 2017). This over-emphasis on planning leads to a tendency to formalize procedures (Böhle et al, 2015), which reduces the flexibility in the system, and the underlying assumption becomes that project management is an exercise in managing scope which is sequentially dependent (Koskela and Howell, 2002). The planning process is seen to be the main difference between traditional plan-based and modern change-based project management methods (Thesing et al, 2021), where continuous short-term plans with a long-term vision, often in the form of iterations, are deployed instead of exhaustive up-front plans. Koskella and Abrahamsson (2004) argued that this leads to more planning in change-based methods, contrary to the perception that these methods involve no planning. Using Complex Adaptive systems as the underlying theory, this continuous planning method allows the project team to respond to environmental and internal factors, share feedback with each other and respond based on their

own schemata (scope requirements), allowing non-linear patterns to emerge at the system level that would not be apparent by calculating the sum of the parts or assuming that scope changes affect the project in a linear fashion (Carmichael et al, 2019) (Alla et al, 2013) (Ellis et al, 2011) (Choi et al, 2001) (Aritua et al, 2009) (Bakhshi et al, 2005) (Edson, 2012) (Kauffman, 1992) (Jain et al, 2004).

The conceptual framework projected that an organisation utilizing Change-Based Project Management would deploy a continuous planning process, that does not bind the team to look at scopes in a linear manner, allowing non-linear, emergent behaviour as changes are found and plans are re-drawn at frequent intervals.

8.4.1.2 Findings from data:

Even within the CBPM setup in the studied organisation, there was unanimous agreement that planning is critical to the success of the project, and the earlier the planning starts, the better. However, it was also commented that there was marginal utility for planning beyond a point, and the cost of the planning team needs to be considered. This was consistent with expectations from literature for change-based management methods.

The teams were implementing a continuous planning process, where the plan was reviewed and adjusted at a daily, weekly and monthly basis, and there was no pressure to stick to an original 'baseline' plan. The project team was involved in the project from start to finish and had ownership of this continuous planning arrangement. This led to better accountability, as compared to having a planning team or a planning engineer separate from the execution team. Each team-member had certain scopes assigned to him/her at the planning stage, and inspections, procurement, engineering and contingency planning were handled at the scope level. The project manager stays involved in the planning of all scopes, usually at an information level but also at an execution level for key scopes. The project manager consolidates all the information into a Work Breakdown Structure, which is a key deliverable from the planning stage and is used throughout the project thereafter. The continuous planning methodology was consistent with the expectations from the conceptual framework and the literature on change-based methods, and the co-located, motivated teams that meet regularly to adjust the plan is aligned with the first principles of the change-based methods (Agile Manifesto, Beck et al, 2001).

Due to the complex and unpredictable nature of the projects, where equipment condition is often only known once the rig is in the shipyard, it was deemed to be important to have contingency planning for parts that might be required, instead of only procuring parts that will surely be required. Having a pipeline of projects and a lookahead at future projects helps in this regard, as significant contingency procurement for 1 project alone is problematic due to excessive cost and the potential of being left with a large surplus of expensive parts if they are not required. By having an available lookahead of future projects, contingency parts can be ordered as a fleet reserve with a higher probability of being used over a multiple project lifecycle.

It was noted that in the studied organisation, due to the flat management structure, a Stage Gate process would not add value as the key people are already aware of the main challenges and milestones in a project. The Stage Gate process was considered a bureaucratic process needed for organisations which were not flat. This aligns with some of the critiques of plan-based methods from literature (Böhle et al, 2015) (Boehm, 2002)(Eden et al, 2000).

8.4.1.3 Variances and Recommendations:

The CBPM approach recommendation from this research effort for practitioners and leaders whose organisations deal with complex projects with a high likelihood of change, is to not tie down their teams to an initial plan and make adaptation difficult in the process. Leaders should look to **set boundary conditions** (time, cost, or whatever is important for the organisation), and then allow the project teams to **plan in a continuous manner** and adjust their resources, scope execution, and priorities as required to meet the boundary conditions. A **flat management structure**, **flexible reporting**, and **need-based change management** discussions instead of formal structured scheduled reviews can help empower the project team in this regard and allow them to adapt better during their complex projects. For asset-heavy industries where equipment reliability is one of the main challenges, having a good quality lookahead of projects and the ability to plan fleet-level **contingency** spare parts greatly helps in dealing with supply chain risks during the project, and is also more cost-effective than individual project-level risk mitigation procurement.

8.4.2 Change Management

8.4.2.1 Expectations from Literature:

As noted in the Literature Review, there is sufficient literature showing that deviation and uncertainty in a project context is inevitable (Hallgren et al, 2005) (Böhle et al, 2015), and the solution may be found not in more complex up-front plans, but in a methodology catering to an efficient resolution of the deviations. Whitty et al (2009) acknowledge that schedule-based tools like Critical Path Method (and PERT) are useful in the planning of projects, but don't account for the inevitable dynamics of real-world uncertainty and changes. Change-based methods attempt to turn this mindset on its head, by embracing change as an inevitable part of project management (Vinekar et al, 2006) (Jain, 2006) and the ability to recognize and respond to changes and errors is considered by practitioners to be one of their biggest advantages (Thesing et al, 2021). Building on this using the theory of Complex adaptive Systems, the organisational empowerment and management ability to deal with changes on the ground allows the project team to learn from their successes and failures and adapt their actions towards a higher likelihood of a positive outcome going forward, as done by agents in a complex adaptive system (Carmichael et al, 2019) (Alla et al, 2013) (Sweetman et al, 2018) (Aritua et al, 2009) (Jain et al, 2004).

8.4.2.2 Findings from Data:

Because the leadership team of the studied organisation felt that changes in MRO projects are a given, the organisation had been setup to deal with them efficiently and expeditiously. The

equipment types on drilling rigs don't allow for comprehensive knowledge of the equipment condition without stripping down the equipment, which is only done during the project. Therefore, a plan-based approach to project management looking to avoid changes is bound to fail as the original plan will start changing from very early in the project. Instead, the management system relies on people to manage the changes and solve problems instead of processes. So, the organisation is more focused on making the right decisions, and not necessarily the process by which that decision was made. Project managers are empowered on the same lines, and as long as the agreed boundary conditions of cost, time and scope completion are met, the project managers don't need any approvals or extended change-management documentation to make change management decisions. Because the organisation is flat, leadership is aware of changes, but that awareness does not translate into intervention or formal approval requirements unless the boundary conditions are affected. Change management is done ad-hoc as well as during periodic reviews at the project team level and is seamlessly built into the continuous planning process where change management is addressed, different supervisors re-evaluate their scope requirements and plans, and the project schedule is revised to account for the new plan.

8.4.2.3 Variances and Recommendations:

The CBPM approach recommendation from this research effort for practitioners and leaders whose organisations deal with complex projects with a high likelihood of change, is to refrain from setting overly stringent change-management protocols, review requirements and approval requirements, and instead to give the project team more **freedom to manage changes** as long as the boundary conditions are not breached. Not only does this lead to better **accountability and ownership** within the project team, but it also leads to agility and nimbleness in responding to changes, flexibility in resource re-arrangement in lieu of changes, and allows the team to behave like an adaptive system within their complex project environment. Just like project managers, in this system, are encouraged to **guide and facilitate** instead of direct, similarly management should guide and facilitate the project team's ambition of meeting the project deliverables, instead of having a low appetite for change management delegation or directing at a micro-level.

8.4.3 The role of the customer

8.4.3.1 Expectations from Literature:

As seen in the literature on plan-based project management, while it is not intentional, the intense focus on preliminary planning and detailed scheduling in plan-based project management often leads to alienation of the customer and any change of requirements by the customers are treated as a negative impact on the project, further leading to a poor customer relationship. Change-based methods attempt to address this unfortunate side-effect by encouraging constant customer engagement, not just when developing the initial specifications, but throughout the project lifecycle (Vinekar et al, 2006). Customer representatives are encouraged to be co-located with the project team and provide regular feedback on progress, iterations etc (Serrador and Pinto, 2015) and are often empowered by the customer's

organisation to make quick decisions (Coram and Bohner, 2005). Kadefors (2004) highlights that trust between customers and contractors can be built up using economic alignment, joint goal formation, regular interaction, and systems catering towards change management, problem-solving and continuous improvement. These are the expectations from literature for a change-based project management approach, and aligns with the adaptiveness, anticipation and co-evolution features of complex adaptive systems because only when the team is able to efficiently deal with changes and move forward can the team stop looking at customer interaction as a detriment and use it to their advantage.

8.4.3.2 Findings from Data:

In the project phase in the drilling rig industry, customer acceptance is a major component of project delivery. The customer acceptance process typically entails a detailed inspection of the rig and a verification of crew competency. While the customer acceptance testing is typically done at the end when the scopes are complete and the rig is nearing readiness, there were two main models for customer engagement in the industry: one where the customer does not have any representatives or direct involvement during the project and only sends the inspection team out to the rig once the scope is completed; and the second where the customer is involved from an early stage in the project and typically has on-site representation at the shipyard throughout the project duration. The studied organisation has a clear preference for the latter, and they encourage customer participation in the planning, scope of work creation, and execution stages of the project. This enables the customer to have ownership in the project and they become part of the team instead of considering themselves to be an auditor of completed work. This is akin to the principles behind the Agile methodology, where customer participation is sought throughout the project. This not the norm in the industry, where most organisations follow plan driven project management methods, and prefer that the customer does not 'interfere' with their project plan. The studied organisation's continuous planning and change-based methodology benefits from early and continuous customer feedback, reducing the likelihood of surprises or issues during the final acceptance testing. The risk of this approach is that if the rig is in bad shape in the early stages of the project, customer representatives could develop a negative bias towards the readiness plans. However, the ownership and partnership that is generated when the customer witnesses the rig's journey through the project lifecycle has a significant benefit as well. Observations from the studied projects also showed that the project where the customer engagement was earlier in the project benefited from a smoother acceptance process and easier closeout of punch-list items.

8.4.3.3 Variances and Recommendations

The CBPM approach recommendation from this research effort for practitioners and leaders would be to **assess the role customers play** in their project deliverables and evaluate the pros and cons of early customer engagement. As found in most Agile literature and as seen in this research effort, **early customer involvement** has significant benefits and coupled with the CBPM philosophy, this could lead to a much smoother customer acceptance and intake process, thereby reducing the risk of encountering last minute issues during acceptance inspections. Also, early customer involvement in scope creation helps ensure no key customer requirements get missed in the project planning and execution.

8.4.4 The role of leadership

8.4.4.1 Expectations from Literature:

As Nerur and Mangalaraj (2005) put it, Agile and traditional organisational setups have conflicting cultures, management styles, organisational forms, and reward systems. Thus, it is imperative that the leadership buys in to the organisation's chosen project management philosophy and is not misaligned with it. The organisation also needs to buy into the behavioural change required to implement a system not based on change-control but rather behavioural-control (Ouchi, 1977) when changes are encountered. Management buy-in, both visible and supportive, played a key role in the success stories though, and to make this balance work is a key aspect of project management transformation. Open dialogue and flat-organisations that enable information flow contribute positively to this effort (Radan et al, 2015). The delegation of control from leadership buy-in in change-based project management methods leads to the empowerment of project teams to self-organise and work on solutions themselves. This is an important facet in the face of changing scopes, as the response to these changes does not require a central command and control mechanism relaying revised responsibilities to the team. Instead, the team organically react to the changes and self-organise towards an effective response. (Edson, 2012) (Alla et al, 2013) (Ellis et al, 2011) (Sweetman et al, 2018) (Choi et al, 2001) (Aritua et al, 2009) (Bakhshi et al, 2005) (Jain et al, 2004).

8.4.4.2 Findings from Data:

The leadership team of the studied organisation was aligned on the principle that a flat management structure and agility of decision-making are critical requirements towards enabling project success. End to end accountability of the project team from the project pricing and planning stage, through to execution and closeout was considered important by the leadership team, and the organisation was setup accordingly. Courtesy the flat management structure, there was frequent interaction between corporate leadership and the project teams and assistance, guidance and support was readily available.

Empowerment of the project team towards decision-making and change-management was evident, which showed the leaderships' trust in the organisational setup, and in the accountability, ownership and competency of the project team. The project teams felt that they have been given the tools and freedom to get the job done, and therefore feel motivated towards achieving the desired outcome, instead of losing ownership due to micro-management and extensive approval requirements which essentially make key decisions someone else's.

8.4.4.3 Variances and Recommendations

The CBPM approach recommendation from this research effort for practitioners and leaders would be to have alignment between the philosophy of the organisation, the structure and hierarchy of the organisation, and the way responsibility, accountability and ownership are managed within the organisation. If projects in their space are deemed to require a change-based project management method, then the leaders need to understand that to truly benefit from the method and allow the team to behave like a complex adaptive system, the supporting management structure needs to be flat, the project team needs to be given the freedom to adapt to changes and make decisions within set boundary conditions, and there needs to be

alignment within the entire organisation towards the implementation and application of this arrangement. Even if one part of the organisation decides to micro-manage and create reporting, approval, or different hierarchal demands of the project team, it will detract from their ability to truly work around changes in an adaptive manner.

8.4.5 Communication

8.4.5.1 Expectations from Literature:

Clegg and Smith (2003) propose to frame the discussion around project management towards organisational setting and the people that are executing the projects in that setting (science of subjects), and not necessarily the project deliverables (science of objects). Metcalfe (1997) notes that the primary effect of plan-based project management methods is enhanced control over the conduct of the project management team, based on tight rules and limited empowerment. Change-based methods rely heavily on regular and free communication to further the collaborative methodology. There are three primary communication enablers often used in change driven methods – co-location of team members, daily stand-up meetings (Mann and Meurer, 2005), and retrospective meetings (Alyatma, 2021). This frequent and flexible communication system is what allows the team to behave like the agents in a complex adaptive system, displaying feedback and connectivity to allow steering the project in the desired direction (Holland, 1998) (Weaver, 1948) (Daniel et al, 2019) (Edson, 2012) (Carmichael et al, 2019) (Alla et al, 2013) (Ellis et al, 2011) (Sweetman et al, 2018) (Aritua et al, 2009).

8.4.5.2 Findings from Data:

The project teams used a combination of planned and ad hoc communication methods like group meetings, site-walkarounds, and smaller (2-3 people) meetings to ensure all stakeholders were participating at optimal levels. It was evident in the meetings that a collaborative approach was taken where the project manager or designee would typically facilitate the discussion but not direct the outcomes. Retrospective meetings were almost unanimously sought, but execution of formal retrospective meetings was not unanimously being done. Instead, it could be observed that regular scheduled meetings, even though not being formally labelled as retrospective, involved a significant amount of retrospective review and tweaking of forward-looking plans accordingly. Schedule review meetings were held fortnightly in both projects, with the project schedule updated and used as discussed under the planning section. The flexibility in communication style amongst the project team and between the project team and management was clear and evident. Formal emails, presentations or documentation were not mandated apart from project weekly reports, or safety incident reports and investigations.

There was also significant interaction between project teams and corporate support functions, and between different project teams, evaluating synergies, and sharing/optimizing material and manpower requirements. It was considered vitally important for the project team to maintain good communication with and involve the operations team in the project planning and execution, as they are the end users of the rig and often know the equipment and rig better and can assist with a lot of things.

8.4.5.3 Variances and Recommendations:

The CBPM approach recommendation from this research effort for practitioners and leaders looking to setup a change-based project management method for their projects, is to make a list of stakeholders that need to be engaged and firstly **identify the planned meetings** that would be carried out. As part of the change-based management philosophy, the team should not follow a directive leadership style in these meetings, and a **collaborative approach** should be taken. Subsequently, the project team should be **empowered** to carry out scheduled and impromptu meetings as per their requirements, enabling nimble communication and change-management. **Retrospective meetings** should be encouraged, either as a standalone periodic retrospective meeting, or an aspect of retrospection should be built into their other scheduled meetings. As much as possible for reporting requirements, **flexibility in communication** protocols should be encouraged to reduce the administrative load on the project team and enable more agility in communication. Finally, stakeholder communication at the project, customer, vendor and corporate level should be planned out and efficiently managed without creating the administrative burden of generating formal stakeholder management plans. This **stakeholder communication** could be as simple as a joint meeting in the morning for on-site stakeholders, and a weekly/fortnightly report for off-site stakeholders.

8.4.6 Team Setup

8.4.6.1 Expectations from Literature:

Metcalfe (1997) notes that the primary effect of plan-based project management methods is enhanced control over the conduct of the project management team, based on tight rules and limited empowerment. Eden et al (2000) note that when changes are encountered in projects, by taking actions that are recommended by conventional methods, project managers themselves are exacerbating the feedback and making the over-runs worse. Change-based methods are usually strong advocates of small, empowered project teams aimed at achieving innovation through individual initiative (Vinekar et al, 2006). The project manager's role is more of a coach and mentor, and less as a director (Coram and Bohner, 2005), especially as it is extremely difficult for an individual project manager to successfully see, and therefore direct, a complex project in its entirety (Sargut et al, 2011). Self-organising behaviour is a key aspect of change-based project management methods (Highsmith, 2003), where the project manager steps back from the traditional role of planner, organiser, and controller, and instead becomes a facilitator or coach who encourages and manages collaboration between team members without impeding their creativity. Jain (2006) emphasizes how multi-skilled small teams of motivated individuals which self-organised was effective, efficient and lead to better customer engagement as well. Team members should be encouraged to nourish their core specialization, at the same time developing other skill sets as part of the agile group (Conboy et al, 2011). This aligns very well with the expectations from agents in complex adaptive systems, where agents have their own schemata but are not bound by too stipulative a rule mandate at the component level, because that will not allow the components the flexibility to respond to environmental changes. (Daniel et al, 2019) (Harkema, 2003) (Holland, 1998) (Ellis et al, 2011) (Cachon et al, 1999) (Alla et al, 2013) (Choi et al, 2001) (Sweetman et al, 2018).

8.4.6.2 Findings from Data:

The project teams get involved from the planning stage, and stay engaged through the execution, commissioning, and closeout phases of the project. By running smaller teams but having them involved from start to end and holding the team accountable for the project outcomes instead of individuals, the organisation has found a successful method for generating ownership and responsibility. The setup also encouraged more independent thinking and sparked self-organising behaviour within the team, as the ownership of the project spurred the team into action whenever a challenge came up, instead of simply reporting it up the line and awaiting a decision.

Empowerment of the project team and having the project manager guide and coordinate instead of direct and instruct was an important aspect of how the teams functioned. Team members felt empowered in their roles as the project manager did not micro-manage their scopes of work. Yet the felt supported because the project manager was always available to guide them and set clear expectations and deadlines. These were collectively monitored and reviewed within the team and course-corrections made if things were not going to plan.

Running small teams in this bespoke arrangement also has its pitfalls, with the system generating a high dependency on individual capabilities and the potential of not having enough contingency workforce if team-members become unavailable. The preference for having team members with multiple-skills was also evident because of the small team size, and this might not always be possible in an organisation and could require dedicated training expenditure.

While the project team members played a role in cost management at a scope level, the overall project cost control responsibility lay with the project manager. While not explicitly mentioned, the researcher gathered that this was because of a few reasons: the organisation had setup a authority based financial approval system, where the project manager had the approval authority for project spends and was therefore accountable for the outcome; also the project team members had no training in financial accounting, management and cost tracking across scopes; and finally because the team was already small, having a cost control responsibility spread out across multiple team members would require each of them to add accounting tracking, cross-referencing, supply chain and finance engagement etc to their workload, which would detract from their work responsibilities at the project site.

8.4.6.3 Variances and Recommendations:

The CBPM approach recommendation from this research effort for practitioners and leaders looking to setup a change-based project management method for their projects would be ensure that the project teams get assigned to the project from the start and **stay engaged** with the project till completion. In order to get the most out of the **self-organising behaviour** desired in complex adaptive systems, the team size should be reviewed and kept on the smaller side of the spectrum. Larger teams end up more layers and reporting lines, which detracts from self-organised decision making. The role of the project manager should be clearly defined, and should be envisioned as a **guide and mentor** on the ground, but also the person who helps keep the team on track by clearly identifying the desired outcomes and boundaries, and helping the team course-correct if things are not going well. Depending on the organisation's setup, thought should be given to **project cost management** responsibilities and if they are better off staying with the project manager, or if the team has the training and bandwidth to accommodate that.

The organisation's financial control mechanism and policy would need to be considered while making that decision as well. Depending on the desired size of project team and the number of projects the organisation plans to carry out at any point of time, thought should be given to **contingency planning** and **training** of project team members to avoid single points of failure and fragility in team strength.

8.4.7 Documentation

8.4.7.1 Expectations from Literature:

Change-based methods try to reduce the emphasis on extensive documentation in favour of more functional milestones (e.g. working prototypes) and face to face communication (Cooper et al, 2016), saving project teams the significant amount of time and effort spent on maintaining exhaustive documentation (Coram and Bohner, 2005) (Vinekar et al, 2006), which aligns with the previously discussed Complex Adaptive Systems' concept of agents with schemata. Also, the decentralized decision-making process of change-based methods reduces the reliance on documentation for communication through various layers of management, making documentation reduction more viable (Annosi et al, 2020). Care must be taken, though, that the approach isn't misinterpreted by the team as one with carefree lack of documentation (Dikert et al, 2016). Critical documentation which could be useful for other projects or larger organisational learning should still be maintained, and so a value-driven documentation approach is endorsed (Fernandez et al, 2008).

8.4.7.2 Findings from Data:

On the projects carried out at the studied organisation, the documentation prepared was focused on the final product and deliverables, typically certificates and reports. This decision was driven by the needs of the internal and external users of the documentation, where process documentation was reportedly never required. The main exception to this were steelwork scopes where process documentation was a regulatory requirement and maintained accordingly. As with scope planning and execution, team members are responsible for document collection. The project manager creates the filing system's skeleton based on the project's Work Breakdown Structure, and then documents are filed within the sub-folders for each scope. Finally, the document folders are copied onto the portable drives and uploaded on the project server at the end of the project. Copies of the drives are handed over to relevant stakeholders in the operations, project, and corporate teams. There was no ERP based filing system used by the organisation. No dedicated document controller was typically used by the project teams, but team members suggested that for projects where the project manager's workload might be high, a document controller could potentially be used.

8.4.7.3 Variances and Recommendations:

The CBPM approach recommendation from this research effort for practitioners and leaders looking to setup a change-based project management method for their projects would be to first **evaluate** what their documentation needs are, based on internal and external stakeholders' requirements. Documentation should not be created for the sake of it and should be limited to

what is usable and desired by stakeholders. This helps in keeping the documentation effort **focused** and avoids the use of resources towards an output which is not useful. Depending on how extensive these documentation requirements are, a filing system should be devised and preferably standardized across projects. Depending on the organisation's documentation requirements, the need for a standalone document controller can be assessed.

8.4.8 Hybrid Setup

8.4.8.1 Expectations from Literature:

Lensges et al (2018) say that depending on the complexity and uncertainty in a project, a traditional, agile or hybrid approach may be most suitable. High complexity-low uncertainty, and Low complexity-High uncertainty projects are good candidates for a hybrid approach, benefiting from some pre-planning but also needing flexibility during the working phase of the projects to deal with changes and technical challenges. Collyer et al (2010) claim widespread support for 'emergent planning' methods, where only a high-level plan is developed first, and finer details are filled in as they emerge. In an attempt to build a theory on managing dynamism within projects, the authors recommend a process wherein the planning for static and dynamic scope elements should be treated in more traditional and emergent ways, respectively. Cooper (2016) and Boehm and Turner (2004) indicate that a hybrid model of plan-based and change-based project management can work very well but how the balance is stuck is key to the success of the model.

8.4.8.2 Findings from Data:

Change driven project management methods, as discussed in the Literature Review section, are currently primarily deployed in the IT product development space where iterative development is possible. In MRO rig projects, iterations are difficult to envision or put into practice, because multiple equipment and systems are in varying stages of inspection/overhaul/repair/installation at any stage of the project. Thus, formulating an iteration with firm rig-wide deliverables at the end of it is not practical. However, as we have seen, the principles behind change-based project management can be deployed effectively in such projects. How the studied organisation brought structure, in lieu of iterations, to the process was to execute a Hybrid project management method where there was a balance between some of the regimented aspects of Plan-based project management and the flexible aspects of change-based project management. There was a focus on planning and attempts were made to carry out detailed planning, procurement and engineering as much as possible. At the same time, the organisation was setup to manage any changes to that plan in an effective and efficient manner.

This balance was visible across the management spectrum - while the end boundaries of time, scope and cost were fixed, there was a lot of flexibility in how those are achieved on site; while periodic reporting on the overall project progress was required, yet there were no requirements for extensive change management approvals for every change encountered in the project; while documentation requirements were simple and fit for purpose, engineering rigor and 'as built' feedback into final documentation was evident; while the project manager controlled several aspects like cost tracking, management communication, reporting, and

commercial negotiations, their management style was setup to be a mentor and guide, allowing flexibility in the team's behaviour and communication styles.

When it comes to scope management, the balance was visible at the project level, while individual scopes often had either plan-based or change-based management styles. Steel, piping and paint scopes were identified as scopes where a regimented approach works well within the MRO space, because proper inspections and planning can significantly reduce changes and an initial plan can be followed through to completion. It also helps that the shipyards use traditional project planning methods, and their primary scope of work is typically the steel, paint and piping jobs. Equipment scopes were deemed to require a flexible approach because equipment condition is only found out during the project, making a plan-based approach with a no-change mentality impossible to achieve. Contingency planning, inspections early into the project, and quick decision-making protocols were the main tools highlighted by the team to deal with these scopes.

8.4.8.3 Variances and Recommendations:

The CBPM approach recommendation from this research effort for practitioners and leaders would be to critically evaluate the type of MRO projects they envision their organisation will undertake, and how much control the organisation is willing to entrust to the project teams in executing those projects. If the MRO projects are such where significant scopes will be subject to change, like in offshore drilling rig projects, then a change-based methodology and organisational setup should be considered. If scopes can largely be pre-planned and the chances of changes are low, then a plan-based method might be preferred. However, depending on the organisation's reporting needs and the actual nature of scopes within the project, the potential to have a **Hybrid model** should be explored. Under this system, there should be a strong focus on detailed planning of the project, yet the organisation should be set up so that the project team can effectively and efficiently manage changes during the project execution phase. The Hybrid model could span the planning process, scope-level management, individual roles and responsibilities, reporting and documentation requirements et al.

Embracing the CBPM approach at a '**first principles**' level also means having the ability to embrace plan-based methods where they work well and create a hybrid model specific to the organisation's project management needs.

8.4.9 The drilling industry and MRO projects

8.4.9.1 Findings from Data:

It was evident from the data that the drilling industry is a dynamic, fast-paced industry which suffers from lack of structure and standardization. There are several challenges that the industry has to deal with, like supply chain risks, industry cyclicality, and the remote location of the drilling rigs that need to be serviced. There was unanimous agreement that drilling rig MRO projects cannot be managed without changes, and the ability to recognize change and react to it in an efficient manner to come up with procurement or engineered solutions, and then getting these approved within the organisation expeditiously was considered a critical success factor.

The complexity of MRO projects cannot be purely managed by extensive planning, though planning does mitigate the level of risk the projects face. Following traditional project management methods, where change is considered an undesirable outcome, has been the current practice in the industry, and the industry-wide performance in projects has been poor. Agile and modern project management techniques are largely unheard of within the industry, and organisations seem to hope that their outcomes, while following the same management techniques as their peers, will be better than their peers – something that has not happened.

8.4.9.2 Variances and Recommendations:

The recommendation from this research effort for practitioners and leaders will be to **critically evaluate** the space within which their business operates, and to have an unbiased look at the key technical, internal and external management challenges they face. If the projects they are dealing with are indeed complex and change is inevitable in them, then embracing a project management method where change is meant to be avoided and change-management is a cumbersome and exhaustive process that requires creating new baselines for the project at every major change, is not a fit-for-purpose management solution. For such projects, change-based methods focused on creating a management system that help the team respond to changes in the most efficient manner, should be given due consideration.

8.5 Conceptual Framework – final version

The conceptual framework for Change-Based Project Management was developed from literature and subsequently validated using empirical data from the case study organisation and two studied projects. Along with validation, it was also important to create a feedback loop using key findings from empirical evidence to improve the conceptual framework (that had originally been created from theory) and present it in its final form. The following are some of the observations and reflections from empirical data that materially improved the conceptual framework.

It was noted that up-front planning (including inspections, long lead procurement, and contingency planning) is important and does make projects easier, but strict reinforcement of the plan (resistance to change) creates the issues – continuous planning is the preferred method even when iterations are not possible/required. This is a key insight into the role of planning in CBPM as a vitally useful aspect of the project management system, but as a continuous process not bound by strong restrictions related to change-aversion (like traditional project management) or iterations (like Agile).

End-to-end accountability of the project team from budgeting to close-out was considered as a key driver of success of CBPM and has therefore been reinforced in the conceptual framework. Accountability is also proposed as part of the Triple-A mechanism for CBPM implementation – one of the contributions from this research effort.

Literature on change-based project management systems (like Agile) had guided the CBPM conceptual framework in defining the role of the project manager as a guide and coach while the project team self-organises. Feedback from the empirical data showed that while the project manager did

indeed follow that role in day-to-day management of the team and scopes of work, he still maintained full control of 2 vital functions – cost management and reporting of progress to stakeholders. This management setup blended well into the management style of the organisation, and this type of hybrid control mechanism is useful feedback for the CBPM conceptual framework, as it endorses the required flexibility and adaptability that the Complex Adaptive Systems approach brings. If CBPM itself mandates its own processes restrictively, then it is killing adaptability and is self-defeating.

One of the notable observations from the empirical data was the organisation's approach of managing within set boundaries in lieu of iterative approach viz the project team is given (by the organisational leadership) set boundaries of cost, time, and scope deliverables and are free to self-organise and manage within those boundaries, without requiring any approvals, till the end of the project. This is opposed to an iterative approach where a review is done at the end of each iteration and targets/plans made for the subsequent iteration. This autonomy given to the project team to manage within the boundaries, which are the business goals of the organisation, is one of the key enablers of CBPM success and is proposed as part of the Triple-A mechanism for CBPM implementation – one of the contributions from this research effort.

The CBPM conceptual framework derived from literature emphasized early and continuous customer engagement. This is undoubtedly useful in Agile project management in the IT and product development phase, where specifications management is vitally important to project success. It was observed from the empirical evidence, that the approach needs to be more nuanced when it comes to MRO projects - early engagement can sometimes be problematic if expectations can't be managed (showing customer a rig in bad condition can be counter-productive). Also, depending on the industry and the customer's financial situation, some customers might not be keen on spending resources before and during the project, and might prefer inspecting the repaired asset at the end, especially if they trust their formal acceptance process and trust the quality of the MRO project team's output. Therefore, while early and continuous customer engagement is preferred in CBPM, it should not be considered mandatory as it could be managed with transparent reporting. The fact that CBPM does not have iterations also eliminates the need for customer feedback between iterations. Initial agreement on the scope, transparent reporting, and joint effort towards the final acceptance process are key enablers of better performance in the CBPM approach.

Retrospective meetings were an expectation from literature for CBPM but were observed to not be uniformly done in the studied organisation. While there were retrospective aspects to some of the organised and ad-hoc meetings that were done by the teams, formal retrospective meetings were noted to be of potential benefit but something that the organisation was not enforcing. This feedback, while it reinforces the expectation from literature, demonstrates how flexibility and adaptability can be achieved without using all the tools the CBPM approach endorses.

It was observed from the empirical data that there was a clear reliance on individual abilities and knowledge of project team members due to the end-to-end accountability and small project team size in the studied organisation. Also, as one of the differentiators of CBPM from other modern methods like Agile is the ability for the team to be involved and working on multiple scopes throughout the non-iterative project lifecycle, this further increases the reliance on individual team member quality and experience. It is, therefore, not going to be straightforward to replace team members and there is a risk that this approach creates single points of failure when it came to knowledge and experience. This concern was noted in literature as well and the empirical data reinforced this expectation from literature.

Finally, the empirical observations on the documentation aspect of CBPM reinforced the expectation from literature but added nuance to it. While documentation requirements were kept functional and minimal, the interesting observation was that the principle behind determining the documentation needs should be to work backwards from internal and external requirements and focus on only those documents. All other process, material or equipment documents were deemed as excess and the need to process and store them was eliminated.

Based on the above feedback, the conceptual framework was improved and is presented in its final form in Table 29, with changes underlined.

Table 29: Conceptual framework for managing MRO projects using Change-Based Project Management - final

MRO Projects Management aspect	**Change-Based Project Management Approach**	**Complex Adaptive Systems**
Planning Process	*Up-front planning is important*; Continuous Planning mentality throughout the project; Suitable for projects where scope breakdown into iterations is not possible; *End-to-End* Accountability of the team is continuous from the planning to execution to closeout phases.	Agents with schemata; Non-linear emergent behaviour;
Change Management	Change is inevitable; swift and nimble change management; Adaptive management style	Adaptiveness, Anticipation and co-evolution
The role of the customer	Customer engagement and active participation throughout the project lifecycle *is encouraged*; *Initial agreement on the scope, transparent reporting, and joint effort towards the final acceptance process*	Feedback and connectivity; Adaptiveness, Anticipation and co-evolution
The role of leadership	Leadership buy-in towards the approach; *Management within set boundaries and delegation of control towards Autonomy of the project team*.	Feedback and connectivity; Self-Organisation
Communication	Communication over processes (Stand-up Meetings, retrospective meetings, co-location); High-frequency informal communication to facilitate self-organising behaviour	Feedback and connectivity; Self organisation; Non-linear emergent behaviour
Team Setup	Smaller teams with varied skillsets spread across multiple scopes; *Flexible approach towards hybrid control requirements;* Ability to be multiskilled; Project manager as a mentor and guide; Self-organising behaviour	Non-linear emergent behaviour; Variety, Feedback and connectivity; Self organisation
Documentation	Decentralized decision making, leading to low documentation emphasis; Extent of documentation driven by final project deliverables	Agents with Schemata

9. Conclusions

9.1 Overview

In this chapter, a summary of key insights from the theoretical and empirical work done in this research effort are presented as propositions, followed by the key contributions for the academic and project management practitioner community. No research is without limitations, and these are presented in section 9.3, leading to directions for future work. The chapter concludes with further research recommendations and propositions that should be pursued to build on the contributions offered in this research. They give direction for scholars to advance knowledge and build a deeper base of evidence for applications of agile and CBPM approaches. It also formalises an approach that can be adopted by practitioners and gives clarity on how to apply an approach that accepts and manages inevitable change in complex projects. In line with the practical nature of a DBA, these two directions are mutually supportive. Increased adoption of CBPM in practice will increase the impact of the research but also generate more potential data that can be researched further.

9.2 Management Insights

9.2.1 The 'Triple A' Mechanism for Change-Based Project Management

The proposed 'Triple A' mechanism is a co-dependant combination of three management aspects – Autonomy, Accountability, and Adaptability.

Autonomy is a word that is often misunderstood in business to mean that teams are allowed to do as they please. In the Agile context, autonomy has been mentioned as a key management aspect (Ciric et al, 2019) (Augustine et al, 2005) (Papadakis et al, 2020) (Kaufman et al 2020) (Sweetman et al 2018), and autonomy is also a considered aspect in Complex Adaptive Systems literature (Choi et al, 2001) (Kauffman, 1992) (Sweetman et al 2018). In the CBPM context, autonomy is integral to the management approach and is fundamental to the mindset. In Agile project management, having an iteration-based management system allows for change management, course correction and continuous planning, thereby providing the ability for management and customers to interject at pre-defined intervals and steer the project towards the desired outcomes. In projects where iterations are not practically suited to the scope of work, CBPM offers an alternative means of achieving similar outcomes by managing the project team within set boundaries. In this approach, the project team is given set boundaries of cost, time, scope deliverables, or whatever are the key success metrics for the business setting and organisation and are subsequently given freedom to self-organise and manage within those boundaries, without requiring any approvals, till the end of the project. This allows them to behave like the agents with schemata from complex adaptive systems (Daniel et al, 2019) (Harkema, 2003) (Holland, 1998) (Ellis et al, 2011) (Cachon et al, 1999) (Alla et al, 2013) (Choi et al, 2001). The management within set boundaries helps feed the Autonomy and Accountability aspects of the 'Triple A' mechanism, by giving the project team the necessary tools to self-organise and manage changes without the bureaucratic requirements of management approval through the organisational hierarchy.

Accountability as an important success factor in Agile implementation is extensively covered in literature (Diem, 2021) (Kerzner, 2003) (Noteboom et al, 2021) (Marnada et al, 2022) (Ahimbimsibwe et al, 2018) (Javdani et al, 2020), however as seen from the knowledge gaps in

the systematic literature review, the importance of accountability towards complex projects like MRO has not been researched adequately. End to end Accountability of the project team from the budgeting of the project, through the planning and execution phases, till the closeout and completion was seen to be a vitally important aspect of the CBPM approach and a key perceived success enabler for the organisation. Having the same team develop the scope of work, execute it and ensure that the final outcomes meet the customers' and organisation's requirements, generates ownership and accountability of the entire process at an individual and group level within the team, thereby allowing the project to behave like a complex adaptive system (Holland, 1998) (Weaver, 1948) (Daniel et al, 2019) (Edson, 2012) (Carmichael et al, 2019) (Alla et al, 2013) (Ellis et al, 2011) (Sweetman et al, 2018) (Aritua et al, 2009). This aspect was pervasive throughout the management system, and the CBPM approach utilizes various tools like management within set boundaries, smaller teams that continue through project stages without a need for handovers, the focus on self-organising behaviour etc to reinforce the team's accountability.

Adaptability is a foundational aspect of the CBPM approach. As seen from the literature (Vinekar et al, 2006) (Saynisch, 2010) (Böhle et al, 2015), traditional project management utilises control and command methods to ensure process adherence with the hope of eliminating changes to a baselined plan, and the team's ability to react to changes is restricted by strict change management and approval protocols. Using Complex Adaptive systems theory to design a project management approach where the agents learn from their successes and failures and adapt their actions towards a higher likelihood of a positive outcome going forward (Carmichael et al, 2019) (Alla et al, 2013) (Sweetman et al, 2018) (Aritua et al, 2009) (Jain et al, 2004), CBPM provides the team ability to adapt to changes , that are inevitable in complex projects, by not restricting the team to strict reporting and approval protocols, promoting cross-functional interaction and self-organising behaviour, and the use of continuous planning processes to react to changes. These management aspects are key enablers of adaptability and lead to better perceived project outcomes in the right contextual setting. Not only does this generate the ability to adapt to changes without bureaucratic processes slowing them down, but this also generates ownership and accountability within the project team as they feel that they have been given the freedom to solve problems without asking for permission, and they truly embrace their own autonomy, accountability and adaptability.

As can be seen from the above commentary, these three aspects of Autonomy, Accountability, and Adaptability are co-dependant and collectively support each other to contribute to the larger Change-Based Project Management approach. Making the team accountable for the project scoping, execution and closeout and giving them the autonomy to manage within set boundaries and self-organize without bureaucratic processes, gives them the ability adapt to changes and allows the project to behave like a Complex Adaptive System.

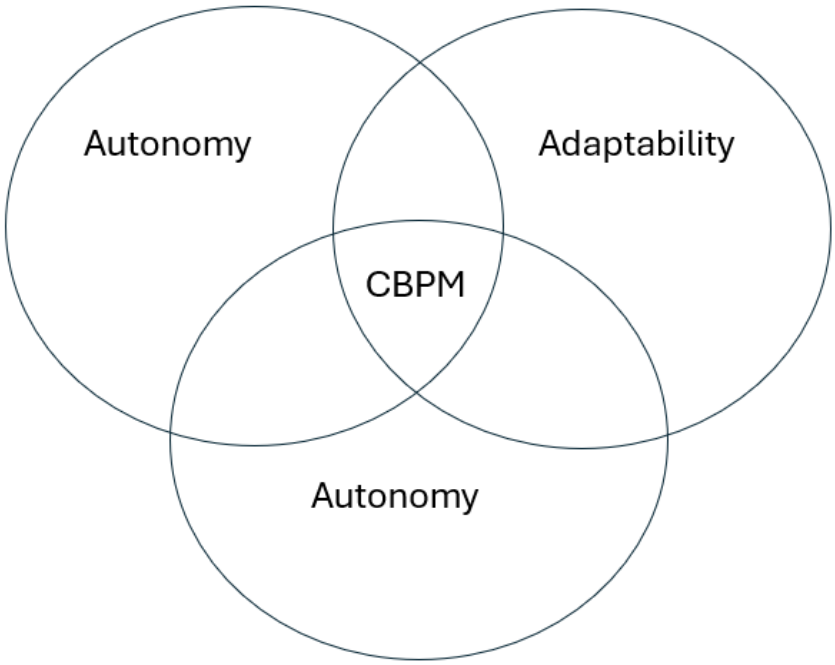


Fig.27 Triple A mechanism for CBPM implementation

Proposition P1: *The implementation of the 'Triple A' mechanism of Autonomy, Accountability and Adaptability co-dependently improves the performance of a complex/MRO project being managed using the CBPM approach.*

If studied individually, in complex/MRO projects being managed using the CBPM approach:

- **P1a:** *The higher the level of Autonomy, using management within set boundaries, the higher the ability of the project team to self-organize and deal with changes like a complex adaptive system*
- **P1b:** *The higher the level of end-to-end Accountability, higher the level of individual and system level ownership from the project team members*
- **P1c:** *The higher the ability of the project team to adapt to inevitable changes like a complex adaptive system, the higher the perceived success of the project*

9.2.2 Project plans as a retrospective diagnostic tool

One of the key insights from the case study was the use of project plans/schedules as a retrospective diagnostic tool, used to evaluate where the project is falling behind, and which scopes need more attention, resources or intervention. In traditional project management, a project plan is used to develop a baseline against which subsequent performance is evaluated and the impact of undesirable changes to the schedule is typically marked as variance against the baseline (sometimes even prompting a re-baseline where changes are extensive) (Kerzner,

2006) (PMBOK, 2017) (Vinekar et al, 2006). Therefore, in traditional project management, project plans are used as a design and predictive tool, with the approach designed to help the project perform as per the design and prediction. In CBPM, project baselines are not given importance during the project lifecycle, and there are no management requirements to report against a baseline or to seek formal approval for baseline amendments. Instead, management only requires reporting if the set boundary (typically overall project duration) is affected. The project manager is the keeper of the schedule, and periodic updates are made based on feedback from various team members. This process allowed the team to get the complete picture of the project timeline but also gave individual supervisors an opportunity to reflect on the status of their scopes and where they need to focus their attention. Thus, it was a backward-looking process that helped the team plan the next steps better.

Proposition P2: *In complex/MRO projects being managed using the CBPM approach, Project plans can better support project performance as a retrospective diagnostic tool rather than a prescriptive baselining tool.*

9.2.3 CBPM requires support from the organisation and not just the project team

The ability to expect and react to change is not something that a project team has in isolation from the larger organisation. As Nerur and Mangalaraj (2005) put it, Agile and traditional organisational setups have conflicting cultures, management styles, organisational forms, and reward systems. Organisational support is important for the success of any project management system (O'Reilly and Tushman, 2004) (Ouchi, 1977) (Tiwari et al, 2021), but it is especially critical for CBPM because the Triple A mechanism for CBPM success requires management support. The organisational setup for quick change management decisions without bureaucratic process or excessive documentation is a key enabler for the required ownership, adaptability and autonomy of the team. CBPM, when restricted to just how a project team should behave, cannot live up to its potential if the reporting structure and change-management protocols in the larger organisation are pedantic and restrictive. For instance, in a scenario where CBPM is only applied to a project team without adequate management support, management within a set boundary of cost and time could be envisioned to continue smoothly while the project team is working within the set boundaries, but the organization's more restrictive requirements might impede CBPM if the set boundaries are breached and the project team needs management approval or interjection. In that scenario, excessive documentation requirement or slow approval processes might negatively impact the autonomy, adaptability and accountability of the project team.

Proposition P3: *The more embedded the CBPM approach is within the organisation, the better the perceived success of the approach.*

9.2.4 CBPM leads to success when applied in the right contextual setting

As was indicated by the interviewees and as shown in the studied organisation's project management performance data, the project management approach used in the organisation is

perceived to have been a success using the organisation's desired success criteria of cost and time. Aspects of quality or customer satisfaction were inherently built into those criteria because the customer acceptance process for drilling rigs intake required that the asset meet the customer and regulatory requirements for quality before the project is deemed complete, and inadequate quality or customer satisfaction would lead to timeline or cost overruns. It was also clear from the data that the organisation did not base its management approach on Agile or other modern change-based methods, and it was intuitively developed by leaders to avoid pitfalls they experienced from the use of traditional methods in the same industry. The context of application was clearly aligned with the contextual setting that CBPM is theoretically founded it. Therefore, it can be observed that within this organisation and industry's contextual setting, CBPM approach was perceived to be successful. This proposition of success is something that could be validated by carrying out a controlled experiment against similar projects where CBPM was not in use and is a further research recommendation discussed later in this chapter.

Proposition P4: *The more suitable the contextual setting for CBPM application, the better the success of the approach.*

9.3 Contributions from this research effort

1. Change-Based Project Management approach

This research effort creates a new approach of Change-Based Project Management, which is potentially a major innovation, offering a new approach for MRO projects and beyond. The approach adapts methods that are assumed to be inappropriate for MRO projects, demonstrating through empirical evidence that they can and are applied. It builds a theoretical foundation derived from Complex Adaptive Systems (CAS) theory to offer a credible and applicable approach to conceptualise, understand and manage complex projects.

2. Conceptual Framework

This research effort constructs and validates a framework for the Change-Based Project Management approach, derived from literature, and validated and improved through empirical evidence.

3. Triple-A mechanism

A theoretical explanation for how CBPM can work and why it can offer effective results is established by reflecting on empirical results in relation to theoretical literature. Accountability is key as it enables projects to behave like CAS by allowing Autonomy in project teams, within set boundaries. Allowing the project to be Adaptive represents a major departure from traditional, plan-driven management. The research offers theoretical reasoning and a starting point for convincing managers to apply such practices and adopt the CBPM approach.

9.4 Limitations and future research recommendations

9.4.1 Generalizability of results

This research effort explored the use of CBPM in managing MRO projects. The attempt throughout the research process was to approach the project management approach at a first principles level and not make it overly specific to the upstream oil and gas drilling rig MRO projects that were studied, or to the drilling contractor organisation which was being studied as a case study. However, MRO projects across industries can vary greatly in their scope and context, and applicability of the methods, recommendations and practices discussed in this research effort might not be consistent across industries.

The conceptual framework that was developed through this research effort is largely industry agnostic, and as long as an organisation is facing similar challenges in their project types, the conceptual framework should provide useful guidance on how a management system could be setup to allow the projects to behave like complex adaptive systems. The drilling rig organisation and projects studied in this research serve as illustrative examples of how this conceptual framework could like in practice, and in which aspects of project management a hybrid approach might be considered by practitioners. Therefore, while the generalizability of the specific results from the case study might not be across industries, the conceptual framework and its implementation methodology could help guide practitioners towards the implementation of Change-Based Project Management in MRO projects across industries.

The case study evaluation and subsequent recommendations have been made with the intent to have cross-industry applicability in MRO projects. However, each industry has its own idiosyncrasies, and even within an industry, different businesses in the value chain can have very different project management situations, requirements and contexts. A further research recommendation would be to study the application of the conceptual framework across different industries and better understand how CBPM can be used for MRO project management regardless of industrial context. These studies could also help researchers and practitioners isolate which are principal recommendations spanning industries, and which are industry-sensitive working methodologies that may not translate well into a different context.

Propositions made in Section 9.2, combined with these generalizability challenges, open the door for further study for validating those propositions in different project contexts. This could help in validating and/or improving the propositions.

9.4.2 Cross-Case analysis

Due to the complexity of the studied MRO projects, emergent scopes and challenges, and autonomy given to the project teams to deal with the changes, cross-case analysis was limited to the scope of work comparisons and analysis done in Chapter 6. If, indeed, available case projects were very similar in scope, context and challenges, cross-case analysis could have yielded more insights into the project management approach as well. However, CBPM relies on flexible management style (as endorsed by the Triple A mechanism), and having perfectly

comparable management style across several projects for cross case analysis might be considered anti-thetical to the CBPM approach. Practically, cross-case analysis within the organisational case study might have to be limited to understanding how scopes were managed in totality and how the projects did against perceived and quantitative metrics, both of which are addressed in Chapter 5.

Future work could test comparative performance, but this would be very difficult to set up because of the complexity of the projects in question. If researchers could set up an experiment to compare two identical projects where the only variable that is altered is the approach to planning and management, we would learn a lot. Realistically, this is not possible because the teams would have their preferences and experiences, the projects would not be identical due to the complexity of scopes, customer requirements and other internal and external factors and changing conditions, and the high value of the projects would make experimentation very difficult to justify. Research funded by customers or research bodies might make this possible and should be considered in future.

Further research might also involve interviews with project teams in different sectors, e.g. to compare CBPM with agile software development and explore to what extent the 'Triple A' factors have the same importance.

9.4.3 The researcher's role within the organisation

As discussed in the Methodology chapter, the researcher is in a leadership role in the company, and therefore his position of power within the organisation needed to be managed within the research context. While there is literature showing the advantages of ethnographic research where the researcher is intimately familiar with the research setting, especially in terms of access, cultural understanding and time-management, the studied organisation being his place of work also increased the risk of him having pre-formed or biased opinions about the organisation's culture, rules or settings. There was also the risk of personal professional pride colouring his attempts at having a neutral position towards the research question, since the successful yet unique project management setup of the organisation is something that the organisation, the researcher included, take pride in.

These limitations, although valid, were mitigated along two lines – managing the effect of the researcher's organisational role on the participants, and managing his own biases, professional pride, and intuitions. The former was done by clearly explaining to the participants that the research is a personal academic endeavour aimed at improvement of project management practices within the industry, and therefore the participants' participation in the research effort has no direct or indirect effect on their employment within the organisation, their work relationship with me, or with others in the organisation. The researcher communicated clearly that this is a process improvement project and their participation in co-creating the improvements will be sought as part of the ethnographic participant-observation methodology. This was validated when participants' feedback to the questions in the interviews were candid, and they were not hesitant to critique the organisational setup and identify the pros and cons of the approach. They seemed to be enjoying the opportunity to think deeply

about their own approach to things at work and introspect on what works and what doesn't quite deliver the outcomes they are looking for. They freely reminisced about previous jobs and past experiences, and the researcher left the interviews quite comfortable with the belief that my organisational role did not affect the interview feedback.

Managing the researcher's own pre-conceived notions was arguably more difficult but fuelled by the desire to academically validate the project management system being studied, and the hope to build a project management foundation from which future research and practice could benefit. The research effort was undertaken to help improve the project management practices in the researcher's current organisation as well as the larger industry, so that the financial viability of the industry can be sustained despite the cyclicality of the underlying hydrocarbon commodity. Making a biased research effort that does not truly reflect the pros and cons of the management system does not aid in that task and defeats the very purpose of the effort. Through the process of the research effort, the researcher has gained a deeper understanding of the organisation's management system, have received positive and negative feedback on various aspects of it, made observations that were contrary to his organisational viewpoint, and built recommendations into this discussion that are not currently in play at the organisation, thereby, hopefully, mitigating any bias towards the organisation's management system and his role in it.

Further research should seek to repeat the results in other contexts or enable other people to confirm and elaborate findings. This is more likely to happen once more organisations adopt the CBPM approach in MRO and other contexts.

9.4.4 Perceived Success

As discussed in the Chapter 2, there is no industry body that compiles and publishes comparative project management performance within the industry, and the case study organisation's success in project management is based on the performance numbers (against cost and time) of completed projects, and the subsequent financial performance of the company that has been largely better than the peer group which has faced debt and liquidity challenges in the past decade. In the absence of an absolute quantitative comparison, the success of the organisation's project management system, and therefore the observed empirical evidence supporting Change-Based Project Management, could be deemed as perceived success. Testing of this perception could be carried out by doing a controlled experiment across similar projects where CBPM is not in use but was outside the scope of this research effort and might not be fully feasible considering the variability of scope and emergent challenges in each project in the MRO space.

A lot has been written about the benefits of agile, and further research could look at the perceived success of organisations and project teams across different project management approaches. This could be done from the perspective of the organization managing the project, where the teams are questioned on their views on the differences between approaches, and/or from the perspective of the client/customer.

Specific to the perceived success of CBPM, for the case study organization there is reason to believe that CBPM improves performance, but in future research CBPM could be applied more widely to test its effectiveness across contexts. Given the opportunity, the author will seek to implement this approach more formally in the organisation and share the approach in the industry to encourage adoption elsewhere.

9.4.5 Complexity Theory

This research effort's contribution towards the use of complexity theory in envisioning the management of MRO projects will hopefully encourage academicians and practitioners to challenge and evolve the traditional methods in other industries and types of projects. Due to the qualitative nature of the project management world, each of these might require a different form of study due to the specific circumstances of their industry's situation, but by challenging the barriers between traditional and modern methods and using complexity theory as the link that joins them, there is hope that this effort spurs future research going beyond the specifics of the current effort.

9.4.6 MRO projects

As was evident from the Systematic Literature Review, MRO and maintenance type projects have not received much academic attention. This is a significant research opportunity, the benefits from which could be reaped by organisations and industries around the world, not only for the benefit of those carrying out MRO projects, but also for those who could learn from MRO projects and apply them in different contexts.

9.4.7 The role of project plans

The innovative use of project schedules as retrospective diagnostic tools shows the potential for further research and study. A schedule is innately attractive to all project management professionals and management teams because it helps provide a snapshot of the project timeline and the interaction between the scopes. However, what that information is used for, how frequently it is updated, why it is updated, the process for making the changes, and what the benefits of making these changes are, are aspects that should be studied further across industries and project management styles. As is evident from this research effort, the traditional treatment of project schedules is not the only way to use them, and once the door to alternative methods of using them is opened, researchers and practitioners could benefit greatly from studying, understanding, and applying them.

9.4.8 Hybrid project management methods

While this research effort focussed on the application of Change-Based Project Management in MRO projects, one of the findings from the data was that there is a scope for hybrid project management styles even in an organisation that espouses change-based project management as a philosophy. This hybrid methodology was visible as a balance between regimented and flexible project management styles in how scopes were managed, how documentation was done, how reporting was done, what the role of the project manager was, and how costs were managed.

In research and in practice, it is important to know the pros and cons of an approach being considered, but there is also value in evaluating if hybrid methods encompassing various approaches are more fit for purpose for a particular application. Tying yourself to a singular approach might make it easier to communicate the methodology, but researchers and practitioners should be encouraged to think outside the box and not restrict themselves to single methodological paradigms.

Hopefully, this research effort will spark further research in change-based project management methods not only in MRO projects, but for other industrial applications outside of software development. It is also the researcher's hope that once this has been researched, the same amount of thought will be put into studying the potential of using hybrid methods and getting the 'best of both worlds'.

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Appendix 1

Case Study Projects: Observations

The below are the key notes from the observations carried out during the 2 case study projects.

Project study 1 – Reactivation Project

Observation Code: C1_1

Location: Shipyard, meeting room on quay side next to the rig.

Observation type: Morning meeting.

Attendees: PM1, CS2, ES1, RM2, Rig crew, Shipyard supervisors, HSE team.

Notes:

- Project Manager leading the meeting agenda and keeping it moving.
- Lots of self-organising.
- A bit of retrospection, but mainly forward looking.
- A lot of issues sorted there and then…only 2 items to be taken offline.
- Clashes were addressed for Permit To Work system.
- Rig company telling the shipyard what equipment and labour will be coming to the rig that day, and vice-versa.
- Several changes discussed with 3 main resolution styles:
    - Technically easy fix – decision taken there and then to proceed. Commercials strictly not discussed (PM1 and Shipyard PM agreed to discuss those offline).
    - Requiring site survey – arranged for immediately after the meeting.
    - Needs further thought if the scope is required (PM1 to discuss later with his team and management).

Demeanour/Mood: Very collaborative meeting – no one shutting others down, no raising of voices or loud disagreements.

Observation Code: C1_2

Location: On board the rig.

Observation type: Site walkaround to discuss lighting scope of work.

Attendees: CS2, ES1, Shipyard Project Manager, Shipyard Electrical supervisor, Shipyard commercial estimator

Notes:

- Walk around the rig to identify lighting scopes of work for remedial as well as upgrades for contractual requirements.
- Mechanical Superintendent was not part of the walkaround. At one location his feedback and alignment were required to agree on the lighting plan. ES1 called him immediately on the phone to reach an agreement and conclude the discussion.

- Part of this scope was in the initial project plan, but several locations were site-specific and changes to the original plan. Many required steelwork, scaffolding, removal of other equipment in the way etc. As the group moved from one location to the next, verbal instructions were given by the project team, with responsibility on the shipyard to write up the full scope for final agreement.
- The shipyard team's plan was to write down the details of this scope, and then give these details to the other department heads and Shipyard Project Manager, who will give manpower and material estimate to the commercial lead to finalize the quote.
- Once the quote is finalized, the Shipyard project manager and PM1 will negotiate and finalize the variation order. Depending on the commercial value, PM1 might need upper management approval before proceeding.

Demeanour/Mood: Collaborative meeting focussed on finalizing lighting locations, and agreeing on the scope of work at each location.

Observation Code: C1_3

Location: Shipyard, meeting room on quay side next to the rig.

Observation type: Morning meeting.

Attendees: PM1, CS2, ES1, RM2, Rig crew, Shipyard supervisors, HSE team.

Notes:

- Project Manager leading the meeting agenda and keeping it moving.
- Most of the meeting specific to special crane lift planned for the day. Close collaboration would be required between multiple departments, including vessel movements with the port authority. After discussing the high-level plan, it was agreed that before the job commences, a pre-job meeting would be held where communication plan (radios and PICs) would be finalized.
- Lots of self-organising – most scope discussions left for the team to resolve amongst themselves.
- A bit of retrospection, but mainly forward looking.
- Discussion on an industry safety incident and lessons learnt.
- Clashes were addressed for Permit To Work system.
- Rig company telling the shipyard what equipment and labour will be coming to the rig that day, and vice-versa.

Demeanour/Mood: Very collaborative meeting – no one shutting others down, no raising of voices or loud disagreements.

Observation Code: C1_4

Location: Project Manager's office.

Observation type: Schedule review meeting.

Attendees: PM1, CS2, ES1, Mechanical Supdt, Buyer, Logistics coordinator.

Notes:

- PM acting as keeper of the schedule and updated it on his computer as the discussion progressed.
- The WBS is used to sequence the discussion. Each PIC provide inputs on status/progress/delays/challenges for each scope relevant to him. Others chime in for clashes and interactions with their scopes, where necessary.
- The schedule is being used more like a look-back and retrospective tool. Most linkages etc not properly done on schedule, and the forward plan being agreed based on how things have gone previously, which scopes are lagging or leading, and which new scopes have been added.
- Several key action items came out of the review, which PICs noted as follow-up actions for them. Actions were based on re-prioritizing of scopes, which was due to:
    - New scopes have come in which interfere with incumbent scopes.
    - Scopes running behind due to material or manpower issues.
    - Scopes brought forward to clear an area earlier for a scope where parts would get delivered only later.
    - Final commissioning, endurance testing and acceptance timeline not touched – all attempts to reconfigure the work plan to still meet the overall timeline.
- 1 additional resource requirement (rope access) identified with enough work queue to mobilize the resource without incurring down time.
- Identified 2 things to be brought to the attention of VP-Projects as potential critical path items that might higher management discussion with vendors.
- This meeting is held on a fortnightly basis.

Demeanour/Mood: Action oriented meeting with a brainstorming atmosphere where the team was trying to solve for a lot of moving parts while still maintaining overall timeline compliance.

Observation Code: C1_5

Location: Shipyard, meeting room on quay side next to the rig; followed up PM1's office

Observation type: Morning meeting, with a follow-up in the afternoon.

Attendees: CS2, ES1, RM2, Rig crew, Shipyard supervisors, HSE team.

Notes:

- PM1 was away, so ES1 was leading the meeting. The format didn't really get affected by this change, which clarifies how PM1 is mainly a facilitator for these interactions.

- The rest of the team responded the same way to ES1's guidance and instructions as with PM1.
- Lots of self-organising – most scope discussions left for the team to resolve amongst themselves.
- A bit of retrospection, but mainly forward looking.
- Clashes were addressed for Permit To Work system.
- Rig company telling the shipyard what equipment and labour will be coming to the rig that day, and vice-versa.
- Later in the day, PM1 came in and had a quick chat with ES1 about the morning meeting and got briefed on key discussion items and action points/plans.

Demeanour/Mood: Very collaborative meeting – no one shutting others down, no raising of voices or loud disagreements. Very smooth handover of responsibilities and information between PM1 and ES1.

Observation Code: C1_6

Location: Project Manager's office

Observation type: Project cost discussion

Attendees: PM1, VP-Projects

Notes:

- PM1 solely managing the commercial tracker for the project. He works with the project accountant on the same. No one else in the project team is intimately involved with the cost tracking.
- Does not seek any details from superintendents on the costing. Committed costs are obtained from Purchase Orders, Shipyard statement of accounts, and fixed price contracts. Forecast-to-complete costs are obtained from quotes, and experience-based estimates for future scopes.
- The WBS is again used to structure this discussion, as the tracker is organised accordingly. There was constant change management while working through it – give and take between scopes to manage the bottom-line costs. Nice to have scopes were added/subtracted based on spend patterns, and alternative vendor plans made accordingly.
- The cost tracker is an excel-sheet based document that has up to date information on all commitments and outstanding forecasts, organised by the WBS. It could be argued that this should be an online system linked to the company's financial reporting system, but the project managers and company leadership team are happy with this fit-for-purpose process that provides them all the information they need for project tracking and reporting.
- The sheet has a summary tab that is finalized every month between the project accountant and project manager, and then shared with the VP-Projects for approval. Once approved, the numbers are shared with the larger finance group and reported to the Board during the monthly management reporting (Projects is an important part of the Board reports at the company).

Demeanour/Mood: The meeting was done in a brainstorming pattern, where problems and opportunities were assessed and solutions for both were discussed for possible implementation. Some difficult decisions were also discussed, and agreements reached on how to move forward.

Observation Code: C1_7

Location: Shipyard, meeting room on quay side next to the rig.

Observation type: Morning meeting.

Attendees: PM1, CS2, ES1, RM2, Rig crew, Shipyard supervisors, HSE team.

Notes:

- Project Manager leading the meeting agenda and keeping it moving.
- Lots of self-organising.
- A bit of retrospection, but mainly forward looking.
- Shift of focus to execution/delays as compared to more of inspections/ID in the earlier meetings. This was because the project was at a much more advanced stage than the previous observation meetings.
- More change-management discussions than previous meetings. Commercial and technical plans were made during the meeting (cost numbers were not discussed but agreements made based on previously submitted quotes or contractual unit rates). A few things decided to be taken 'offline' due to commercials in the way of technical execution. However, on the ground the work continued due to the ballpark levels being correct and due to unit rate agreement in place as a backup.
- Clashes were addressed for Permit To Work system.
- Rig company telling the shipyard what equipment and labour will be coming to the rig that day, and vice-versa.

Demeanour/Mood: Very collaborative meeting – no one shutting others down, no raising of voices or loud disagreements.

Observation Code: C1_8

Location: On the rig, at the drill floor (the area where the drilling takes place).

Observation type: Special scope-specific meeting.

Attendees: PM1, CS2, ES1, RM2, Rig crew, HSE team.

Notes:

- The meeting was held due to major change in schedule due to vendor delays on the engineering front of the rig floor upgrades to the Top Drive, Pipe handling system and the cyber control system. The entire discussion was a change management discussion.

- Project Manager PM1 opened the meeting by giving an update to the team on the delay in the scope delivery from the vendor, the overall timeline, and that this change needs to be managed as a team, so the final schedule commitments are still met.
- The timeline was discussed and effect of these delays on other activities was reviewed, with all personnel chipping in with thoughts and views.
- Several activity timelines were changed to accommodate the rig floor activities at the end. The team started self-organising specific tasks around each other's requirements.
- Project schedule was not updated at the time, but the team committed to reverting with individual scope timelines for the next schedule update meeting.
- Leadership engaged to escalate within vendor organisation the few key outstanding vendor deliverables.

Demeanour/Mood: Troubleshooting meeting, but people came with a problem-solving mindset and engaged actively in the problem statement and potential solutions.

Observation Code: C1_9

Location: Project Manager's office.

Observation type: Schedule review meeting in the aftermath of C1_8 meeting.

Attendees: PM1, CS2, ES1, Mechanical Supdt, Buyer, Logistics coordinator.

Notes:

- PM acting as keeper of the schedule and updated it on his computer as the discussion progressed.
- Focus of this meeting was on resolving clashes and ensuring enough time for key activities in light of the rig floor scope delays.
- The WBS is used to sequence the discussion. Each PIC provide inputs on status/progress/delays/challenges for each scope relevant to him. Others chime in for clashes and interactions with their scopes, where necessary.
- Several key action items came out of the review, which PICs noted as follow-up actions for them.
- The revised schedule was still in line with the overall timeline after making individual scope adjustments.

Demeanour/Mood: Action oriented meeting with a brainstorming atmosphere where the team was trying to solve for a lot of moving parts while still maintaining overall timeline compliance.

Observation Code: C1_10

Location: Rig meeting room

Observation type: Customer acceptance punchlist meeting.

Attendees: PM1, CS2, ES1, RM2, Mechanical Supdt, Buyer, Rig crew

Notes:

- On the Project study 1 project, the customer acceptance team visited the rig briefly and gave a deficiency punch-list to the team before leaving. The final acceptance and verification of the punch-list closure would only be done when the rig was mobilized to Saudi Arabia.
- The meeting was called to discuss the customer acceptance deficiency punch-list after the initial visit by inspectors.
- Project manager PM1 and rig manager RM2 assigned PICs to each punch along with action items and timelines for completion.
- All team members noted down their individual action items. Self-organising from there on for the actual closeout of tasks and coordination amongst themselves.
- Some punch-list items were not clear and were given to the rig manager so he could call the inspectors and request clarification.
- Some punches did not have a clear metric for closure, which caused some confusion within the group.
- Action items were mainly around procurement, shipyard corrective work, engineering, procedures, training, and incomplete scopes.
- It was agreed that this meeting would be held every 3 days where the status of the punch-list closures would be updated, and target closure dates revised (if any changes).
- Accordingly, Rm2 planned to send the updated punch-list to the customer once a week so they are aware of the progress made.

Demeanour/Mood: Action oriented meeting with a brainstorming atmosphere where the team was trying to solve for the punch-list while still maintaining overall timeline compliance.

Observation Code: C2_1

Location: Shipyard meeting room

Observation type: Project kick-off meeting (before rig arrival)

Attendees: PM2, ES2, MS2, Buyer, Logistics supervisor.

Notes:

- Project Manager leading the meeting agenda and keeping it moving.
- PM2 discussing the plans for the project and going through the entire WBS with the team.
- As each scope item is discussed, each PIC chimes in with the status of their readiness, and requirements, concerns, and action items. Others voice any conflicts and bring up any cross-scope interactions.
- The project manager played the role of facilitator, helping the PIC group reach agreement and create specific achievable action items.

Demeanour/Mood: Very collaborative meeting – no one shutting others down, no raising of voices or loud disagreements.

Observation Code: C2_2

Location: Project Manager's office

Observation type: Project cost discussion

Attendees: PM2, VP-Projects

Notes:

- PM2 solely managing the commercial tracker for the project. He works with the project accountant on the same. No one else in the project team is intimately involved with the cost tracking.
- Does not seek any details from superintendents on the costing. Committed costs are obtained from Purchase Orders, Shipyard statement of accounts, and fixed price contracts. Forecast-to-complete costs are obtained from quotes, and experience-based estimates for future scopes.
- The WBS is used to structure this discussion, as the tracker is organised accordingly. There was constant change management while working through it – give and take between scopes to manage the bottom-line costs. Nice to have scopes were added/subtracted based on spend patterns, and alternative vendor plans made accordingly.
- The cost tracker is an excel-sheet based document that has up to date information on all commitments and outstanding forecasts, organised by the WBS. It could be argued that this should be an online system linked to the company's financial reporting system, but the project managers and company leadership team are happy with this fit-for-purpose process that provides them all the information they need for project tracking and reporting.
- The sheet has a summary tab that is finalized every month between the project accountant and project manager, and then shared with the VP-Projects for approval. Once approved, the numbers are shared with the larger finance group and reported to the Board during the monthly management reporting (Projects is an important part of the Board reports at the company).

Demeanour/Mood: The meeting was done in a brainstorming pattern, where problems and opportunities were assessed and solutions for both were discussed for possible implementation.

Observation Code: C2_3

Location: Project Manager's office

Observation type: Tuesday retrospective meeting

Attendees: PM2, ES2, MS2, Buyer, Logistics supervisor.

Notes:

- The Project Manager made some introductory comments and recapped his view of how things were going (some good, some not so good).
- The discussion was done one PIC after the other, with each recapping what was done well, what was not achieved, what was ongoing, and what is to be focussed on in the next week. They also brought up clashes, interaction with other scopes, and coordination issues with the shipyard or the rig team.
- Issues were discussed whenever brought up and a clear agreement reached between the team on the action items emerging from that. PM2 played the role of facilitator in this discussion. Several plans were changed/modified as a result of this exercise.
- A quick review of the WBS was done after everyone had spoken, to ensure there are no scopes that have fallen through the cracks. No issues were found on the execution side, but 2 procurement items status was not known and became an action item for the buyer.
- PM2 summarized key focus areas at the end. There was a good discussion around them and some changes made to individual plans due to that.

Demeanour/Mood: Very collaborative meeting – no one shutting others down, no raising of voices or loud disagreements.

Observation Code: C2_4

Location: Shipyard, meeting room on quay side next to the rig.

Observation type: Morning meeting.

Attendees: ES2, MS2, Rig crew, Shipyard supervisors, HSE team.

Notes:

- Project Manager not present in this meeting.
- The rig OIM (Offshore Installation Manager) lead the meeting and kept it on track.
- Discussed work done during the night shift and work plan for the day. A bit of retrospection, but mainly forward looking.
- Changes were highlighted and a couple of potential clashes averted via open discussion. Lots of self-organising as team members agreed between themselves to coordinate and/or resolve things during the day.
- Agreement was reached where the project team and shipyard needed rig assistance, and vice versa.
- Permit to Work and Energy Isolation were discussed, and a plan agreed for the day.

Demeanour/Mood: Very collaborative meeting – no one shutting others down, no raising of voices or loud disagreements.

Observation Code: C2_5

Location: Rig meeting room

Observation type: Customer acceptance punchlist meeting.

Attendees: PM2, ES2, MS1, Rig Manager, Rig crew, Customer's acceptance inspectors.

Notes:

- On the Project study 2 project, the customer acceptance team stayed on board for a prolonged period of time to go through the entire acceptance process while the rig was in the shipyard.
- The meeting was called to discuss the customer acceptance deficiency punch-list together with the customer's acceptance team.
- Project manager and rig manager assigned PICs to each punch along with action items and timelines for completion.
- All team members noted down their individual action items. Self-organising from there on for the actual closeout of tasks and coordination amongst themselves.
- Some punch-list items were not clear and were verified with the inspectors who gave straightforward answers.
- Some punches did not have a clear metric for closure, which was clarified satisfactorily with the inspectors.
- Action items were mainly around procurement, shipyard corrective work, engineering, procedures, training, and incomplete scopes.
- It was agreed that this meeting would be held every 3 days where the status of the punch-list closures would be updated, and target closure dates revised (if any changes).

Demeanour/Mood: Action oriented meeting with a brainstorming atmosphere where the team was trying to solve for the punch-list while still maintaining overall timeline compliance. Very helpful to have the actual inspectors on board and collaborating with the team.

Observation Code: C2_6

Location: Rig, out on deck

Observation type: Punch closure walkabout with inspectors and project team.

Attendees: ES2, MS1, Customer's acceptance lead inspector.

Notes:

- Walkaround to close out 6 punch items – these were items deemed closed by the project team, and the PICs were taking the lead inspector to each location so he could verify the closure and close the punch in the punch-list tracker.
- Good camaraderie and trust shown between the project team and the inspector. Discussions were technical and professional.
- Clear communication of work done, and work planned.

- 4 punches closed successfully, 1 submitted for minor rework (to be closed based on photographic evidence), and 1 escalated to management to review (sorted later)

Demeanour/Mood: It was obvious that there was a good working relationship between the project team and the inspector(s) courtesy of time spent together at the shipyard.

Observation Code: C2_7

Location: Rig meeting room

Observation type: Rig handover and closeout meeting.

Attendees: All project and rig supervisory team.

Notes:

- The project completion and handover meeting was setup the day before the rig was scheduled to depart from the shipyard on her voyage to India to commence the contract.
- The project manager summarized all completed scopes, using the WBS for discussion. The documentation package and closure presentation were handed over to the rig operations team.
- All open scopes were summarized with details of parts on order, status of work completed, and outstanding action items. The rig manager assigned these outstanding works to his PICs, so that these could be completed later in operations.
- Any project team deliverables outstanding were clarified, and the project manager committed to chasing them up till completion.
- Financial plan (whether the cost would hit the project budget or the rig operations budget) was discussed for all outstanding scopes.
- Remaining open items from the customer acceptance punch-list were discussed and the plan and timeline for closure agreed, with the rig team taking responsibility for taking care of them.
- The team shook hands and thanked each other for the mutual support.

Demeanour/Mood: Good mood with congratulatory discussions but also a clear focus on making sure the rig is ready to commence operations on arrival at the destination.

Appendix 2

Case Study Projects: Scope of Work Analysis

Project C1

		Type	Changes encountered?	Change Classification	Change connectivity	Change resolution
WBS 1	**Steel and Hull**					
1.01	Primary Steel Replacement	Shipyard	Yes	1	Y	2
1.02	Secondary steel	Shipyard	Yes	2	Y	2
1.03	High pressure piping	Shipyard	No			
1.04	Low Pressure piping	Shipyard	Yes	3	Y	2
1.04	ACCOMMODATION	Shipyard	No			
1.04	HELIDECK	Shipyard	No			
1.04	PAINTING	Shipyard	No			
WBS 2	**OEM Equipment**					
2.01	Mud Pumps	Overhaul	Yes	2	Y	2
2.02	Drawworks	Overhaul	Yes	4	Y	2
2.03	Elmagco Brake	Overhaul	Yes	4	Y	3
2.04	Top Drive	Upgrade	Yes	4	Y	3
2.05	Crown Block	Procurement/Install	No			
2.06	Travelling Block	Procurement/Install	No			
2.07	Rotary Table	Overhaul	Yes	2	Y	1
2.08	Deadline Anchor	Overhaul	No			
2.09	ST-120 Iron roughneck	Overhaul	Yes	4	Y	3
2.1	Bridge racker	Overhaul	Yes	4	Y	3
2.11	Overhauling Rig floor HPU	Overhaul	No			
2.12	ENGINES	Overhaul	No			
2.13	Generators (main and emergency)	Overhaul	No			
2.14	Upgrade E-gen	Upgrade	Yes	3	Y	2
2.15	Upgrade the emergency switchboard	Upgrade	Yes	3	Y	2
2.16	BOP winches & BOP Lifting Frame	Overhaul	No			
2.17	CRANES	Overhaul	Yes	3	Y	2
2.18	JACKING SYSTEM	Overhaul	Yes	1	Y	1
2.19	Skidding system	Overhaul	Yes	1	Y	1
2.2	Derrick	Inspection/Remedial	Yes	2	Y	1
2.21	Finger Board	Inspection/Remedial	No			
2.22	BOP	Procurement/Install	Yes	2	Y	1
2.23	Choke Manifold	Procurement/Install	Yes	2	Y	1
2.24	Diverter system	Overhaul	Yes	3	Y	3
2.25	KFDJ	Procurement	No			
2.26	Risers, crossovers and spools	Procurement/Install	No			
2.27	Hoses and piping	Procurement/Install	Yes	2	Y	2
2.28	Koomey system and lines	Procurement/Install	Yes	4	Y	4
2.29	Well Test manifold	Procurement/Install	No			
2.3	Poor boy degasser (MGS)	Procurement/Install	No			

2.31	Flare Booms fabrication and installation	Procurement/Install	Yes	2	Y	2
2.32	Safety Valves/ drill string Float valves purchasing	Procurement	No			
2.33	Tubular purchasing	Procurement	No			
2.34	Subs purchasing	Procurement	No			
2.35	Reamer purchasing	Procurement	No			
2.36	Lifeboats	Overhaul	Yes	2	Y	1
2.37	New FRC platform installation	Upgrade	No			
WBS 3	**Inspections and Certifications**					
3.01	Lifting Gear - inspection and remedial/purchase	Upgrade	Yes	3	Y	2
3.02	Casing stabbing Basket	Upgrade	Yes	2	Y	1
3.03	DROPS	Inspection/Remedial	Yes	3	Y	2
3.04	Transformers	Inspection/Remedial	No			
3.05	MCC deep cleaning and check bus Bar torquing	Inspection/Remedial	No			
3.06	PRVs and Gauges- inspection and remedial/purchase	Inspection/Remedial	Yes	1	Y	1
3.07	Firefighting inspection - annual	Inspection/Remedial	No			
3.08	Fire Detection System inspection.	Inspection/Remedial	No			
3.09	Gas Detection System inspection	Inspection/Remedial	No			
3.1	Visual Alarm	Inspection/Remedial	Yes	1	Y	1
3.11	Wet Chemical cylinder	Inspection/Remedial	No			
3.12	New NOVEC 1230 for LER room	Upgrade	No			
3.13	New Foam system for Shaker house	Upgrade	Yes	1	Y	1
3.14	Hydro test all the CO2 bottles	Inspection/Remedial	No			
3.15	New Fireman locker - procurement & installation	Upgrade	No			
3.16	Rescue equipment	Procurement	No			
3.17	spill kits	Procurement	No			
3.18	Escape Packs	Procurement	No			
3.19	Jacob Ladders	Procurement	No			
3.2	life jackets / life vests	Procurement	No			
3.21	Anti skid	Procurement/Install	No			
3.22	safety Gates	Procurement/Install	No			
3.23	Ring Buoys	Procurement	No			
3.24	scales	Procurement	No			
3.25	crash kits	Procurement	No			
3.26	Lad safe	Procurement/Install	Yes	1	Y	1
3.27	Medical	Procurement	No			
3.28	SPS UTG	Inspection/Remedial	No			
3.29	UWILD	Inspection/Remedial	Yes	1	Y	2
WBS 4	**System Integration and contractual upgrades**					
4.01	Shale shakers replacement	Upgrade	Yes	2	Y	2

4.02	De-Gasser	Upgrade	Yes	2	Y	2
4.03	Mud processing pumps	Upgrade	Yes	2	Y	2
4.04	Mixing System	Inspection/Remedial	Yes	2	Y	2
4.05	Compressed Air system	Upgrade	Yes	1	Y	2
4.06	Lighting	Upgrade	Yes	3	Y	2
4.07	Heat Exchanger	Inspection/Remedial	Yes	1	Y	2
4.08	Tuggers, winches, sheaves	Upgrade	Yes	1	Y	1
4.09	Handling tools	Procurement	No			
4.1	Overhauling PS-21	Overhaul	Yes	3	Y	3
4.11	Drilling CCTV	Upgrade	No			
4.12	Security CCTV	Upgrade	Yes	1	Y	2
4.13	HVAC system	Upgrade	No			
4.14	Current injection Test	Inspection/Remedial	No			
4.15	SCR health check	Inspection/Remedial	No			
4.16	Towing system	Upgrade	Yes	1	Y	2
4.17	Rig-sense Upgrade	Upgrade	Yes	4	Y	3
4.18	Trip Tank Upgrade	Upgrade	Yes	4	Y	2
4.19	Zero Discharge	Upgrade	No			
4.2	Overhaul all centrifugal pumps	Overhaul	No			
4.21	Drillers Control HMI System	Upgrade	Yes	4	Y	3
4.22	Vessel Management System	Inspection/Remedial	Yes	1	Y	2
4.23	PAGA	Inspection/Remedial	Yes	1	Y	1
4.24	PABX	Inspection/Remedial	No			
4.25	Entertainment System	Inspection/Remedial	No			
4.26	Server and VSAT	Inspection/Remedial	Yes	1	Y	1
4.27	UPS	Inspection/Remedial	No			
4.28	Raw water pumps	Inspection/Remedial	No			
4.29	Galley Equipment	Inspection/Remedial	No			
4.3	Talk Back System	Inspection/Remedial	Yes	2	Y	1
4.31	water Makers	Inspection/Remedial	Yes	2	Y	2
4.32	Loading Station	Inspection/Remedial	Yes	1	Y	2
4.33	Personal and Cargo Basket	Inspection/Remedial	No			
4.34	Sewage unit	Inspection/Remedial	No			
4.35	Cement unit	Shipyard	Yes	2	Y	2
4.36	Bug blowers	Procurement/Install	No			
4.37	Cyber-base upgrade	Upgrade	Yes	4	Y	3
4.38	Preload dump valves overhauling	Inspection/Remedial	Yes	2	Y	2
4.39	Cascade System	Upgrade	Yes	2	Y	2

Project C2

		Type	Pre-inspection possible?	Changes encountered?	Change Classification	Change connectivity	Change resolution
WBS 1	**Steel and Hull**						
1.01	Hull steel replacement	Shipyard	Yes	Yes	1	Y	2
1.02	High Pressure Piping	Shipyard	Yes	Yes	2	Y	2
1.03	Low Pressure Piping	Shipyard	Yes	Yes	2	Y	2
1.04	Helideck Painting & Netting Load test	Shipyard	Yes	No			
WBS 2	**OEM Equipment**						
2.01	Drawworks	Overhaul	No	Yes	4	Y	3
2.02	Mud Pumps	Overhaul	No	Yes	3	Y	2
2.03	Top Drive and swivel	Overhaul	No	Yes	2	Y	2
2.04	Crown Block	Overhaul	No	Yes	1	Y	2
2.05	Traveling Block and Hook	Overhaul	No	No	1		2
2.06	Rotary Table	Overhaul	No	No			
2.07	Deadline anchor	Overhaul	No	No			
2.08	Engines	Overhaul	Periodic	Yes	4	Y	4
2.09	Generators (main and emergency)	Overhaul	Periodic	No			
2.10.1	Cranes	Overhaul	No	Yes	3	Y	1
2.10.2	BOP Hoists	Overhaul	No	No			
2.11	Jacking and Skidding System	Overhaul	Yes	Yes	2	Y	2
2.12	Derrick and Stabbing Board	Overhaul	No	Yes	2	Y	1
2.13.1	13 5/8" BOP	Overhaul	Periodic	No			
2.13.2	21-1/4"BOP	Overhaul	Periodic	No			
2.13.3	BOP-29 1/2 Diverter	Overhaul	Periodic	No			
2.13.4	HCR Valves, Manual valves, Blocks etc	Overhaul	No	No			
2.13.5	Koomey system and lines	Overhaul	No	Yes	2	Y	2
2.13.6	Choke Manifold	Overhaul	Periodic	Yes	2	Y	1
2.13.7	Mud Gas Separator	Overhaul	No	No			
2.14	Lifesaving equipment	Overhaul	No	Yes	1	Y	2
2.15	DC Motors	Overhaul	No	Yes	2	Y	1
2.16	Elmagco Brake	Overhaul	Periodic	No			
2.17	Iron Roughneck (ST80)	Overhaul	No	Yes	2	Y	1
WBS 3	**Inspections and Certifications**						
3.01	Lifting Gear - inspection and remedial/purchase	Maintenance	No	Yes	1	Y	1
3.02	DROPS	Inspection/Remedial	No	Yes	2	Y	1
3.03	PRVs and Gauges- inspection and remedial/purchase	Maintenance	No	Yes	1	Y	1

3.04	SPS Machinery	Inspection/Remedial	No	No			
3.05	SPS Hull	Inspection/Remedial	Yes	Yes	1	Y	2
3.06	Firefighting inspection	Inspection/Remedial	No	No			
3.07	Current Injection testing	Inspection/Remedial	No	No			
3.08	Transformers and distribution system maintenance	Inspection/Remedial	No	No			
3.09	EX Survey and remedial	Maintenance	Yes	No			
3.1	Radio Survey, MODU, IOPP etc	Inspection/Remedial	No	No			
3.11	Dry Docking, Tugs and Warranty Surveyor etc	Inspection/Remedial	No	Yes	3	Y	2
WBS 4	**Systems Integrity**						
4.01	LP mud - valves, pumps, mud guns, agitators etc	Inspection/Remedial	Yes	Yes	1	Y	1
4.02	Standpipe and cement manifold	Inspection/Remedial	No	Yes	1	Y	1
4.03	Pressure Vessels	Inspection/Remedial	Yes	No			
4.04	Mud Processing (shakers, augers, desanders, desilters, degasser & mud cleaner etc)	Inspection/Remedial	Yes	No			
4.05	Compressed air system	Inspection/Remedial	Yes	No			
4.06	P-tanks	Inspection/Remedial	No	No			
4.07	F/O purifiers	Inspection/Remedial	Yes	No			
4.08	HVAC and Refrigeration	Inspection/Remedial	Yes	No			
4.09	Lighting	Inspection/Remedial	Yes	No			
4.1	Tuggers, winches, sheaves	Inspection/Remedial	Yes	No			
4.11	Drilling instrumentation system	Inspection/Remedial	Yes	No			
4.12	NDT - drilling tools, fishing tools etc	Inspection/Remedial	Yes	No			
4.13	Choke panel, standpipe gauges, sensors etc	Inspection/Remedial	Yes	No			
4.14	Hydraulic tongs	Inspection/Remedial	Yes	No			
4.15	Blowers, fans etc	Inspection/Remedial	Yes	No			
4.16	Heat Exchangers	Inspection/Remedial	Yes	No			
4.17	Fire and Gas detection system	Inspection/Remedial	Yes	No			
4.18	Radio and Communications equipment	Inspection/Remedial	Yes	No			
4.19	CCTV	Inspection/Remedial	Yes	No			
4.2	Galley and Laundry equipment	Inspection/Remedial	Yes	No			
4.21	HPUs	Inspection/Remedial	Yes	No			
4.22	PA, GA and Telephone	Inspection/Remedial	Yes	No			
4.23	Oily water separator	Inspection/Remedial	Yes	No			
4.24	Sewage treatment system	Inspection/Remedial	Yes	No			
4.25	Watermakers	Inspection/Remedial	Yes	No			
4.26	Water pumping and transfer systems	Inspection/Remedial	Yes	No			
4.27	Bilge and preload systems	Inspection/Remedial	Yes	Yes	1	Y	
4.28	Fog Horn, Navigation Light and Obstruction Light etc	Inspection/Remedial	Yes	No			
4.29	Anchor Winch and Moorning System	Inspection/Remedial	Yes	No			

4.3	Drill line	Inspection/Remedial	Periodic	No			
4.31	Doghouse	Inspection/Remedial	Yes	No			
WBS 5	**Contractual Upgrades**						
5.01	Jetting System	Shipyard	NA	NA			
5.02	Cellar deck & Texas Deck	Inspection/Remedial	No	Yes	1	Y	2
5.03	Minimum 768 Kpbs bandwidth for ONGC	Procurement	NA	NA			
5.04	Mud Pump Liners	Procurement	NA	NA			
5.05	Mud Mixing System	Inspection/Remedial	Yes	No			
5.06	Mud Processing Equipment	Upgrade	NA	NA			
5.07	Facilities for handling SOBM	Upgrade	NA	NA			
5.08	Brine Filtration Unit	Procurement	NA	NA			
5.09	Tubular: DP, HWDP, DC and Pup Joints	Procurement	NA	NA			
5.1	Pipe for cleaning 20" x 30" Annulus	Procurement	NA	NA			
5.11	Tubular Handling Tools: Tongs, Elevators, Slips, Lifting Subs etc	Procurement	NA	NA			
5.12	Pipe Spinner	Procurement	NA	NA			
5.13	Tubing Handling Tools: Tongs, Elevators, Slips, Lifting Subs etc	Procurement	NA	NA			
5.14	Casing Handling Tools: Tongs, Elevators, Slips, Lifting Subs etc	Procurement	NA	NA			
5.15	Casing Bushing	Procurement	NA	NA			
5.16	Pile Hammer	Procurement	NA	NA			
5.17	BOP 21-1/4" x 2,000 psi stack: one Annular & Double	Procurement	NA	NA			
5.18	BOP 13-5/8" x 10,000 psi stack: one Annular , one single and one Double	Procurement	NA	NA			
5.19	Diverter System	Procurement	NA	NA			
5.2	Cross Overs & Spacer spools/DSAF	Procurement	NA	NA			
5.21	Ram Blocks (for both 21.1/4" & 13.5/8" BOPs)	Procurement	NA	NA			
5.22	Test Stumps: 29-1/2", 21 -1/4" & 13-5/8"	Procurement	NA	NA			
5.23	Fishing Tools including Taper Mills, 7" Shooting Nipple, Multi-String Cutter, Bit Breakers & Big Gauges	Procurement	NA	NA			
5.24	Communication Equipment	Procurement	NA	NA			
5.25	Drilling Instrumentation System	Overhaul	NA	NA			
5.26	CCTV/camera	Upgrade	NA	NA			
5.27	Auto Driller	Upgrade	NA	NA			
5.28	Coring Tools	Procurement	NA	NA			
5.29	Helipad: In compliance with latest DGCA Rules/Guidelnes including the peripheral lights. TD/PM & H lights.	Upgrade	NA	NA			
5.3	Compliance of Different Regulatory - Appendix 2(g) G	Upgrade	Na	Na			
5.31	Inside BOP and FOSV:	Procurement	NA	NA			
5.32	Drift Indicator (Totco 0-16 degree) with baffles plates and complete with wire line retrieving tool	Procurement	NA	NA			
5.33	Wiper for 2-7/8", 3-1/2" & 4-1/2" tubing	Procurement	NA	NA			

5.34	Hole Opener (for soft formation) with detachable Bull Nose of suitable length and compatible threaded connection 1 eac 23" & 1 ea 26"	Procurement	NA	NA			
5.35	Casing Rotating Scraper : New Purchase	Procurement	NA	NA			
5.36	Spiral Blade Stabilitizers for Hole Sizes	Procurement	NA	NA			
5.37	Cementing Unit	Upgrade	NA	NA			
5.38	Batch Mixer	Upgrade	NA	NA			
5.39	Well Testing: Burner Booms Recertification	Overhaul	NA	NA			
5.4	King Post and Swivel plate	Upgrade	NA	NA			
5.41	Deck Compressor	Upgrade	NA	NA			

Appendix 3

Interview Questionnaire

Corporate

1) *Introduction*
    - *Introduction on the project.*
    - *Consent for audio recording.*
    - *Ask them to ignore my role in the organisation and view this as a research effort.*
    - *Observations:*
        - *Appearance of the interviewee.*
        - *How keen he/she was.*
        - *Other things that might not translate in audio recording.*

2) *Industry Experience*
    - *How did you start your career.*
    - *What makes the drilling business unique in your eyes.*
    - *How has your experience in the industry been.*
    - *Other industries you have worked in.*

3) *Project management experience (outside of Shelf Drilling)*
    - *What role do projects play in business.*
    - *How do you define project management in MRO.*
    - *Describe a typical project for me.*
    - *How has your experience been, with respect to MRO Project Management in Upstream Oil & Gas.*
    - *What do you think are key challenges.*
    - *What do you think are key strengths.*
    - *Have you heard of Agile or other change driven Project Management methods.*
    - *Have you heard of PMBOK and Traditional Project Management methods.*
    - *Industry level view of projects - how has the industry done, what is the perception of success/failure, and the interviewee's first-hand experience with that.*

4) *Studied Organisation*
    - *How has your experience been with the Studied Organisation's projects*
    - *What makes project management in the Studied Organisation different, if at all?*
    - *What are the pros and cons?*
    - *What would you like to see improving?*
    - *What are things we do too little of?*
    - *What are things we do too much of?*
    - *How does customer engagement work at the project level? Examples?*

Project Teams

2) *Introduction*
    - *Introduction on the project.*
    - *Consent for audio recording.*
    - *Ask them to ignore my role in the organisation and view this as a research effort.*

- *Observations:*
    - *Appearance of the interviewee.*
    - *How keen he/she was.*
    - *Other things that might not translate in audio recording.*

3) *Industry Experience*
    - *How did you start your career.*
    - *What makes the drilling business unique in your eyes.*
    - *How has your experience in the industry been.*
    - *Other industries you have worked in.*

4) *Project management experience (outside of Shelf Drilling)*
    - *What role do projects play in business.*
    - *How do you define project management in MRO.*
    - *Describe a typical project for me.*
    - *How has your experience been, with respect to MRO Project Management in Upstream Oil & Gas.*
    - *What do you think are key challenges.*
    - *What do you think are key strengths.*
    - *Have you heard of Agile or other change driven Project Management methods.*
    - *Have you heard of PMBOK and Traditional Project Management methods.*
    - *Industry level view of projects - how has the industry done, what is the perception of success/failure, and the interviewee's first-hand experience with that.*

5) *Studied Organisation*
    - *How has your experience been with the Studied Organisation's projects*
    - *What makes project management in the Studied Organisation different, if at all?*
    - *What are the pros and cons?*
    - *What would you like to see improving?*
    - *What are things we do too little of?*
    - *What are things we do too much of?*
    - *How does customer engagement work at the project level? Examples?*

6) *Details on the project management methodology*
    - *Planning Process*
        - *What is your typical role in planning process? What do other team members do?*
        - *What does a day look like during the planning phase of a project?*
        - *What is the role of project plans in your daily life?*
    - *Execution*
        - *What is your typical role in the execution process?*
        - *What does a day look like during the execution phase of the project?*
    - *Close out and follow-up*
        - *What is your typical role in the close-out and follow-up process?*
        - *What does a day look like during the close-out and follow-up phase of the project?*
    - *Communication*
        - *Is the concept of a remote project team effective in drilling rig MRO projects?*
        - *What are the advantages and disadvantages of co-location in your view?*

    - *Where are you empowered? (Discuss with examples as necessary)*
    - *Where do you feel a lack of empowerment? (Discuss with examples as necessary)*
- *Change Management*
    - *How often does the project go in line with what you had planned?*
    - *Where does it usually deviate?*
    - *How does change management work in the Studied Organisation's projects - what happens when there is a change?*
    - *How do you feel that works?*
- *Documentation*
    - *How do you document what you do?*
    - *What are your feelings on the level of documentation being used in the Studied Organisation?*
- *Team Setup*
    - *Are you encouraged to be multi-skilled?*
    - *Who decides the buildup of the team? What is the process?*
    - *What happens if the resources are too many or too less?*
    - *Who are the Team members you typically interact with, and how is that interaction carried out (meetings, ad-hoc etc.)?*
    - *Does the team self-organise?*
    - *What is your involvement in project cost management? Would you like to see that role increase, decrease, or stay the same?*
- *The role of the customer*
    - *How does customer engagement work at the ground level? (Discuss with examples as necessary)*
    - *What would you like to see more/less of?*
- *The role of leadership*
    - *How does leadership support work for your projects?*
    - *What would you like to see more/less of?*
- *Where do you think you do well?*
- *Where do you think you can improve?*

7) *Hypothetical and predictive questions*
    - *If you got a chance to setup a project team from scratch, what are the key things you would do differently to the Studied Organisation's model?*
    - *Project management*
        - *Retrospective meetings*
            - *Do you do them?*
            - *Do you consider them good idea? What would you like to see discussed?*
            - *Or, why do you think they are a waste of time?*
            - *How often should they be held?*
        - *Documentation*
            - *Do you think documenting MOC works?*
            - *Would you like to see it in your project teams?*
            - *Is a documentation engineer useful?*
        - *Planning Process*
            - *Are you satisfied with the planning process in the studied organisation?*
            - *Do you believe in continuous planning? Do you practice it?*

        - *What does it entail?*
        - *How would you envision it works?*
        - *Is a Planning engineer useful?*
    - *Self-organising behaviour*
        - *How does it impact the team dynamics and output?*
        - *What would you want to see done differently?*
    - *Resource adequacy*
        - *Any key areas where you think the Studied Organisation's system lacks?*
        - *How should those gaps be filled - more people or multi-skilled approach?*
    - *What else do you suggest can be done to better adapt to the dynamic environment each project brings?*
- *Hybrid Project Management*
    - *How on your view (if at all), can flexible and regimented approaches co-exist? How do you envision that would be?*
    - *What role does individuality play in PM? Do you prefer building projects around individuals or vice versa?*
    - *How does the size of the project influence the approach (regimented vs flexible) in your eyes?*