END-TO-END INTEGRATED ACTIVITY PLANNING AND SCHEDULING FRAMEWORK

by

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This thesis is the result of the author's original research. It has been composed by the author and has not been previously submitted for examination which has led to the award of a degree.

To my dear wife and family

Thank you.

ABSTRACT

There is a strong business need to enhance the planning and scheduling performance in a Global Company (GC) within the Oil and Gas industry where a focus on executing critical business activities in an increasingly more complex environment; significant Enhanced Oil Recovery (EOR) projects, a high volume of new wells, declining brownfields, resource constraint, and ageing facilities with implied integrity issues and constant replacement of assets. An external benchmark conducted in 2014 through a 3rd party international consultant for 28 companies belonging to the GC, revealed that its upstream operations' performance was below aspired levels relating to metrics including operational safety, production deferment and operating cost. Plant shutdowns are becoming complicated due to ageing EOR facilities where a constant change in process conditions affects asset integrity. Appropriate planning and scheduling are necessary to reduce production losses resulting from inefficiencies and inadequate time for the preparation of work and procurement of resources, to bring back in service within the agreed window is a significant challenge for global oil and gas companies.

This research investigated the challenges confronted by the GC in implementing effective planning and scheduling. There was no strong leadership to drive planning in the GC, the culture of proactive planning was missing, and the planning process was not consistent. Moreover, there was no clear organizational structure with defined roles and responsibility in some of the companies. There was subsequently a need for a clear framework to explain all elements required to ensure effective planning and scheduling in the GC. This research contributed to knowledge by developing an Integrated Activity Planning and Scheduling (IAPS) framework to address the GC challenges while being suitable to be used by any company in the oil and gas industry. The IAPS framework was implemented and tested in three companies belonging to the GC and demonstrated its effectiveness by delivering business outcome and standardized replication. For example, Company-A reduced the Non-Productive Time (NPT) of the marine fleet, which in turn reduced the standby charges by $480,000 over the 12 months and enabled the improvement of fleet utilization. Extrapolating these savings within other logistic fleets would enable Company-A to make considerable savings and achieve the cost optimization target. The results of the application of the framework have demonstrated that IAPS is a crucial enabler for managing the asset performance in a global oil and gas operating company. The IAPS framework led to enhance operational safety, reduced planned deferment, increased integration opportunities, and reduced costs which are key metrics to improve the GC competitiveness to run a profitable oil and gas business. The IAPS Framework is currently live and used in the GC, contributing to the economy.

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Nomenclature

AR	Activity Readiness
BOE	Barrel of Equivalent Oil
CART	Capacity, Achievement, Relation, and Technical
CR	Change Request
CTCO	Coiled Tubing Clean-Outs
CTR	Cost time and resource
GC	Global Company in which the research conducted in
HSSE	Health, Safety, Security, & Environment
IAPS	Integrated Activity Planning and Scheduling
IPS	Integrated Production Systems
IS	Integrated Schedule
KPI	Key Performance Indicator
LNG	Liquid Natural Gas
MILP	Mixed-integer linear programming
PM	Preventive maintenance
POB	People on Board
PMTS	Preventive maintenance time slots
SCM	Supply Chain Management
SME	Subject Matter Experts
TA	Turnarounds
UOC	Unit operating cost

Chapter 1 INTRODUCTION

1.1 Background

The upstream oil and gas business model is comprised of different phases starting with exploration, appraisal, development, production, sales, and ends up with abandonment. An oil field has typically an economic's life span of between 15 to 25 years where oil and gas extracted, and revenue gained. The production phase is one of the most critical phases which directly impacts the field performance and business outcomes. In the production phase, facilities are operated and maintained, and the associated reservoir managed to the best economical level until the end of life of the field.

Through time, facilities age and are subject to failure, and consequently, maintenance activities are required. As the field matures, supplementary enhanced oil recovery technology is installed, typically incurring minor modifications to the facilities. Sustaining and improving production targets requires the development of new reservoirs and the optimisation of existing ones. For such complex operations, different business functions required to support the asset management to run and maintain operations most effectively.

The upstream oil and gas business consists of different functions and disciplines focused on maintaining operations: exploration; development; well engineering; well services; project services; operation; maintenance; turnaround; optimised recovery; and, logistics. Each of these disciplines has its sub-disciplines. For example, the maintenance discipline consists of mechanical, electrical, instrument, rotating, inspection, reliability, condition monitoring, and painting sub-disciplines. These disciplines and associated sub-disciplines play a crucial role in managing the technical activities from planning to execution. Almost every significant activity in the upstream industry requires multiple disciplines to work closely together - very few activities can be completed using a single discipline. The average number of activities a small company conducts in a field daily is typically over 100, many of which involve operations that have a significant risk element. Such high risk and complex operations require integration to avoid conflicts between different activities, optimise the equipment downtime, and utilise the optimised resources.

Planning and scheduling are fundamental to the oil and gas business; it is imperative that all work to be carried out on hydrocarbon production-related facilities and assets, whether as part of routine operations or during a turnaround, is managed and executed safely and efficiently. The complexity of planning content, typically increasing in detail as activities approach their

execution date. The purpose of this research is to investigate the performance of planning and scheduling in a Global Company[1] (GC) within the Oil and Gas industry and to develop an integrated activity planning and scheduling framework and validate it. The research will also develop a standard approach to deploy the framework in all companies worldwide that belongs to the same GC.

1.2 The business case for developing the IAPS framework

The performance concerning integrated planning & scheduling within the GC is low: almost 40% of the planned activities not executed for various reasons such as missing materials, missing contracts, or unavailability of resources at the time of execution. Such poor planning performance has proven to be costly to the company in terms of capital efficiency, production and resources. In one of the GC companies, the poor planning has resulted in a non-productive time of marine vessels of 40%, and helicopter seat utilisation of 51%, both of which contributed to a logistics spend exceeding $671 million. The poor execution in the same company due to poor planning resulted in stock material of $481 million and increased rig non-productive time to 35% which is equivalent to loses of $9.7 million for a single rig, and the company has seven rigs. The poor planning has also increased the backlog of corrective maintenance jobs to 12,700, putting facilities' integrity at high risk. Exploiting such business impact on 28 companies belonging to the GC explains the significant losses and correcting them demonstrates this research's criticality.

As a result of this performance, most of the GC companies would become non-competitive, particularly in low oil prices, and highly competitive business environments. One of the essential metrics in the oil and gas industry to measure competitiveness is the Unit Operating Cost (UOC), the total expenditure incurred by a company to produce, store, and sell a product. The UOC in the GC was rising against declining production and deteriorating safety performance. The GC hired a 3rd party international consultant in 2014 to conduct an external benchmark for 28 companies belonging to the GC and compare their performance with peer group companies in the oil and gas industry. The external benchmarking revealed that GC's upstream operations' performance was below aspired levels relating to metrics including

[1] *The name of the company was decided to be completely confidential and therefore the name has been changed to a Global Company 'GC' for the purpose of analysis and discussion. The author conducted the research in the GC, throughout the research duration and was responsible for the development of the Integrated Activity Planning and Scheduling Framework.*

operational safety, production deferment and operating cost. Out of the 28 companies, 22 were considered medium to high cost, and 24 companies were considered medium to low production efficiency. The significant facilities shutdown or what called in the GC "turnaround" was an average of 20 days/year compared to the top half of peers who average fewer than ten days/year. Within the oil and gas industry, time correlates directly to money, and these extended shutdowns are costly in production and cash costs. Despite a relatively high Preventive Maintenance (PM) ratio to Corrective Maintenance (CM) and extended planned shutdowns, the GC unplanned losses remain high.

An urgent turnaround of performance was needed to reduce the UOC and improve facilities' availability and, in turn, boost production. One of the solutions to achieving this is to implement effective planning & scheduling, which is the system that integrates a subset of such activities carried out by functions on a facility into a single integrated and consistent plan. The integrated plan could cover a single location or asset, as well as a group of integrated assets using, for instance, the same pipeline system. Its application is dependent on the value chain of each company. The below Figure 1-1 Integrated oil and gas production system concept illustrates a typical upstream oil and gas industry business covers the surface and sub-surface assets, hydrocarbon processing facilities, utilities, evacuation systems, onshore facilities, dispatching, and may include midstream, downstream and third-party operated assets. IAPS, in its greater context, can integrate all upstream business activities. **The research defines IAPS as a process that integrates a subset of activities carried out by functions on a facility into one plan. These activities could impact safety, production, capacity, and cost, resulting in simultaneous operations or using shared critical resources such as aircraft, vessels, heavy cranes, or skilled labour. The IAPS links the long-term strategic plan and covers medium-term to short-term time horizons and integrates with other company plans and processes.**

For example, assume four different activities carried out in different parts of the same producing asset which consists of a well producing 1000 barrel of oil per day, facilities, pipeline and hiring a workboat costing USD 10000 per day:

- One activity in wells to replace a subsurface safety valve that takes one day;
- One activity in facilities to tie in a chemical injection line that takes two days;
- One maintenance activity to replace an actuator that takes two days; and,
- One activity in production to run a downhole survey that takes three days.

Different functions carry out these activities within the company. Making these activities visible in a single plan allows better integration, reduces conflicts, reduces safety exposure, allows the facility's downtime to be fully optimised, and improves sharing resources—two scenarios considered here: non-integrated and integrated activity planning. The non-integrated scenario would equate to eight days of shutdown for the company, 8000 barrels of oil deferment, and result in using the workboat for eight days costing $80,000. The integrated scenario would result in an optimised facility shutdown of three days, 3000 barrel of oil deferment, and $30,000 cost for sharing the workboat to execute all activities.

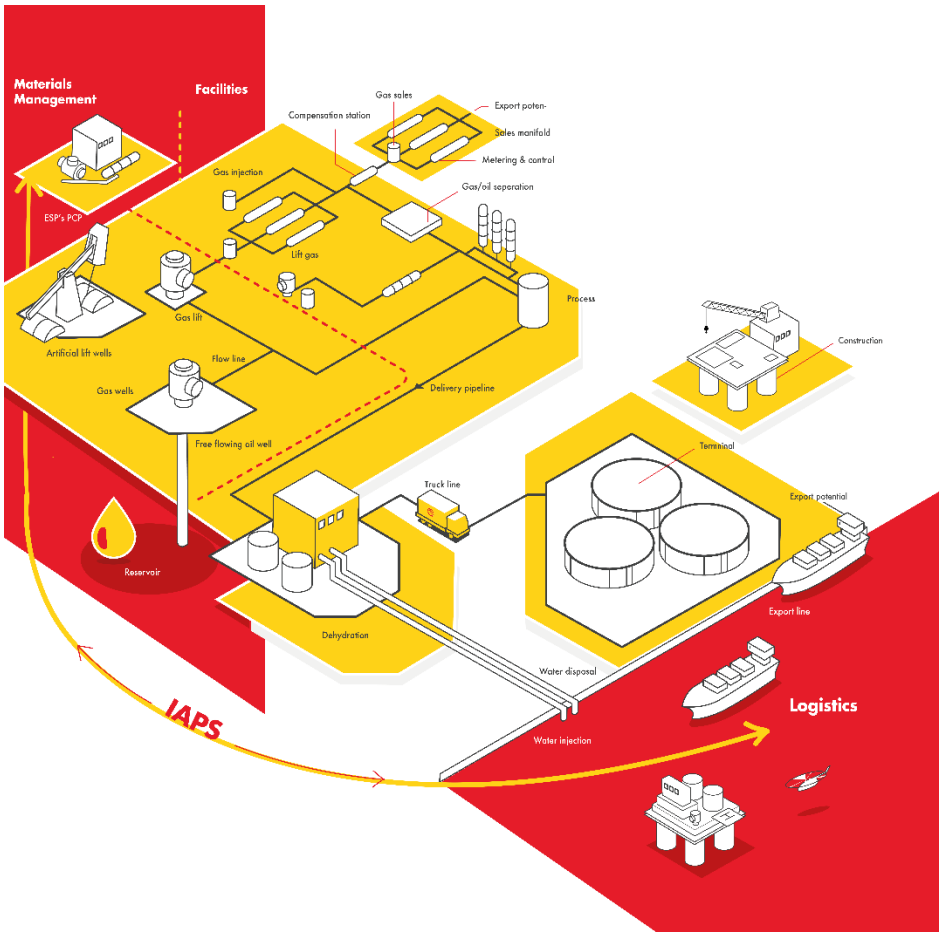


Figure 1-1 Integrated oil and gas production system concept

From a performance perspective, the lack of an integrated plan relates to more oil and gas deferment and loses. The oil and gas business is very complex; the above example occurs every day in different fields with much more complex activities and long durations. The impact of poor planning and poor execution is huge on oil and gas companies.

1.3 The Oil industry and GC challenges in integrated activity planning

The literature review did not reveal any comprehensive IAPS framework to address the Oil and Gas industry's challenges after many years; it looks that this research area was not a focus or overlooked. The GC uses an integrated activity planning procedure consisting of four blocks (build functions plans, prepare for integration, produce integrated plans, and manage integrated plan) with high-level description however the planning performance is still below aspired targets. The external benchmarking results also confirm that the GC performance is below average compared to other industry companies in the same peer group. The researcher conducted a preliminary investigatory workshop in the GC in January 2016 with several Subject Matter Experts (SMEs) to understand the challenges confronted in implementing integrated activity planning in different countries. The workshop was managed and chaired by the researcher and attended by 30 SMEs from 30 different countries. The workshop used face to face conversation to analyse performance and list various challenges. The workshop started with each company's current performance belongs to the GC then moved to analyse the main challenges faced by the subject matter experts in their companies to implement the existing integrate activity planning procedure and end up by summarising the requirements for a new planning framework.

The preliminary investigatory workshop's most significant outcome was that the existing integrated activity planning procedure was unsuccessful in the GC due to a lack of appropriate implementation in the different countries in which it used. There was no strong leadership to drive it, and a culture of proactive planning was missing. Another finding was that the existing integrated activity planning procedure was not consistent across all companies belonging to the GC, and hence the procedure was not being fully implemented. It recognised that perfect execution of individual steps was of limited use if not all process steps executed to a sufficient standard. The current procedure focuses only on the steps of building-integrated plans and ignores to describe the organisational structure with clearly defined roles and responsibilities. If multiple parties share control over activities, there is a risk nobody take responsibility for the whole, and the overall deliverable is compromised. The workshop revealed other challenges that grouped as follows:

1. There was no direction setting by top leaders: the business outcomes were evident at the upper management level, but the transfer to lower and execution levels was missing. The company vision not translated into an operational sense by building affordable plans.

2. Lack of some leaders' ownership of functional and integrated plans: many did not attend meetings and did not hold people accountable for planning performance. The lack of leadership support resulted in unsolved conflicts, abused and unrealised opportunities, and sub-optimum resource management.

3. Planning done in silos due to limitations in the existing integrated activity planning procedure: the existing procedure was very high level and not sufficiently explicit to guide functions and asset planners to follow a stepwise process, which would, in turn, lead to a different interpretation and application. There was a lack of understanding of the procedure. The procedure was also not fully integrated with other strategic planning procedures, business planning, maintenance execution, turnaround, material management, and logistics management.

4. Insufficient medium-term planning led to the lost value of optimisation in the long term: analysing the current gaps in the GC upstream operations integrated planning performance, indicated that many companies executed integrated activity planning in the short-term (90 days) horizon only, and with the single objective of minimising deferment.

5. Inadequate management of change to ensure robust risk management and the trade-off between different opportunities: the safeguarding of plan delivery is paramount, and performance should be protected through standardised management of the change process which was not currently available. Each discipline, function, and asset used different procedures and requirements, which resulted in scattered information and practices, and a loss of a straight line of sight to the number of changes accommodated every month.

6. The activity readiness check is missing to mature activities: activities should be screened using a pre-defined activity readiness checklist in different plan horizon gates to ensure readiness for execution. The functional planners typically indicated that their activities were mature and ready for execution most of the time, whereas, in reality, they were not and subsequently resulted in late cancellation during the execution phase and impacted the overall business performance.

7. Poor functional plan credibility: most of the function's plans not linked to current business priorities; they contained low levels of activity definition or detail, and occasionally one functional plan negatively influences another making it sub-optimal.

8. Inconsistent application of a standard toolset: each company belong to the GC selected different software applications to build an integrated activity plan; there is no consistency across the companies belong to the GC. The software applications were not fully integrated and did not support each other resulting in intensive manual data entry and repetitive work.

9. Inconsistent documentation of risk and opportunity: The plan did not document all reviewed risks and opportunities, and did not provide an auditable trail for further improvements. Such a transparent register helps manage risks in executing plans and generate discussions on how to improve the quality of plans.

10. Non-standard reporting of integrated activity planning Key Performance Indicators (KPIs): not all companies were currently reporting integrated activity planning KPIs, and some use different sets of KPIs. The existing performance dashboard highlights the planning process performance only without linking these performance indicators to business performance, which undermines the necessary improvement to enhance business performance.

11. Competency of Role: some assets lacked competent planners to perform associated process and systems to integrated planning and an understanding of their roles in the organisation. There was no exact training and coaching strategy with agreed targets. The succession planning was weak, and planners felt that they had reached the end of the road in their career.

12. Continuous improvement plans are missing: a root cause analysis of plan performance not undertaken consistently, and a feedback loop not established. There were inadequate sharing of best practices across the different companies belonging to the GC and sub-optimal knowledge sharing, which slowed the group's improvements.

13. Insufficient integration of resources: integrated activity planning maximises the business value when fully integrated with logistics, materials management, and maintenance. It should create a single integrated process that enables assets and functions to develop well-aligned forward-looking, integrated plans in all-time horizons that support decision making for shared resources utilisation and optimisation to achieve business outcomes.

From these challenges, it was clear that the currently integrated activity planning procedure is not adequate to enforce implementation neither to achieve the GC business targets. The

procedure focuses on a process only and ignores other vital elements such as behaviour, culture and leadership. The SMEs require a framework addressing all the above challenges and include elements that contribute towards organisational effectiveness. These elements related to for example clear asset direction towards integrated planning; leadership support for robust integrated activity planning procedure implementation; organisation structure to support integration; staff competence to address quality; standardised systems to mine massive data sets for an accurate integration view; and, robust ground rules to manage different cultures in the GC. The framework should provide a means to analyse the planning, scheduling and execution phase using specifically designed business and process KPIs to drive, rather than merely measure, and enable the efficient response to disruptions caused by unplanned activities. Implementing the framework should be translated into business performance improvement concerning production, cost, and efficiency to measure its effectiveness.

1.4 Research aims and objectives

This research aims to develop a framework for integrated activity planning and scheduling to address the challenges currently faced in GC and support the GC to improve business performance. The framework will be validated to assist engineers in the planning and scheduling different business units in the global oil and gas industry. The research involves investigating process parameters, variation and robust operation conditions and identifying those parameters that need more accurate estimation. The following objectives defined in order to achieve this aim:

- Objective-1: The research will evaluate available models from the literature review to address the recognised challenges to take the latest developed solutions and highlight gaps in knowledge. The literature learning should help understand how other industrialise or companies addressed integrated planning, which is discussed in Chapter 2.
- Objective-2: The research will design a methodology to gather data, analyse data, and create the required framework elements which are discussed in chapter 3
- Objective-3: The research will design a standard replication model that can help implement the framework across different GC companies. The framework would be implemented in multiple companies belonging to GC worldwide and validate its effectiveness in improving business performance which is explained in chapter 4.

- Objective-4: The research will identify missing elements or gaps in the literature and will address these gaps by creating new solutions for all challenges faced by the GC. The missing elements or gaps in the literature will be addressed through this research and subsequently contributed to the overall integrated planning and scheduling field knowledge. The framework is explained in chapter 5.
- Objective-5: The research will evaluate the framework by implementing it in various companies and test its effectiveness in improving the GC performance. The research will also highlight the different challenges faced during implementation and proposes a standard deployment approach to ensure consistent and successful implementation, which is explained in chapter 6.
- Objective-6: The research will discuss the framework's strengths and weaknesses and recommend further studies to improve the framework. Such improvements will ensure sustainable framework effectiveness and highlighted in chapter7.

The success of the recommended IAPS framework through the satisfaction of the aim expected to deliver improved quality plans by confirming activities readiness; increased work execution by proactively ensuring site readiness; minimised wastage in the use of resources (e.g. material) during execution; establishment of robust governance structures at different levels of the organisation for feedback loop and continues improvement; support for the GC to improve business performance; and consistent implementation among different companies belonging to the GC. The framework evaluated through the following KPIs, which are used widely in the Oil and Gas industry:

- **Improved GC business result performance trend:**
    a. **Cost reduction**: reducing the non-productive time of the logistics marine fleet, which would improve the utilisation and reduce standby charges paid to the suppliers.
    b. **Production increase:** improving the availability of facilities. The reducing facilities downtime increases the availability and consequently increases production.
    c. **Capital efficiency**: improving the material on-time delivery, reducing material stocking, and reducing the CAPEX to purchase more stock material.
- **Improved IAPS process leading and lagging KPIs trend:**

a. Integrated Schedule delivery (%): activities executed as per plan in the current month. A higher value corresponds to better execution of the activities.

b. Activity Readiness (%): activities which met the readiness criteria and included in the execution plan. A higher value means that most of the plan's activities satisfy the requirements and are more likely for execution.

c. Short Term Plan Stability (%); activities in the plan remain unchanged for three months (90 days). A higher value relates to fewer changes in the plan, which indicates a successful transfer of Medium-Term plan activities to Short Term plan.

d. Medium-Term Plan Robustness (%): changes in the MT plan activities, which negatively impact the business plan target. A lower value represents a better indication for robustness as it indicates a successful transfer of business plan activities to Medium Term plan.

1.5 Thesis structure

The thesis starts with the introduction in Chapter 1, which includes explaining the industrial requirements for the IAPS framework retrieved from the GC through a workshop discussion with subject matter experts. The literature review reported within Chapter 2, investigates IAPS main process criticality and main deliverables, how it should be implemented, where it has been implemented, and the main results achieved. The literature review ends with a critical comparison between existing knowledge and the industrial requirement to explain the gaps that this research should address and contribute to the overall knowledge. In Chapter 3, the thesis explains the research methodology used to analyse the existing IAPS process performance and how to develop a new IAPS framework to address the identified gaps. A detailed description of the fieldwork and investigation using deep-dive workshops in different companies to conclude the main gaps in GC and proposed solutions explained in Chapter 4. In Chapter 5, the thesis presents the proposed end-to-end IAPS framework in which was developed and tested in three case-study companies, and its effectiveness examined in Chapter 6. After explaining the results in Chapter 6, the thesis includes discussing and reflecting on the challenges faced during implementation and how these could further be addressed. Chapter 7 articulates the discussion of implementing IAPS framework and highlights strengths and weaknesses. In Chapter 8; the thesis articulates the recommendation and contribution to knowledge. In Chapter 9; the research closes with the conclusion highlighting the research overall working integrated activity planning and scheduling field.

Chapter 2 LITERATURE REVIEW

2.1 Introduction

Fink stated that 'a research review is a systematic, explicit and reproducible method for identifying, evaluating, and synthesising the existing body of completed and recorded work produced by researchers, scholars, and practitioners' (Fink, 2005).

The research strategy described here was based on the above principles using Cooper's Taxonomy of literature reviews and a transparent research process. The PhD research aims to develop an Integrated Activity Planning and Scheduling implementation framework to address the GC challenges for application within a highly complex business environment such as the upstream oil and gas industry. The IAPS implementation should produce a high-quality integrated plan that drives safe, reliable, and cost-effective operations. The research will focus on a detailed and "proven" integrated planning process and end-to-end integration with other processes such as material management, maintenance execution, turnaround management, and logistics services as available in the literature review.

The literature review questions to be answered in pursuit of this research are:

1. What is the available knowledge in relevant literature in Integrated Planning frameworks in upstream oil and gas industry or other complex industries that can learn from and replicate?
2. How were existing frameworks deployed, and what are the critical requirements for successful implementation?
3. How have current frameworks helped different organisations to deliver better business performance, and how was this success measured?
4. What are the gaps in the literature relevant to the Integrated Planning framework in upstream oil and gas industry or other complex industries that can be covered in this research and contribute to the field knowledge?

An IAPS implementation framework solution might not necessarily be obtained solely from published research form the upstream Oil and Gas industry and might exist in other complex and critical industries such as air force, aerospace, or shipping. Hence, the literature search words will be tested in the Oil and Gas industry and other industries to explore a complete Integrated Planning framework research coverage.

Following Cooper's Taxonomy of Literature Reviews as described by Randdolph (2009); the methodology to review integrated planning literature will consider:

- **Focus**: This research will focus on (i) research outcome as searching for the latest integrated planning framework; and (ii) practices or applications in how this integrated planning framework used and any significant results achieved. It recognised that other foci: (iii) research methods; and (iv) theories would be looked at if they discovered within the review.
- **Goal**: the goal of the research is to integrate reviews of integrated planning frameworks, critically analyse how it has been implemented, and contribute to delivering value in the industry and identifying opportunities to strengthen the framework or close gaps.
- **Perspective**: the primary research will be qualitative as it follows the research methodology described in the next chapter, and opinion will be highlighted.
- **Coverage:** an exhaustive review with the selective citation will be used. Planning as terminology is widely used, and the focus of this research is related explicitly to integrated planning. The research will use peer-reviewed journals (refereed), conference proceedings (published and not published), books, official publications, organisations reports, and thesis as per the research criteria. The research will not be limited based on geographic location but will use English as the base language. The period for the search decided to start from 1995 onwards to refer to the most recent research.
- **Organisation**: the literature will be presented as a mix of conceptual and methodological formats (as appropriate). The literature will be presented in an essay style following a logical and structured manner.
- **Audience**: the literature review and thesis will be written for an academic audience but should consider a wider audience of oil and gas industry practitioners who are not purely academic and technically and practically focussed.
- **Scoring Rubric**: the literature review will use Boots and Beile (2005) five-category rubric for evaluating a literature review which has been cited by Randdolph (Randdolph et al., 2009) and should ensure that it considers all of the following: coverage, synthesis, methodology, significance and rhetoric.

In this literature review, four databases were used (Science Direct, Suprimo, One Petro, and IEEE Xplore). A transparent process followed in order to execute a consistent literature review with a clear audit trail. After defining the research questions, the data collections stage starts by searching in recognised databases. The results are refined and recorded in a reference list per database. All searched for data were profiled and recorded in four different spreadsheets according to the searching database used to represent an audit trail for future reference. The data analyses start by reading through, understand the contribution and check to learn if it addresses the literature review questions. The identified gaps recorded, and the literature review summarised. The process illustrated in Figure 2-1.

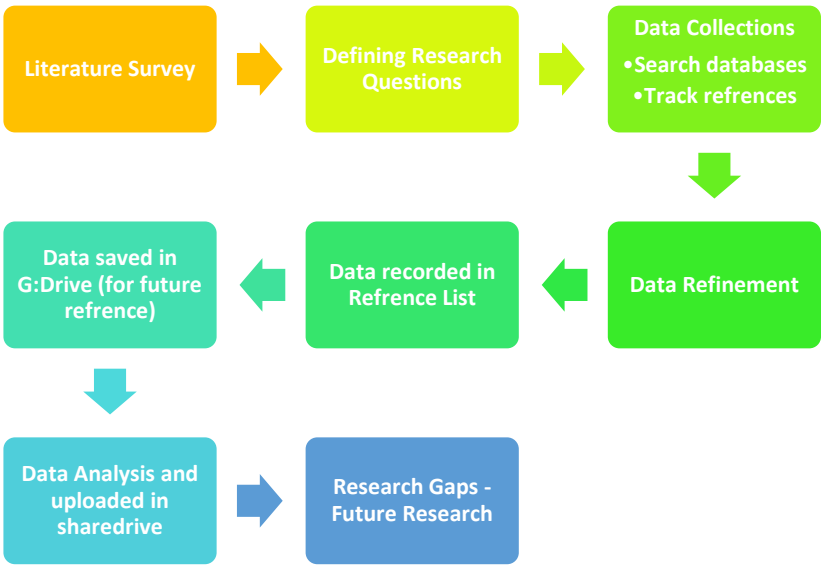


Figure 2-1 Literature Review Process

As different industries may use different terminologies and definitions of terms, the research phrases created to use standard terminology such as “planning” to exact and specific phrases such as “Integrated Activity Planning Framework” to ensure full coverage in the literature review. The following eighteen phrases used: “Planning”; “Integrated Planning”; “Integrated Activity”; “Planning in oil and gas industry”; “Integrated Activity Planning”; “Integrated planning”; “Integrated Activity Planning”; “Integrated Planning” AND “oil and gas”; "Integrated Planning" AND "operation"; “Integrated Activity Planning” AND “Operation”; “Planning Framework”; “Integrated Planning Framework”; “Integrated Activity Planning Framework”; “Integrated Activity Planning” AND “Framework”; "Integrated Planning" AND "Operation" AND "Framework"; "Integrated Planning" AND "Operation" OR "framework";

"Integrated Activity" OR "Integrated Planning" AND "Framework"; “Planning framework” AND “oil and gas”.

The 18 research phrases divided into six cycles, with three research phrases in each cycle. In the 1st cycle; the research phrase “planning” revealed 670882 references, and the research phrase “Integrated Planning” revealed 84124 references, whereas the research phrase “Integrated Activity” revealed 53595 references. Such a massive number of results made it not practical to go through all results. There was a necessity to narrow the research phrase to more specific terms to focus more. The 2nd cycle's research phases were more focused and revealed 1661 references, 415 references, and 534 references. From a glance through the results, many references sorted out to be reviewed in details at a later stage, and many were not relevant. The 3rd cycle of the research phrases revealed one reference, six references, and 89 references with some were relevant, and others were not. The 4th cycle revealed 81 references, 337 references, and 0 references with few were relevant. The 5th cycle revealed 0 reference, 0 references, and 11 references and the 6th cycle revealed 374 reference, 143 references, and 90 references with many were not relevant.

After going through the screening process and ranking relative references through coverage, synthesis, methodology, significance and rhetoric total of 276 references were identified and in the last cycle of reading the 276 the most relevant to the research were 92 (science direct:8, Suprimo:46, OnePetro:13, and IEEE:25).

Although the literature review focused on the oil and gas industry, other industries considered to have a broader view of extracting best practices, similarities, or differences for lateral learning. This chapter covers the integrated planning and scheduling framework in different industries such as autonomous aerospace, transportation industry, utility industry, and manufacturing industry. The literature review studies challenges faced in each industry, a review of critical success factors for implementation, and learnings from change management and cultural influences. At the end of the literature review, a summary of available integrated planning and scheduling framework elements compared to the industrial requirement will be presented with potential gaps that will be addressed in this research.

2.2 Integrated planning definition and concept in other industries

It is essential to start with identifying available definitions for planning and scheduling to formalise what is written in the literature and within this research context. According to Verderame and Floudas (2008), planning occurs over a long-time horizon and determines what

the aggregated target is and laying out a course of action to achieve the desired objective. In contrast, scheduling occurs in a short time horizon and determines the resource allocation to different tasks. The scheduling process identifies the sequence of tasks and which unit should be utilised and incorporates time and resources into the plan based on activity networks. A process was described as a sequence of activities undertaken by different organisation members with a clear flow of information to deliver a specific product or service (Walter and Werner, 2010).

Planning involves the setting of goals and objectives and defines the activities to accomplish the goals and objectives. From a practical perspective, it also involves reviewing the safety, constructability, maintainability and operability of the plant. It formulates the strategies to achieve them, arranges the means required and monitors all steps in their proper sequence (Váncza et al., 2004).

Scheduling is used to convert the plan into a timetable and involve defining the relationships and utilising analogues and benchmarks. It also involves assessing the resource's limits and concluding the schedule risk assessment against the defined schedule. It decides when the activity can be done and assigns an appropriate number of workers to the jobs during each day of work (Váncza et al., 2004).

Sandmeyer et al. was stating that planning as a concept refers to coordination and control and rationalised decision-making (Sandmeyer et al., 2004). A rationalised decision is required for selecting the most appropriate future activities while considering given limitations and constraints. Coordination and control are alternatively required to keep the system within an agreed performance envelope (Sletbakk Ramstad et al., 2010). Integrated planning should explicitly relate to strategic decisions that might affect one another to be dealt through a transparent process, cover a multiple year time frame, and endeavour to produce a balanced programme while enabling appropriate decisions (Sandmeyer et al., 2004).

The term integrated planning is used extensively in many different industries, such as local government, manufacturing, energy, utilities, transportation, architectural engineering, land and water, aerospace and military (Sandmeyer et al., 2004). Small and Yasin (1997) justified the importance of integrated planning to address:

- "an increasingly complex and competitive global and national business environment";
- "the need for strategic responses"; "the need to establish organisational goals and performance measure during the strategy formulation and planning phases";

- "the need for structural (process) changes to meet organisation goals";
- "the need for infrastructural adjustment to support new technology";
- "investment justification"; and,
- "technology choice" (Small and Yasin, 1997).

The growing demand for oil and gas and the complexity of the development decisions give rise to optimal planning of oil and gas development projects (Shakhsi-Niaei et al., 2014). The consumption of energy and the area of production planning has been a research area over the last decade (Beck et al., 2019). Cities requirements for energy is in the raise and governments developing an integrated method for planning to ensure sustainable supply (Gargiulo et al., 2017). To maximise oil and gas production and increase facilities availability, the importance of planning activities rises. The optimal planning of both green and brownfield oil and gas field development projects is an important issue because the corresponding investment decisions and production deferment loses are irreversible (Shakhsi-Niaei et al., 2014).

Planning sets the goals and resources and scheduling details the activities in a set of operation sequences with assigned comprehensive resources, as explained by Váncza et al. (Váncza et al., 2004). Ineffective scheduling may waste resources and inhibits the full execution of an approved plan where the weak plan will prevent organisations from meeting their strategic intent (Váncza et al., 2004). It also provides a mechanism for project schedule control (Verderame and Floudas, 2008).

The elements factored into integrated planning will differ from sector to sector, but the concept is consistent and remains the same (Sandmeyer et al., 2004). Plans can be acknowledged as a tool to improve communication and coordination. They create a shared understanding of a situation at hand to deliver the enterprise's goals (Sletbakk Ramstad et al., 2010). The identified literature as per the research criteria did not reveal a complete definition for planning and scheduling, although above kinds of literature aligned with the IAPS definition in this research and the GC. IAPS defined as a process that integrates a subset of activities carried out by functions on a facility into one plan. These activities could impact safety, production, capacity, and cost, resulting in simultaneous operations or using shared critical resources such as aircraft, vessels, heavy cranes, or skilled labour. The IAPS links the long-term strategic plan and covers medium-term to short-term time horizons and integrates with other company plans and processes. IAPS framework will be used as an integration tool between various functions within the company.

Autonomous aerospace:

The autonomous aerospace industry uses similar planning blocks, and horizons to the Oil and Gas industry, starting from a long term mission plan to a medium-term plan to a short term plan, with increasing level of activity detail in the plan, gets closer to the execution phase (Chien et al., 1999). The short-term planner normally sequences the activities considering given targets and should track resource management and data management, giving clear roles and responsibilities. Such clarity in responsibility would help in organising the work and tracking performance. The aerospace system is very sophisticated and uses real-time systems to manage complex missions supported by simulations to reach the most appropriate plan execution. Autonomous spacecraft often equipped with on-board software that provides actions and procedures to achieve mission goals. In the most sophisticated missions, the spacecraft operates autonomously, interacting with the ground system and personnel only when needed (Chien et al., 1999).

Arvizu (1996) described the process of planning within the Air Force and emphasised in a model of clear decision tree and communication between three parties (decision-makers, decision illuminators, and decision executors). The Air Force planning model starts with a mission area assessment to transform Strategy-To-Task. Then move to mission needs analysis to decide Task-To-Need. The model develops a plan after conducting mission solutions analysis and convert Need-To-Concept which end with technology selection, acquisition process and building capability for successful operations and sustainment (Arvizu, 1996). This model has similarities with the Oil and Gas industry, particularly during the development phase, but the concept also can be used during the operation phase. The first three steps are crucial in integrated activity planning linking the company vision and strategy to operational plans.

Transportation industry:

Airline schedule planning is vital within this industry as effective decision making is crucial to profitability. In the airline industry, schedule planning problem is complex and defined as the sequence of decisions made to obtain a fully operational flight schedule (Cadarso and de Celis, 2017). They proposed a mathematical model to update base schedules in terms of timetable and fleet assignments and showed that integrated scheduling reduced the number of passengers that would otherwise miss connections. This work's significant contributions were the development of an integrated approach to solve the airline-scheduling problem, where schedule design, fleet assignment, and passenger use are jointly optimised. Such a concept is very aligned with the IAPS framework in which is looking for all elements contributing to

improved planning in the GC. Flight planning using a hierarchical framework contains three interacting layers consisting of air traffic management, flight management system, and air traffic users which needs a clear optimisation process (Zhang et al., 2011). The Oil and Gas industry is also using three interacting layers in IAPS consisting of the plan owner, plan executor, and plan governance in which clear process required to optimise and improve integration.

Ertogral and Öztürk (2019) investigated integrated production scheduling and workforce capacity planning for the airline industry's maintenance and repair operations. Maintenance, repair, and overhaul activities for the airline sector are subject to strict regulations to ensure the safety and the continuity of flights and critical equipment regularly undergo maintenance at fixed intervals. The study focussed on tackling the problem of integrating overhaul production scheduling of routable items and workforce planning and developed a mathematical model that used constraints related to inventory balance, capacity restriction, and demand satisfaction type. A similar approach of using a mathematical programming model was used to solve material delivery by establishing a set of feasible options to guarantee that products are stored and shipped on schedule, minimizing operational costs (Menezes et al., 2017). One of the challenges in implementing integrated activity planning in the GC is to resources the right material and resources at the right time and the right place. The GC uses sophisticated software to determine the physical stock level; however, the main challenge is planning the activity at the right window and executing the plan.

Transportation systems are essential for society and have many planning challenging, and the railway is no difference. Train services and the maintenance of a rail network need to be scheduled efficiently but have mostly been treated as two separate planning problems (Meng and Zhou, 2019). Planning and scheduling play a critical role within the general transportation industry to ensure flow efficiency to transport a large volume of the passenger. Meng and Zhou (2019) studied to optimise an integrated train service plan with variable demand focussed on an integrated team to run the framework starting from passenger demand to service capacity constraints to infrastructure constraints with a feedback loop to improve planning. Demand planning is proliferating, and IAPS framework considers the use of demand planning while building the IAPS plans. The concept of an integrated team managing the IAPS framework with a feedback loop to continuously improve the process is essential.

Zhang et al. (2019) investigated a model to identify the operation modes and the timetable of trains, by integrating the time window selection of regular maintenance on high-speed railways to reduce the impact of train maintenance in availability. Simultaneously, Luan et al. (2017)

developed a simultaneously scheduling trains and planning preventive maintenance slots on railway network instead of sequential scheduling method. Lidén and Joborn (2017) proposed an optimisation model for integrated planning of railway traffic and network maintenance. They established a long-term tactical plan that optimally trains free windows within the schedule which were sufficient for a given volume of regular maintenance and the planned train traffic. Such a concept aligned with the IAPS framework time horizon's thinking to look at the medium-term plan (tactical plan). Simultaneous operations concept is also widely used in the oil and gas industry with extra care to identify risk exposure.

Utility industry:

In the utility sector and particularly in power generation, Value-Based Reliability Planning is established to ensure proper planning to deliver optimum value to the industry. Schellenberg et al. suggested enhancing this trade-off model, including customer interruption cost, to determine the best investment to improve planning (Schellenberg et al., 2014).

Engel (2000) highlighted that planning should begin from a strategic level then decomposed into a tactical and operational level to achieve an economical and profitable business. Engel (2000) also highlighted the importance of explicit knowledge in existing regulations, information of risk-sharing, determination of required reliability and infrastructure needed to meet future requirements (Engel, 2000).

Dedecca et al. (2018) studied the importance of integrated governance constraints on the generation and transmission expansion planning of the European North Sea offshore grid from 2030 to 2050. The study developed an integrated Mixed-Integer Linear Programming (MILP) model of offshore generation and transmission expansion planning to study the effect of integrated governance constraints. Such review supports the thinking of the IAPS framework that the organisation structure can create constraints, and it will be essential to identify bottleneck within the existing structure and governance in the GC.

Zhang et al. (2017) studied integrated design, planning, scheduling renewables-based fuels and power production networks, and developed a multiscale model for the integrated optimal design and operation. Their proposed model allowed selecting a feasible process network derived from a given superstructure network, while simultaneously optimising detailed operational schedules for the selected processes. At the GC, each company has an entirely different configuration for facilities and network, and one solution can not fit all. However, at an asset level (field), such a model might help optimise facilities' downtime while other networks are functioning.

Manufacturing industry:

Manufacturing, like any other industry, faces challenges to integrate process planning and production planning. According to Cunha et al., process planning in manufacturing is more concerned with the technological requirement, and production planning and control are more responsible for utilising resources such as labour, machine capacities, and production quantities. The production planning and scheduling performed after process archetype and configuration of machines; most of the time decisions taken at the shop floor affected the entire manufacturing system (Cunha et al., 2000). Cellular manufacturing planning processes designed to plan at macro and micro hierarchical levels through different time horizons. Macro process planning is the long-term planning exceed one year. Micro process planning focuses on optimisation at the feature level and is considered short-term planning (Hasanzadeh et al., 2009). The oil and gas industry needs a longer window beyond five years planning due to the complexity of projects and construction time required. The Hasanzadeh et al. (2009) definitions of macro and micro can be equivalent to the medium-term and short-term plans in the IAPS framework.

Chaoyu et al. (2019) developed a methodology for integrating the detailing design and installation planning of reinforcement bar for waste reduction and productivity improvement within the construction industry. They highlighted previous research that had developed mathematical models to minimise reinforcement bar cutting losses analytically without integrating engineering design, workforce plan, detailed estimating, and environmental factors into the optimisation. Chaoyu et al. (2019) focused on integrating reinforcement bar stock procurement and cutting plan for each layout arrangement alternative in a particular structural component.

Goods manufacturing also use hierarchical demand-driven planning frameworks to reduce waste, reduce inventory cost and avoid product returns (Farahani et al., 2013). The high competition, expensive storage capabilities, and fast new product launches drive the planning optimisation and adaption of a pull-based planning framework based on just-in-time principles, which assumes a relatively stable demand pattern by studying customers' behaviours and requirements (Farahani et al., 2013). The integrated planning of project scheduling and material procurement considering the environmental impacts were studied by Tabrizi (2018) with the development of a model which minimise project costs in addition to environmental impacts. The model considered the simultaneous planning of the project scheduling, material procurement problems and impacts in execution. In the process element part of the IAPS framework; it would be useful to create a list of risks and opportunities for the plan and develop scenarios to manage such impact.

2.3 Importance of linking integrated planning and scheduling

The importance of linking integrated planning and scheduling as one process has been the focus of past research: Chu and You (2014), Shi et al. (2014), Little et al. (2000), Majozi and Zhu (2001), Ishizuka and Okamo (2007). This research has highlighted the advantage of integrating planning and scheduling; planning can solve problems at a strategic level by focusing on long term issues and scheduling at lower level focusing on operational aspects. Developing a reliable connection between planning and scheduling supported by dynamic optimisation significantly improves overall performance.

According to Verderame and Floudas (2008), planning from a time perspective focusses on a long-time horizon, while scheduling focusses on a short time horizon and determining resource allocation to different tasks. Dealing with planning and scheduling as separate entities lead to resource waste and ineffective execution due to inadequate resources management. Shah (2005) noted that "on average less than10% of the material processed by a pharmaceutical firm ends up as final product", while Du Pont also noted that a polymer facility could reduce working capital from $160M to $95M as a result of integrating planning and scheduling as cited by Verderame and Floudas (2008). Exxon demonstrated a similar result by reducing operating inventory by 20% and operating cost by 2% annually due to integrating planning and scheduling Verderame and Floudas (2008). A lack of an integrative framework for planning and scheduling leads to poor management of chemical plant resources. Verderame and Floudas (2008) suggested using a novel framework to integrate planning and scheduling for multipurpose and multiproduct using forward rolling plan horizon. They linked the medium-term schedule with production disaggregation model. The forward rolling plan used to solve successive scheduling periods, while the remainder was solved using planning, and this proved to be more effective in demand management as the beginning of the planning horizon contains the most accurate forecast Verderame and Floudas (2008).

Internal and external process integration is crucial for organisations aiming to succeed in global competition (Hasanzadeh et al., 2009). The manufacturing industry must quickly respond to demand change and allocate appropriate resources to ensure improved production with lower cost. Hasanzadeh et al. suggested an integrated planning and production control processes model linking tactical planning of one year (macro) to a short term of three months to weekly cell planning (micro) to a minimum of two days planning with a clear feedback loop between different planning horizons (Hasanzadeh et al., 2009).

Shankaran et al. (2009) emphasised the importance of integrated planning and scheduling in Distributed Real-Time Embedded (DRE) systems where input workloads and resources

available are in dynamic changes and need to be continuously managed (Shankaran et al., 2009). They advocate for using a sophisticated software application to support end-to-end planning and resource management due to the complexity. The research focused on developing the software rather than process or data to ensure system stability and reduce downtime through the autonomous operation. The software is essential, but the process is necessary, too; the IAPS framework focuses on all elements.

For manufacturing organisations with three-stage production processes that include stamping, welding and assembling, and painting; integrated planning and scheduling demonstrated to provide value in producing feasible production plans and reducing inventory (Yan and Zhang, 2007). Most of these organisations have focussed on master production schedules in manufacturing resources planning, and keep the planning separate from scheduling, leading to the development of an unrealistic production plan. As most of the manufacturers have more than one processing stage; the main challenge is to obtain a balance in the production line between second stage processing time and last stage to reduce machine overtime, inventory of spares, and set up time of the first stage. Suppose the second processing line is faster than this will keep the last processing time longer in duty. Yan and Zhang (2007) developed an integrated optimisation model to address the challenges between planning and scheduling using a genetic algorithm (Yan and Zhang, 2007). The higher the number of manufacturing stages, the more complicated is the planning and scheduling. The nature of business still requires planning and scheduling to play a significant role in ensuring optimum production. Kirchner and März (2002) confirmed this in building a vision of a self-adaptive production system that integrated all of the company internal data systems with the planning system, to automatically select the best configuration of the production line (Kirchner and März, 2002). Majozi and Zhu (2001) shared a similar vision, but from a different perspective, building a continuous-time formulation for scheduling the multipurpose batch process (Majozi and Zhu, 2001). In both cases, the focus was in technology and algorithm solution, one of the elements in the IAPS framework.

The GC currently uses the integrated activity planning procedure and does not explicitly cover the scheduling requirements in great details. Such a lack of details and linking the planning and scheduling created challenges in building quality plans. The IAPS framework will address such a challenge and aim to link the planning and scheduling in one process and under one framework. The importance of linking planning and scheduling demonstrated through various literature and studies is considered a significant change for the GC to adopt a new philosophy for planning and scheduling and selecting a new name of the framework (IAPS).

2.4 Integrated planning frameworks

Strasunskas et al. (2012) created an integrated operations framework with four dimensions (process, people, technology and organisation) supported with performance evaluation through agreed key performance indicators (KPIs). This framework tested within Norwegian oil companies that specifically focussed on integrated planning and drilling. The framework confirmed that implementing an integrated planning tool was of suitable value, but process changes, people competency and organisational culture were more valuable than an integrated planning tool (Strasunskas et al., 2012). Such finding is key to IAPS framework and emphasis in the importance of other elements.

Business Process Models (BPM) are used within the industry to simplify and standardise their processes; they help design complicated processes and make it leaner (Dombrowski and Hennersdorf, 2009). Flowcharting techniques used to engage different practitioners in actively participating in designing the necessary process by sharing knowledge and critically challenging each step in the process. In general, the flowchart illustrates the connectivity between different operations and illustrates the data flow from one task to another. A fundamental principle in BPM is to create a feedback loop to ensure continuous improvement to the designed process (Dombrowski and Hennersdorf, 2009). An optimisation of a single process would likely be sub-optimal for multiple processes. The chain of processes and their connectivity to each other needs to be checked and optimised. Planning has evolved from being a one-time activity, or a sole process to a continuous improvement approach integrates with other processes. Using specific indicators; producing a common platform enabling people to participate effectively in managing one plan is crucial (Dombrowski and Hennersdorf, 2009).

Business Process thinking was introduced in the late 1990s and focus on executing the process to achieve the desired outcome regardless than departmental or functional agendas. Within the Oil and Gas sector, thinking remained functional as for many years performance was based on a robust functional structure, using experienced people to run field operations in a hierarchical organisation (Walter and Werner. 2010). Functional thinking focusses on sub-goals and targets; a lot of time and efforts spent to determine which department is responsible for what and tend to forget that all functions are jointly responsible for delivering broader company goals. Walter and Werner proposed a process management system called THINK (Twist Habits and Integrate Knowledge), to overcome siloed functional thinking and promote process thinking across organisational boundaries, and support everyone sees the full picture (Walter and Werner 2010). THINK was used and consider the process as evaluation and control tools and support people to change their mindset from traditional thinking to better cooperation and

utilisation of collective thinking and group wisdom. The THINK concept conducted through four key activities: operate; analyse and steer production; identify opportunities; and, plan to produce specific processes to ensure quality delivery of each stage (Walter and Werner. 2010). Such an approach focuses on the desired outcome and drives process development to establish the IAPS framework.

The THINK model as illustrated in Figure 2-2, starts at a high level by developing a suite of business management processes consisting of operational excellence, asset management excellence, asset development excellence, and planning excellence. The model then reflects these processes' optimisation through (operate- analyse- identify- plan). In GC, the business management processes exceed the four processes considered by Walter and Werner and includes governance, project management, human resources, and finance processes. The criticality is not only in optimising individual process but integrate all processes in the business management suite.

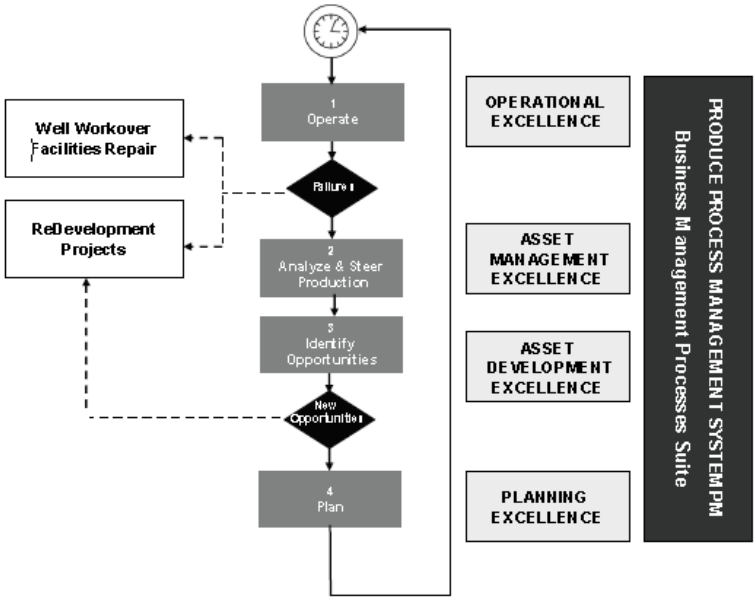


Figure 2-2 Produce process - production excellence (Walter Ondracek and Werner Liebl 2010, page 10)

A functional mindset traditionally drove process management to maintain knowledge within a department and control information between functional units (Walter and Werner, 2010). New process thinking has shifted this functional focus towards collective thinking and knowledge integration, enabling the organisation to deliver common goals instead of individual or departmental goals. A functional mindset still imposes significant barriers to collective thinking to improve business performance, which should be resolved through

thinking. Putting the right people in the right place with the right information is essential, but not sufficient on its own to achieve the required levels of performance (Walter and Werner, 2010). Collaboration is not achieved by putting different people in one room with state art of technology, but by valuing different perspectives, discussing opportunities, sharing enthusiasms and achieving more significant results (Derenzi et al., 2009).

The Oil and Gas industry is as facing knowledge transfer challenges within their organisation through a lack of governance or a holistic methodology (Saxby and Burridge, 2013). Many factors affect this knowledge transfer, such as talent migration, technology revolution, and staff turnover. Saxby and Burridge outlined a methodology to benchmark a company's organisational effectiveness through Knowledge Intelligence (KI); the KI model provides a means to examine the ability of the organisation to use the group knowledge and wisdom and apply them systematically to make critical decisions in reducing risk, increase certainty, and improve performance (Saxby and Burridge, 2013). Their theoretical approach focussed on capturing and recording the group's knowledge within a system and allows everyone to access and learn from others. The methodology reflects the group's ability to recognise a situation and use this learning to master a solution; in their views; people discussion and networking were vital to achieving this. Once the group have made the best use of the shared experience to develop a solution, Saxby and Burridge stated that the next step was to collaborate and implement the agreed solution to be in a stronger position to meet future challenges (Saxby and Burridge, 2013). The model relied on specific business enablers such as innovation, collaboration, communication, culture, and people competence. It covered elements of organisational effectiveness and explained the "what" but lacked detail about the "how" and "who". However, the model was theoretical and needed testing and putting into practice for better understanding and further improvement. There is no evidence yet of benchmarking of KI across different organisations.

Sletbakk Ramstad et al. (2010) proposed a theoretical framework for organisational capabilities for successfully implementing integrated planning that focussed on: organisational learning; communicative capabilities; agility and resilience; and, mindfulness. The first element emphasizes the importance of the organizational learning capability within the framework to change actions based on available content, and that learning must closely connect to the work practice. The second element within their framework is the organisation's communication capability, to present the potential value of integrated planning, and subsequently positively influence organisational cultures. The third element is the organisational resilience and agility in managing frequent deviations to the plan and unintended requests. It highlights the importance of the organisation to be flexible to manage

change, retaining balance and control. The last element in the framework is mindfulness in which the organisation continues to search for best practices and adopting new tactics to handle unexpecting situations. Considering the organisation as a system and composes of different functions work as subsystems in a specific environment emphasises the importance of a transparent process framework defining system goals, control operation, and clarifying the interaction between subsystems (Sletbakk Ramstad et al., 2010).

One of the benefits of the integrated plan is to enable knowledge-intensive decision-making by integrating information and collaboration across organisational and geographical boundaries. People take the knowledge-intensive decision, and hence people competency should be improved hand by hand with the integrated planning process (Sletbakk Ramstad et al., 2010). The Queensland department and local government considered integrated planning to ensure excellent performance (Yearbury, 1998). Due to the importance of the concept of integrated planning in delivering optimum results, higher education establishments have designed and developed professional education programmes, for example, entitled "Integrated Planning and Budgeting" (Atkinson, 2002) as cited by Sandmeyer et al. (Sandmeyer et al., 2004). These programmes emphasised controlling budget as per the approved plan and put various controls in the hierarchy system, especially in approving variances and changes orders. Such controls help the thinking in IAPS framework to assign explicit plan authorisations at each level.

Companies and sectors use different techniques to approach integrated planning: the Kuwait Oil Company launched integrated planning and performance management, supported by a programme management office for a successful implementation of a strategy to ensure alignment, promote the implementation of change management, and achieve strategic objectives (Figarella and Al-Mezel, 2012). Rework and redundancy in the opportunity maturation process has motivated Chevron's Gulf of Mexico Business Unit to launch an asset investment solution to align business planning and asset development plans between different stakeholders. The asset investment solution made the vision of integrated planning a reality by creating a single platform for integrating all data (Charles et al., 2014). Chevron formed a project team from different disciplines supported by a steering group to guide the project. One of the significant shortcomings of this research was that the project focused on building a tool before understanding or re-designing a process. The tool should have been developed to replicate an efficient process; otherwise, it could inadvertently automate existing waste in the process. The project should have modelled both the "as-is" and "to-be" processes, before creating the model. The project team admitted to facing problems to convince key stakeholders of the benefit of using one application, as they could not create a compelling response to the

question “what is in it for me?”, which in turn indicated a need for a clear change management programme (Charles et al., 2014).

The Spanish multinational energy company REPSOL addressed planning challenges using in-house expertise to produce a standard process (Erena, 2002). Their approach started with conducting internal and external benchmarking to determine the “best practice” approach. They created a centre of process development and improvement using capable in-house personnel to meet the goals set with a culture of continuous improvement. They aimed to develop a standardised process across all their refineries supported by the same organisation structure. This model has proved beneficial to REPSOL by improving safety levels, reducing investment, reducing unused stock, using standard spare parts, simplifying technologies, reducing project costs, and integrating organisation (Erena, 2002). It was not clear from the research what was the developed process, how it implemented and what was the learning. The approach is quite generic; using in-house experts who understand the company business and culture is useful but using external expertise to bring different views adds value.

Wiek and Walter developed Transdisciplinary Integrated Planning for sectoral development and took strategic decisions within complex systems. The approach focused on the decision-making approach, starting from goal formation then followed by system analyses for each sector, then building different scenarios and evaluating these scenarios using multi-criteria assessment and ending up with strategy building. It guides to start planning at different sector then rollup plans and decisions at a higher level to build an integrated plan. They highlighted that further research was required to refine the Transdisciplinary Integrated Planning procedure to support embedding in different organisations and institutions (Wiek and Walter, 2009).

Narayan described a model for linking the human interface to technology and hardware, creating a proper balance to deliver a sustainable performance (Narayan, 2012). In Figure 2-3; Narayan investigated the link between maintenance, reliability, quality, asset integrity, process safety, and profitability with human behavioural aspects bringing a holistic approach. It emphasised that human reliability contributed significantly to all aspects of reliability throughout all phases from design to operation, as over three-quarters of failures during the life of the equipment is attributable to human error. Narayan model helped define the input and output of the main drivers and drive the attention in underlying causes of human influence. The model focussed on the importance of human factors within control to put the necessary improvement plans in place, adjust behaviour, and lead the organisation towards successful business results (Narayan, 2012). Such a model is vital for the IAPS framework to address the

culture element. Understanding the main drivers for human reliability (behaviours and competence) with the main drivers (motivation, experience, training, and procedure) helps design the culture element. The IAPS framework will provide precise solutions to these main drivers to ensure effective IAPS implementation.

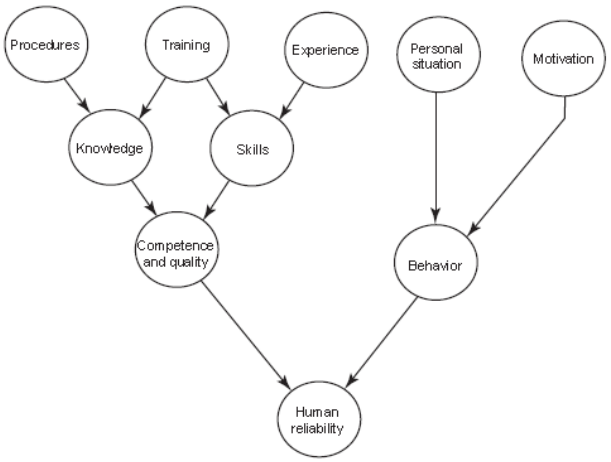


Figure 2-3 Factors affecting human reliability (Narayan, 2012, page 189)

Siloed thinking is a challenge within organisations where separately controlling different departments and functions, can lead to sub-optimal results, and require an integrated approach with an integrated planning framework (Rødseth et al. 2015). The use of Key Performance Indicators (KPIs) is one of the tools used to monitor organisation performance supported by a continuous improvement model such as Plan-Do-Check-Act (Rødseth et al., 2015). The IAPS framework will design a specific KPIs for process and business goals to evaluate the IAPS framework performance.

In their research; Rødseth et al. (2015) focused on maintenance activities and developed a profit loss indicator that measured waste in factory and overall equipment performance. The overall equipment performance indicator has been used widely in industry, can be used to measure daily performance during operational activities, trigger tactical activities to resolve identified root cause problems, and decide to invest in new equipment or upgrade an existing one as a strategic activity. The weakness of overall equipment performance indicator is that it does not translate performance in financial terms which is essential to multidisciplinary decision making, particularly in ranking and prioritising different activities and available options. They also explained the profit loss indicator concept of calculating the profit loss at different levels (equipment level, system level, plant level, and process-level) and considered such losses an extra cost. The profit loss indicator concept was novel in that maintenance

activities were monitored but focused only on one function of the industry. The integrated production system considers multiple functions such as wells drilling, projects, subsea, operation, logistics, wells services. The KPI is subsequently required to be extended to integrate other functions if it is to be used in the Oil and Gas industry.

2.5 Value of integrating planning process with other processes

Most companies focus on their competitive advantage and core business; hence some of the side business such as logistics started to be outsourced to specialised service providers. This model helped companies focus on delivering their business objectives but introduced a new challenge to build up a robust integrated plan to minimise waste and secure value (Mutke et al., 2013). Material management is a crucial element in achieving efficient operations and a profitable business. A typical material management question relates to the trade-off between storing high volumes of critical spare parts while minimising storage, remains challenging to answer. Deploying the right spare parts with a qualified service engineer at the right time in the right place when needed, represents the operation team requirements that need to be fulfilled. Cordes and Hellingrath (2014) attempted to address this question through a tactical integrated planning model which aligned inventories with transportation and activities demand. Their solution focused on building a demand forecast dependent on information about the technical system's status, condition monitoring, production planning, and maintenance service activities. Tactical planning was used to help to determine required inventories for the whole system well in advance, and contribute to minimising high-cost spares in warehouses (Cordes and Hellingrath, 2014).

Mutke et al. demonstrated the importance of having an integrated plan linked with fourth-party logistics service providers which generally provided transportation, handling and storage of goods, packing, finishing, and clearing. Mutke et al. suggested using a simulation tool to secure the appropriate management of material, personal, and information, especially in radical changes during operation (Mutke et al. 2013). The GC uses the third party to provide logistics, and such service considered critical for smooth execution of activities in IAPS. Translating the IAPS plan in logistic plan and transferring the data to the logistic service provider will be crucial.

Said et al. regarded integrated planning as an essential process linked to the production forecasting process (Said et al., 2014). Their research with ADMA-OPCO (a major offshore operating company) focussed on utilising an integrated planning process to understand how activities affect the production forecasts. To achieve this, the company developed an

application to visualise production impact resulting from the interaction of field activities. The application incorporated a business logic to recognise the reservoir constraints, the wells' potential, and facilities capacity. The tool supported the recognition of simultaneous operations such as shutting a well during workover activities, which reduced the time spent in checks and data validation. The tool also provided integrated activity schedules for different fields and supported scenario build-up to select the most appropriate model (Said et al., 2014). The tool has proven the concept of integrating the reservoir, wells and facilities for better management but did not provide a transparent, integrated planning process or framework for integrating all activities in platform especially those not linked to production impact. Many activities need to be included in the integrated plan due to their impact in Health Safety & Environment (HSE), shared resources, safe manning level, and people on board, which not considered within the ADMA-OPCO application.

Supporting a decision through a mathematical optimisation tool helped Petrobras optimise production (Teixeira et al., 2013). The tool was used within the Petrobras Research and Development centre for three offshore assets to investigate the best scenario for facilities shutdown and to integrate related platform activities. Teixeira et al. reported that for the cases considered for testing, an improvement of 1.18% in total oil flow rate produced (Teixeira et al., 2013). The system focussed on production impact activities and did not consider other activities in the field, making the scope limited to production only.

Brandolese et al. (1996) stressed the importance of building a functional maintenance plan integrated with production planning through an integrated planning process (Brandolese et al., 1996). Their research highlighted that the development of such integration involves many organizational challenges that need to be addressed as maintenance planning and production planning are often delegated to different company functions (Brandolese et al., 1996). In GC, the functions are more than production and maintenance; it consists of project, wells, drilling, subsea, pipeline and many more. All functions activities as high impact safety, production, or resources (cost) should be included in IAPS plans.

Nourelfath et al. (2010) supported having both production and maintenance plans integrated, using with tactical planning to bridge the gap between the strategic planning level (long term), with the operation planning (short-term). The proposed plan durations were defined as one week or less for operational planning; one month or more for tactical planning; and, one year or more for strategic planning (Nourelfath et al., 2010). Oil & gas industry looks for more than five years as a strategic plan; it includes complex projects which take long duration for

execution. The tactical plan's outlook usually is within two years, which is relatively not aligned with Nourelfath's definition.

For adverse weather planning, particularly in offshore environments, Höllt et al. proposed a dynamic simulation for sea level. Their study was based on the Gulf of Mexico, a challenging area for oil and gas deepwater operations. The simulation provided a long-term environmental forecast with increased accuracy over a time frame of one to two weeks, helping the planning team identify the right window for the offshore activity operation (Höllt et al., 2013). Adverse weather conditions provide challenges not only for oil and gas industry operations but also for air traffic management (Zhang et al., 2011), who described the criticality of having accurate weather forecasting to make a flight planning decision and enhance situational awareness. The weather forecast is considered part of the hierarchical flight planning framework for air traffic management (Zhang et al., 2011). The importance of Höllt et al. researches is considering external factors that might affect the plan's execution. Taking into consideration different scenarios for such uncontrolled events lead to creating a more credible plan. In the IAPS process; a step to check external factors will be considered to ensure readiness for any weather disturbance.

This research has demonstrated the importance of linking an integrated planning process with other processes such as maintenance, production, logistics, procurement, material management, and weather forecast. Integrated activity planning should not be implemented in isolation; otherwise, it will be less effective with reduced value in delivering business optimisation. The end-to-end concept of integrating IAPS with other processes would provide more value to the GC, and above researches highlight the value of this integration.

2.6 Oil and gas business challenges and the requirement for integrated planning

Oil and gas are used extensively as sources of power, particularly in industrialised countries and are considered primary contributors to the economy. This requirement has created a worldwide demand involving highly intensive operations to be met. The industry can be split into two segments, upstream, which includes exploration and production, and downstream, which deals with processing and refining crude oil and gas and their distribution and commercialisation. The volume of activities within these two segments increases from one year to another to meet growing needs (Salazar-Aramayo, 2013).

In this challenging oil and gas business; all operating companies are targeting "production excellence", which not only means first in class operation, but also means effective control of cost and production, and continuously identifying and realising opportunities to maximise the value of assets (Walter and Werner, 2010). Historically, the planning process in upstream oil and gas has been regarded as a time consuming and inefficient process due to many alliterations (Charles et al., 2014). Significant effort spent in collecting data from different sources and multiple functions and parts of the organisation in order to build a holistic view of a company's activities within a given time frame; this is varying from weeks in a small organisation to months in a large organisation and complex business (Charles et al., 2014). In an ever-changing environment, leaders should have access to the right information at the right point in time to make well-informed decisions (Charles et al., 2014).

The various functions such as reservoir management, drilling, projects, operation and maintenance; all have different activities planned with allocated resources specific to their domains. These plans allow different functions to manage workforce, material, and different resource requirements to deliver their functional objectives and review their performance. However, having many separate plans leads to a "silo functioning" organisation with little ad-hoc integration between different functions. Non-integrated planning within functions has resulted in poor resource management for the asset as a whole (Sletbakk Ramstad et al., 2010).

Nourelfath et al. (2010) stated that production planning and preventive maintenance planning are mutually conflicting as the production managers perceive the downtime of equipment to perform maintenance as a production loss. As a result, production and maintenance plans are sub-optimal for minimising combined maintenance and production loses (Nourelfath et al., 2010). Offshore operations are exposed to many challenges such as different weather conditions; strict operations and maintenance requirements; ageing production and process plants; difficulties in construction which demand an accurate in-service inspection and maintenance in the right location, at the right time; and, using the right resources and approaches in order to sustain the overall integrity of the production facilities (Senevirantne and Ratnayake, 2012). Inspection and maintenance strategies and plans are subjected to frequent changes and revisions based on new findings and the facilities' overall reliability (Senevirantne and Ratnayake, 2012). Risk-Based Inspection tool used to build the inspection plans and create overall maintenance strategies. The plan is developed both in the short and long term, and the inspection can be conducted in-service (during operation) or planned during plant shutdown (Senevirantne and Ratnayake, 2012).

Technical integrity assurance is one of the most critical elements in oil and gas production plants, and inspection and maintenance decisions are considered crucial elements. Therefore, it is vital to develop a mechanism to integrate large volumes of data from different sources to make an optimum decision (Senevirantne and Ratnayake, 2012). It is essential to highlight that only 20% of the equipment in oil and gas processing facilities, contributes to 80% or higher of the total risk, as the equipment categorised into four classes: pipes; pressure vessel and tanks; valves; and, other equipment. The pressure vessels and tanks reflect the minority of the processing plant equipment, contributes to the highest risk. Using inline inspection and reducing human expertise helps manage a large volume of inspection data and help in taking the right judgment (Senevirantne and Ratnayake, 2012).

According to Bello et al.; integrated activity planning is a pivotal process to optimise cost and increase product availability. A plan underpinned by resource allocation and activity building blocks to deliver business goals is crucial for the oil and gas business. The IAP process has been designed to cater for three-time horizons: the medium-term plan with a two-year cycle; the short-term plan with a 90-day cycle; and, the very short-term plan representing a seven to 28 days schedule (Bello et al., 2011). The short term and very short-term plan focus on operational execution, while the medium-term plan reflects tactical planning and focusses on activity integration and resource alignment. Bello et al. suggested reviewing the medium-term plan quarterly and integrating it with the production forecast to identify clashes between different activities and allocate the right resources. It was clear from their case study in the Niger Delta, that performing a medium-term plan helped increase project profitability, provided early warning mechanism for business performance, and fostered cross-functional integration. The process proposed by Bello et al. consisted of four stages: propose; fit; agree; and, execute. During the proposed stage, each business function was responsible for creating an activity plan spanning two years; which involves all activities integrated from exploration, projects, well drilling, well services, modification, hydrocarbon maturation, and maintenance and operations. In the fit stage, all functional activities were integrated into an asset plan to determine the best fit and optimise the shutdown windows. The various asset plans were integrated at the corporate level and discussed within the leadership team for final endorsement at the agreed stage. Once the plan was endorsed, it then moved to the last stage “execution” where the plan was rolled out in a three-month horizon and handover to a short-term planning team to progress the activities (Bello et al., 2011). Bello et al. definition provided for the planning horizon times is consistent with the GC planning horizon and can be used in developing the end to end the IAPS framework. This concept is useful from a process

perspective but does not address the other elements in the IAPS framework such as organisation structure, culture or leadership.

Sulaiman and Husin (2000) emphasised the importance of an effective integrated planning system to improve the management and control of operational activities and optimise the development options over the oil field's life cycle. Managing integrated planning in the long term contributed to maximising the value of the field, which is, in turn, translated into cash flow. The changes for activities in the plan need to be managed carefully at the proper authority level to protect value (Sulaiman and Husin, 2000). Bello et al. identified the importance of controlling any changes to plan to ensure ad-hoc changes did not affect the overall plan's goal delivery. The change controls should aim to maintain high levels of stability in production as unmanaged changes reduced the integrated plan effectiveness and wasted allocated resources to deliver agreed on activities (Bello et al., 2011). The integrated plan performance should be tracked through well designed KPIs on a monthly and quarterly basis. Bello et al. demonstrated that the integrated planning process helped build a collaborative work culture across business units. However, their research did not explain how this was implemented in the organisation or illustrate the appropriate approach to manage behavioural changes.

Integrated Activity Planning benefits are not limited to normal operations and help during exceptional situations and make the business more resilient to adopt changes, stay in operation, and prepare for uncertainties. Business continuity depends on drawing scenarios and ensuring that organisations survive unexpected disasters (Dey, 2011). Integrated planning is regarded as a tool for ensuring safe and optimised operations (Sletbakk Ramstad et al., 2010).

Managing uncertainty in planning is a significant challenge as plans should address identified uncertainties very explicitly and provide a means of reducing risks to plan execution. Verderame et al. addressed uncertainties to mitigate risk by using a mathematical framework. The framework covered a broad range of techniques including conditional value-at-risk; chance constraint programming; parametric programming; fuzzy programming; and, two stages stochastic programming. It is fundamental for the integrated planner to understand constraints and uncertainties during planning and scheduling (Verderame et al., 2010). Once these constraints and uncertainties have been addressed within the plan; feedback should be considered in the planning and scheduling framework to refine production targets. Within the chemical, petrochemical, and pharmaceutical industries the forms of uncertainty related to unit capacities, unit breakdowns (availability), processing time, transportation time, and market price need to be addressed during planning (Verderame et al., 2010).

2.7 Planning tools

The planning process is generally supported by computational tools that can aggregate data from multiple sources and visualise the input in a dynamic view to provide a continuous update. Advances in IT and big data processing has increased the opportunity to integrate large volumes of information, but further support is required to help participants interpret and create a shared understanding and agreement of the information received (Sletbakk Ramstad et al., 2010). BP, a major international oil and gas exploration and production company, have used integrated planning to meet aggressive commercial gas demand from Trinidad and Tobago assets; an oil and gas field that consists of seven production fields. There was an urgent need for improved collaboration between development and production teams, which required facilities engineers, drilling, and other functions, to streamline the development of a single decision support tool accelerating the project analysis cycle time by 30%. BP's main challenges were poor portfolio performance due to an over-simplified portfolio model due to limitations in communication, human and computing resources. Therefore, they developed one planning tool to include all complex project activities for better discussion (Koosh et al., 2003). This solution is considered as a project funnel rationalisation, and maturation and such a tool will not help in integrating activities and scheduling resources.

Drabble (1998) have discussed a range of intelligent planning technologies, including SAP/R3, ILOG, Red Pepper, i2, SRI/SIPE, and DARPA/Rome. These technologies were successfully and widely used in different industries for integrated planning and scheduling and have provided real-time planning to ensure operations targets are met. The SAP/R/3PP-PI system was used for integration and resource management, linking the Material Requirement Planning system at the floor shop, with the manufacturing process to react to changes and ad hoc orders. The ILOG/Schedule has been used within aerospace and defence sectors for constraint reasoning to address workforce and equipment's effective use. In Red Pepper, reactive agents provided different facilities to satisfy the customer's requirements, while i2 used reactive agents to manage the global supply chain. The SRI/SIPE system used for general purpose planning to resolve oil spill recovery problems in the San Francisco Bay area. The system supported the determination of best plans against evaluation criteria and response options to unexpected events. Other systems like DARPA/Rome were developed to build planning and scheduling in response to logistics requirements in crises events. It allowed the user to visualise the provided logistics and review the implications for any change. A critical assessment of different tools, their specialities and functionalities can provide insight into how these technologies should be integrated. Each of these technologies addresses specific user

requirements for improving planning and scheduling. Drabble argued that organisations should not discard their existing planning and scheduling technologies, but rather build up a transparent process, supported with a multi-agent planning architecture to share the data and foster quality planning across the organisation. Drabble suggested that more research was required to focus on initiatives to allow legacy systems to interact and support any newly developed integrated planning and scheduling process (Drabble, 1998). Lv et al. proposed integrating a planning and scheduling tool with an Enterprise Resources Planning (ERP) system. This tool would help planning to achieve a new level of intelligence about optimising resources (Lv et al., 2009). In the GC, the planning tool used is Primavera P6, and the ERP system is SAP. Taking Lv et al. and Drabble recommendations, the GC planning and ERP tools will need to be integrated for improved resource optimisation and effective planning, which will be addressed in this research.

2.8 Summary and gaps in knowledge

Through the literature review; different concepts, models, approaches, and frameworks have been identified concerning Integrated Planning and Scheduling. The use of complex planning systems differs from one industry to another, but most of the literature reviewed has emphasised the importance of planning and scheduling. The literature has revealed that integrated planning is recognised as a critical business optimisation process that cuts across all functions (including contractors) that plan or carries out activities on or alongside hydrocarbon facilities. For example, the planning and scheduling definitions mentioned by Bello et al. (2011) reflect what is used in the oil and gas industry, particularly in the category of the plans, duration, and building blocks. Literature has extended the integration within the integrated planning process to include other business frameworks such as production, maintenance, logistics, and material management to deliver optimum business results that resonate with the GC requirements.

This research's main objective is to develop an end-to-end IAPS framework to address the GC's challenges in implementing an effective IAPS process. The GC company requires an end to end framework, to address all elements starting from clear ***direction, organisational structure, people, process, systems, data, culture, and leadership.*** There was no single framework within the literature that address all these elements. This review has also demonstrated no proven methodology or consistent approach used to deploy an IAPS framework across different companies. The human element and behavioural influence have been highlighted within a small proportion of the published literature but did not

comprehensively conclude or explain in detail these implications. The framework of Strasunskas et al. (2012) was the closest to the GC requirements. Their proposed framework included dimensions relating to the process, people, technology and organisation supported with performance evaluation through agreed KPIs (Strasunskas et al., 2012). This framework was tested in Norwegian oil companies focusing on integrated planning and drilling. The framework confirmed that implementing the integrated planning tool was not perceived as the primary value, which was reflected within the process changes, people competency, and organisation culture. However, it did not address the people competency or explain how to manage different cultures to promote planning. For change control, Derenzi et al. (2009) stated the need for a transparent change management and communication programme with a clear commitment from the asset management. He also stated the requirement for a strong sponsorship to dissolve barriers and get staff commitment (Derenzi et al., 2009), aligned with the GC challenges and requirements. However, the study did not reveal a specific solution or technique to ensure leadership commitment. The framework of Sletbakk Ramstad et al. (2010) was also appropriate with some of the GC requirements, particularly in the organisational capabilities. However, other elements such as direction setting, leadership, cultural, organisation structure, and the people element were not covered intensively. The framework was also theoretical and was not tested to confirm its effectiveness. Table 2-1 summarise the gap in knowledge by comparing key identified frameworks with the GC/oil industry requirements.

Table 2-1 Comparison between key identified frameworks in the literature and IAPS framework required elements

Framework & Author	IAPS Framework Elements							
	Direction Setting	Organisation Structure	People	Process	Systems	Data	Culture	Leadership
Strasunskas, D., Tomasgard, A. and Nystad, A.N. (2012) A Framework to Assess Value of Intelligent Petroleum Fields and Integrated Operations, *Society of Petroleum Engineers*, pp. 1-11.		X	X	X	X			
Dombrowski, U. and Hennersdorf, S. (2009) Business Process Models Supporting participatory layout planning, *IEEE*, pp. 113-117.				X				
Walter, O., and Werner, L. (2010) Mature Oil and Gas Fields: T*H*IN*K Process to Achieve Mature Field Production							X	

Excellence, *Society of Petroleum Engineers*, pp. 1-12								
Saxby, D. and Burridge, G. (2013) Knowledge Intelligence (ki), *Society of Petroleum Engineers*, pp. 1-11.			X				X	
Sletbakk Ramstad, L., Halvorsen, K. and Wahl, A.M. (2010) Improved Coordination with Integrated Planning: Organisational Capabilities, *Society of Petroleum Engineers*, pp. 1-11.			X				X	
Sandmeyer, L.E., Dooris, M.J. and Barlock, R.W. (2004) Integrated Planning for Enrollment, Facilities, Budget, and Staffing: Penn State University, *New Directions for Institutional Research*, 123, pp. 89-96.				X				
Figarella, L. and Al-Mezel, F.S. (2012) Technology Applications in Kuwait Oil Company to Reach Objectives Set in 2030 Strategy, *Society of Petroleum Engineers*, pp. 1-10.			X		X	X		
Charles, T., Zhakiyanov, B., Moreland, C., Back, M. and Bailey, E. (2014) Transforming Portfolio Optimisation through Reengineered Process and Technologies, *Society of Petroleum Engineers*, pp. 1-7.					X	X		
Erena, C.G. (2002) Working Teams As An Integration Tool, 17th World Petroleum Congress, World Petroleum Congress, pp. 1-12.			X				X	
Wiek, A. and Walter, A.I (2009) A transdisciplinary approach for formalized integrated planning and decision-making in a complex system, *European Journal of Operational Research*, pp. 360-370	X			X				
Narayan, V. (2012) Business Performance and maintenance: How are safety, quality, reliability, productivity and maintenance related, J*ournal of Quality in Maintenance Engineering*,18(2), pp. 183-195.			X	X			X	
Rødseth, H. Skarlo, T. and Schjølberg P. (2015) Profit loss indicator: a novel maintenance indicator applied for integrated planning, *Advances in Manufacturing*, 3(2), pp. 139-149.			X	X				
Drabble, B. (1998) Modern Planning and Scheduling Technologies, *Computing and Control Engineering Journals*, pp. 123-126.					X			
Verderame, P.M. and Floudas, C.A. (2008) Integrated operational planning and medium-term scheduling for large-scale Industrial batch plants, *Industrial &*				X	X			

Engineering Chemistry Research, 74(14). 4845-4860.								
Sulaiman, S. and Husin, M.T. (2000) Development of Operations Reference Plan (ORP) for Asset Management, *Society of Petroleum Engineers*, pp. 1-9.				X	X			
Bello, H., Onabanjo, T., Godswill, C., and Dennar, L. (2011) Maximizing Profitability and Production Availability through Application of the Principles of the Medium-term Integrated Activity Planning (MT-IAP), *Society of Petroleum Engineers*, pp. 1-7.			X	X	X	X		

From previous literature review; it is evident that most research to date has focussed on one, or a small number of elements. Much of the research has focussed on planning tools and systems, and the research concerning the soft side of organisation culture and leadership is sparse. The literature review did not reveal any comprehensive IAPS framework to address challenges in the Oil and Gas industry after many years; it looks that this research area was not a focus or overlooked. As a result, it opens an opportunity for this research to bridge this gap and contribute to knowledge by developing a comprehensive end-to-end integrated activity planning and scheduling framework, which covers all elements of the oil industry/GC requirements and test the implementation of the framework in different companies belonging to GC to investigate its effectiveness. The identified gaps in the literature review will be addressed using the knowledge and experience of the GC organisations. The research will take a collective of best practices from different operating companies and merging the practices from published research with the GC practical know-how, and such framework will be generalised to be used in Oil and Gas industry.

Chapter 3 RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents research methodologies available in the literature and the rationale for the research position adopted within this investigation. The advantages and disadvantages of available research methodologies are discussed in detail before an appropriate methodology is chosen.

This section has also focused on critical cycles to develop a framework for effective management of end to end integrated activity planning and scheduling. The development of an integrated framework through implementing a research methodology serves as the focus for this research project.

3.2 Methodology

Administering a research methodology contributes to demonstrating coherence and quality of the research. An appropriate methodology brings all the research elements together and allows for a coherent research project (Johnson and Clark, 2006). The methodology should demonstrate that data was collected correctly, interpreted comprehensively, and drawn reliably (Crotty, 1998). It is generally accepted that the researcher's past experiences, assumptions, understanding of the world, and beliefs will influence the research design and consequently, the research results. Whether the researcher is consciously aware of them or not, at different stages of the project, assumptions will be taken, and the researcher was required to ensure that these assumptions are evaluated and aligned with the research questions and do not jeopardise the research results.

The research design is the plan for how the research questions will be addressed, and the importance of defining clear questions cannot be overemphasized. A well thought out methodology review should lead to credible research which underpins the selected philosophy, approach to theory, methodical choice, strategies, time horizon techniques and procedures (Saunders et al., 2016).

All research is unique, developing new knowledge in a particular field, or answering a specific problem in a particular organisation (Tsoukas and Knudsen, 2003). Saunders et al. explained a variety of options for the researcher to consider when selecting the most appropriate approach, considering the research questions, research field, and researcher's past experiences,

assumptions, understanding of the world, and beliefs. The following summarises the process of selecting the research methodology, which is discussed in the following sections:

- Research design is a way to operationalise the research objective and questions into a coherent research project reviewing all given assumptions and decisions taken throughout all stages.
- Research philosophy dictates the research design typically and can be based on positivism, critical realism, interpretivism, postmodernism, or pragmatism.
- The approach to theory development can be achieved through deduction, abduction, or induction.
- Different research methods are available, and a choice must be made to use mono-method quantitative, mono-method qualitative, multi-method quantitative, multi-method qualitative, mixed-method simple, or mixed-method complex.
- The research strategy is related to the research objective and questions; the strategy could involve experiments, surveys, archival research, case studies, ethnography, action research, grounded theory, narrative inquiry, or combinations. The researcher's decision needs to be taken to ensure coherence with other elements in the research design.
- The research strategy is related to an appropriate time horizon and is typically either cross-sectional or longitudinal.
- Data collection and analysis requires clear procedures to be put in place; attention should be paid to the data validity and coverage. Relationship with research questions and variables should be established to build a proposition and theories systematically.
- Other practical considerations affect the design of the research, such as the role of the researcher.

3.3 Research philosophy

The research philosophy is referred to as a system of assumptions and beliefs for the development of knowledge. This is an explorative journey to understand the philosophical position and translate this into coherent research practice (Alvesson and Sköldberg, 2000). Different factors influence the research practice, such as availability of finance to conduct the research, accessibility to data, and the time frame. There is a need to take an informed

philosophical choice after questioning the research assumptions and belief and understanding different business and management (Saunders et al., 2016).

Three types of research assumptions are highlighted in the literature: Ontology, Epistemology and Axiology.

- **Ontology** represents the research object and the nature of reality. Ontology described as "the study of being", Bilau et al. (2018) is concerned with the nature of reality of the assumptions we make about reality. That is, ontology is associated with the question "whether social entities need to be perceived as objective or subjective", "how things are", and "how things work", suggesting realism and idealism as the two ontological assumptions. The research object could relate to management, individuals, events, or organisations. The researcher ontology determines how to see the world and influence what to research. The ontology supports deferent points of views in transforming challenges to opportunities and address real gaps (Thomas and Hardy, 2011).

- **Epistemology** embraces assumptions about knowledge, acceptance level, legitimacy, and how best to communicate this knowledge to others (Burrell and Morgan, 1979). Epistemology concerns the requirements for approaching research to yield acceptable and valid knowledge in a field of study, and it could be either objective or subjective. While an objective epistemology considers the outside world as hypothetical impartial, a subjective epistemology views the world "in the realm of clarifications from reflection" (Eriksson and Kovalainen, 2008).

- Knowledge can range from interpretations to facts, textual data to numerical data, or narratives to stories, which provides a great choice of methods for its creation (Martí and Fernández, 2013). It is essential to understand the implication of epistemological assumption in selecting the research methodology and the limitations and significance of the research findings.

- **Axiology** concerns the nature of values and the researcher's basis for value judgment. A researcher's value, beliefs and experiences can be expressed as long unbiased about the concept (Bilau et al., 2018). The two-value axiology position relates to positivism (value-neutral), and interpretivism (value-laden), which relates to the research process's values and ethics. Heron (1996) argued that values are the bases for human actions which influence the research decision. Selecting a specific research methodology or data set for analyses represents a researcher's belief. The

researcher needs to understand the personal values concerning the research topic to help make the right judgment about the research results.

Understanding these three philosophical concepts helps improve awareness of continua's multidimensional set: objectivism and subjectivism (Niglas, 2010). Objectivism integrates assumptions about natural sciences, whereas subjectivism integrates assumptions about arts and humanities (Niglas, 2010). Awareness of the objective or subjective nature is essential for the researcher to understand their values and manage them accordingly, to prevent bias on the findings. Table 3-1 describes the continua's extremes in terms of objectivism and subjectivism, and their relation to the three philosophies ontology, epistemology, and axiology: positivism, post-positivism, and realism.

Table 3-1 Philosophical assumption as a multidimensional set of continua (Saunders et al., 2015).

Assumption Type	Questions	Continua with two sets of extremes	
		Objectivism	Subjectivism
Ontology	What is the nature of reality? What is the world like? For example: What are organisations like? What is it like being in organisations? What is it like being a manager or being managed?	Real External One true reality (universalism) Granular (things) Order	Nominal/decided by convention Socially constructed Multiple realities (relativism) Flowing (processes) Chaos
Epistemology	How can we know what we know? What is considered adequate knowledge? What constitutes good-quality data? What kinds of contribution to knowledge can be made?	Adopt assumptions of the natural scientist Facts Numbers Observable phenomena Law-like generalisations	Adopt the assumptions of the arts and humanities Opinions Narratives Attributed meanings Individuals and contexts, specifics
Axiology	What is the role of values in research? How should we treat our values when we do research? How should we deal with the values of research participants?	Value-free Detachment	Value-bound Integral and reflexive

3.3.1 Research questions and objectives

The research questions and objectives summarised in the following Table 3-2. The questions will be answered in chapter 4, and 5 and the research will consider a few companies as testing fields and then replicate the validated framework across other companies in the GC.

Table 3-2 Research question and research objectives

Research Questions	Research Objectives
What is the available planning framework by which oil and gas assets can integrate activities and schedules with all functions to achieve a standardised way of working throughout the assets across the globe within an organisation? If not available, then develop one.	To review/develop the Integrated Activity Planning & Scheduling (IAPS) Framework, which aims to fulfil the requirements of oil and gas assets in order to achieve: a. Optimised production deferments, b. Improved new production delivery, c. Reduced cost of waste through efficiency, d. Integration of various multi-disciplinary functions by developing end-to-end IAPS process
How should the theoretically designed end-to-end framework be transformed into a practical process in assets and prove that the designed framework delivers the required value and improves business outcome?	To develop a standard deep dive and implementation approach. Evaluate asset performance based on specific business and IAPS process KPIs. Understand field challenges in the implementation of end-to-end process to create sustainability and evaluate stakeholder's response globally.
What is the appropriate governance, tactics and organisation model to ensure sustained implementation for IAPS end-to-end process?	To develop tactics to support IAPS implementation and identify the measures for effective management of post-implementation process performance of IAPS process.
How to ensure feedback loop for continuous improvement to keep proved processes is continuously updated with best practices worth replicating?	To develop a framework utilising the company practical experience with academic research and industry best practices to produce an end-to-end process. Also, use a feedback loop through assurance review and knowledge sharing across the organisations.

3.3.2 Research philosophies

There are five philosophies for research: positivism, critical realism, interpretivism, postmodernism and pragmatism.

- **Positivism:** this philosophy embraces working with an "observable social reality to produce law-like generalisations" (Saunders et al., 2016). The positivist philosophy focuses on strictly scientific methods and real data. It is the only phenomenon that can be measured, observed, counted, and leads to credible data (Crotty, 1998). Positivists develop knowledge from the philosophical perspective that reality exists in the outside world (Saunders et al., 2016). They hold the view that the researcher is independent of the subject under observation (Saunders et al., 2016), and as a result, research is conducted using quantitative methods through experiments, simulations and surveys that can be statistically analysed and replicated. Positivist research typically formulates a hypothesis for knowledge verification.
- **Critical realism:** this philosophy focuses on explaining observed events through underlying structures of reality and advocates that what is viewed is a sensation and representation of reality. Critical realism states that there are two steps to understand the world: the sensation we experience; and, the mental process that goes on for a

while after the experience (Reed, 2005). Realism, like positivism, assumes a scientific approach to knowledge development, except that the realists' philosophical position is anti-positivist, were triangulation through a survey is applied in seeking the truth. For the realists, it is crucial to provide interpretations for the socially constructed environment.

- **Interpretivism:** The purpose of interpretive research is to create a deep and new understanding of social worlds as different groups perceive realities differently (Crotty 1998). Interpretivism or social constructivists view knowledge as being socially constructed, context-dependent and complex. Interpretivism recognises the significance of history and practice in knowledge development. They hold the philosophical view that research participants play a veritable role in the research process. The researchers' background and experience influence the object under study (Crotty 1998), which shapes the discussion's interpretation with participants on the specific context being understudied.

- **Postmodernism**: this philosophy emphasises the role of relations and power of language as there is no cognitive way of determining the right way to describe the world, instead that it is agreed and decided collectively (Foucault, 1991). Within sociology, postmodernism is defined as an intellectual project developed since the 1970s mainly within philosophy and the humanities. It has been adopted, adapted, and enriched as a response to the theoretical and empirical challenges raised by contemporary developed societies' cultural features. This includes the advent of communication technologies such as postmodernism, a methodology for social science-based on intuition, emotion, faith, subjective judgment, imagination, and introspection.

- **Pragmatism:** this philosophy starts with a problem and develops a practical solution that informs future practice. Pragmatists are more concerned with the outcome and focus on research problem definition and questions considering the value-driven output. Pragmatists acknowledge that there are many ways to conduct

  research and interpret data taking the most credible methods to reach a practical solution (Kelemen and Rumens 2008). Pragmatist researchers develop knowledge without direct commitment to research philosophy and reality: "Pragmatists do not see the world as an absolute unity" (Creswell, 2013). They believe that research occurs in a varying context, be it historical, social or political, and that the world view can be dependent and independent of the mind. As a result, the pragmatists

apply pluralistic research approaches for data collection and analysis for knowledge development. Pragmatists are mostly concerned with the utilisation of available research approach to understanding and solving the research problem.

The following **Table 3-3** summarise the five research philosophies to the three assumptions (ontology, epistemology, axiology) and highlights typical research methods,

Table 3-3 Five research philosophies in relation to the three assumptions

Ontology (nature of reality or being)	Epistemology (what constitutes acceptable knowledge)	Axiology (role of values)	Typical Methods
Positivism			
Real, external, independent One actual reality (universalism) Granular (things) Ordered	Scientific method Observable and measurable facts Law-like generalisations Numbers Causal explanation and prediction as a contribution	Value-free research is detached neutral and independent of what is researched. Researcher maintains an objective stance.	Typically deductive, highly structured, large samples, measurement, typically quantitative methods of analysis, but a range of data can be analysed.
Critical realism			
Stratified/layered (the empirical, the actual and the real) External, independent Intransient Objective structures Causal mechanisms	Epistemological relativism Knowledge historically situated and transient Facts are social constructions Historical causal explanations as a contribution	Value-laden research acknowledges bias by world views, cultural experience and upbringing. The researcher tries to minimise bias and errors. The researcher is as objective as possible	In-depth, historically situated analysis of pre-existing structures and emerging agency. Range of methods and data types to fit the subject matter
Interpretivism			
Complex, rich Socially constructed through culture and language Multiple meanings, interpretations, realities A flux of processes, experiences, practices	Theories and concepts too simplistic Focus on narratives, stories, perceptions and interpretations New understandings and worldview as a contribution	Value-bound research The researcher is part of what is researched, subjective Researcher interpretations key to the contribution Researcher reflexive	Typically inductive Small samples, in-depth investigations, qualitative methods of analysis, but a range of data can be interpreted
Postmodernism			
Nominal Complex, rich Socially constructed through power relations Some meanings, interpretations, realities are dominated and silenced by others	What counts as 'truth' and 'knowledge' is decided by dominant ideologies Focus on absences, silences and oppressed/repressed meanings, interpretations and voices	Value-constituted research Researcher and research embedded in power relations Some research narratives are repressed and silenced at the expense of others	Typically deconstructive-reading texts and realities against themselves In-depth investigations of anomalies, silences and absences

Ontology (nature of reality or being)	Epistemology (what constitutes acceptable knowledge)	Axiology (role of values)	Typical Methods
A flux of processes, experiences, practices	Exposure of power relations and the challenge of dominant views as a contribution	Researcher radically reflexive	Range of data types, typically qualitative methods of analysis
Pragmatism			
Complex, rich, external 'Reality' is the practical consequences of ideas A flux of processes, experience and practices	The practical meaning of knowledge in specific contexts 'True' theories and knowledge are those that enable successful action Focus on problems, practices and relevance Problem-solving future practice as a contribution	Value-driven research Research initiated and sustained by the researcher's doubts and beliefs Researcher reflexive	Following the research problem and research question Range of methods: mixed, multiple, qualitative, quantitative, action research Emphasis on practical solutions and outcomes

Table 3-4 summarises the IAPS research objectives of various methodologies and compares ontology, epistemology and axiology.

Table 3-4 Research objectives of various methodologies

Research Objective	Ontology	Epistemology	Axiology
To develop Integrated Activity Planning & Scheduling (IAPS) framework which aims at fulfilling the objectives in Oil and Gas assets in order to achieve a) Optimised production deferments, b) Improved new production delivery c) Reduced cost of waste through efficiency d. Integration of various multi-disciplinary functions by developing "end-to-end" IAPS process.	Knowledge is derived from a real process where challenges to opportunities were identified in the current research project.	Data was collected through multiple-case studies and historical experiences through qualitative Questionnaires and validated through expert opinion surveys from assets across the globe; thus, an Epistemological view approach was applied.	The study was not independent of the researcher at the initial knowledge drawing stage, thus value-bound.
Evaluate stakeholders' response across the globe and develop "End to End" Process maps to improve global processes and understand field challenges in the implementation of End to End Process.	In this research project data, input and analysis were drawn from process maps across global assets and facts are related to "how things really are" and "how things work".	The research project seeks to collect and analyze data to provide knowledge about effective management of integrated activities spread across disciplines and functions. Therefore, it is deemed suitable	This study was not independent of the researcher, thus Value-bound.

Research Objective	Ontology	Epistemology	Axiology
		to approach the study through the pragmatic lenses of "what works" in finding an appropriate answer to the research questions.	
To identify the measures for effective management of post Implementation Process Performance of IAPS process	Since ontology is associated with the question "whether entities need to be perceived as objective or subjective" both assumptions are considered in this project. This activity assesses the implemented process changes, comparing the target performance of the affected KPIs to the new performance of the improved process.	Since the background and experience of this study's existing process include people, process and technology with wide-ranging experience in the management, Epistemological views will be applied for most of the research objective.	The study was not independent of the researcher thus Value-bound
To develop a framework and Utilise the company practical experience and leverage it with academic research and industry best practices to produce the best-in-class end-to-end process.	Knowledge is derived from deep-dive workshops with Subject Matter Experts (SMEs) from around the globe to ensure quality process design. During this activity, understanding is obtained of how the existing process really is conducted; therefore, realism applies.	The study seeks to identify the measures for managing identified issues affecting each business unit's performance. To identify the measures; data were collected through evidence-focused reviews and experts' opinions survey using the Delphi method. A Pragmatists research approach was applied.	The researcher's experience and opinion were required at the initial stage of drawing Knowledge but the researcher’s opinion and experience were not required at the knowledge validation stage as it is collective feedback from different global entities within the organisation. That study was not independent of the researcher at the initial knowledge drawing stage; thus Value-bound. At the knowledge validation stage, the study became integral and reflexive as it includes incorporating the lessons learnt across global assets.

3.4 Research approach

A research approach could either be inductive, deductive or abductive (Bilau et al., 2017). From a data collection point of view, the deductive approach concerns theoretical a development that is rigorously evaluated through several propositions related to the theory, and it is more predisposed to positivist research. Similarly, the inductive approach concerns making sensible meaning of the data collected and analysed from a given phenomenon by identifying themes and patterns for the formulation of a theory presented in the form of a conceptual framework. The inductive approach is predisposed to interpretivism research, often concerned with the context being understood and the utilisation of small sample size deemed to be appropriate. The abductive approach also relates to research data collection for exploring a given phenomenon, themes and patterns identification, conceptual framework development, and testing the validity of results. Research that starts with a theory, and designs a strategy to test the developed theory, is considered deductive. If the research starts with data to explore or develop a theory, then the approach is inductive. Where the research starts with data to explore or develop a theory then test the theory through additional data and modify then the approach is abduction. (Ketokkivi and Mantere, 2010). There is also an option of using different approaches in combination depending on the research requirements. Table 3-5 summarises the logic, generalisability, use of data, and theory to each of the three approaches.

Table 3-5 Deduction, induction and abduction: from reason to research (Saunders et al., 2016).

	Deduction	**Induction**	**Abduction**
Logic	When the premises are correct; the conclusion must be true	Known premises are used to generate untested concussions	Known premises are used to generate a testable conclusion
Generalisability	Generalising from the general to the specific	Generalising from the specific to the general	Generalising from the interactions between the specific and general
Use of Data	Data collection is used to evaluate propositions or hypotheses related to an existing theory		Data collection is used to explore a phenomenon, identify themes and patterns, locate these in a conceptual framework and test this through subsequent data collection and so forth
Theory	Falsification or verification	Generation and building	Generation or modification, incorporating existing theory where appropriate, to build a new theory or modify existing theory

The abductive approach is appropriate for this research as it examines different elements in the IAPS framework, building on existing data, building a robust framework, and then testing the validity of the framework validity by collecting additional data.

3.5 Research methods

A research strategy reflects a researcher's plan for answering research questions. It is the procedural framework between the philosophical research positioning, and the choice of methods to be applied for data collection and analysis.

The use of quantitative, qualitative or mixed methods research depends on the research nature and requirements. Quantitative is more related to numeric data, and qualitative considers non-numerical data. However, this simple differentiation is narrow and can cause problems. The research methodology is dictated through critical thinking by linking the research philosophy with the research assumptions and questions. The problematic side comes from the occasions where numeric and non-numeric data are used within one investigation; an example is a questionnaire followed by an in-depth interview with some open questions to deepen the analyses in one area. In this case, the methodology is defined as mixed (Saunders et al., 2016).

- Quantitative research design is typically related to positivism, but can also be used in pragmatist and realist philosophies. It allows the examination of relationships between variables using a wide range of graphical techniques and statistics. Quantitative methods use deductive approaches and might use a single data collection technique (mono method) such as questionnaire, or more than one technique (multi-method) such as questionnaire and structured observation using statistical analyses. The quantitative method includes strict controls in data collection to ensure validity and associated with experimental research strategy (Saunders et al., 2016).
- Qualitative research design is often related to interpretive philosophy as researchers need to make sense of the phenomena studied and be used in pragmatist and realist philosophies. The researcher needs to operate within a natural setting and context and build trust to obtain an in-depth understanding (Denzin and Lincoln 2011). A qualitative method starts typically with an inductive approach, but can also start with a deductive approach to test an existing theory (Yin, 2014). Qualitative methods are used to study the participant's responses and analyse the relationship to create a conceptual framework. It uses non-standardised data collection such as semi-structured interviews which are considered as either mono or multi-method such as

in-depth interviews and diary accounts. Qualitative methods use case study, historical research, grounded theory and action research (Saunders et al., 2016).

Figure 3-1 and Figure 3-2 represent the mind mapping for qualitative and quantitative methodologies (Queirós et al.; 2017). Mind mapping considered an excellent tool to promote thinking, encourage brainstorming and understand complex reality (Davies, 2011). Each method has its characteristics, and the researcher should understand which situation the most appropriate method is.

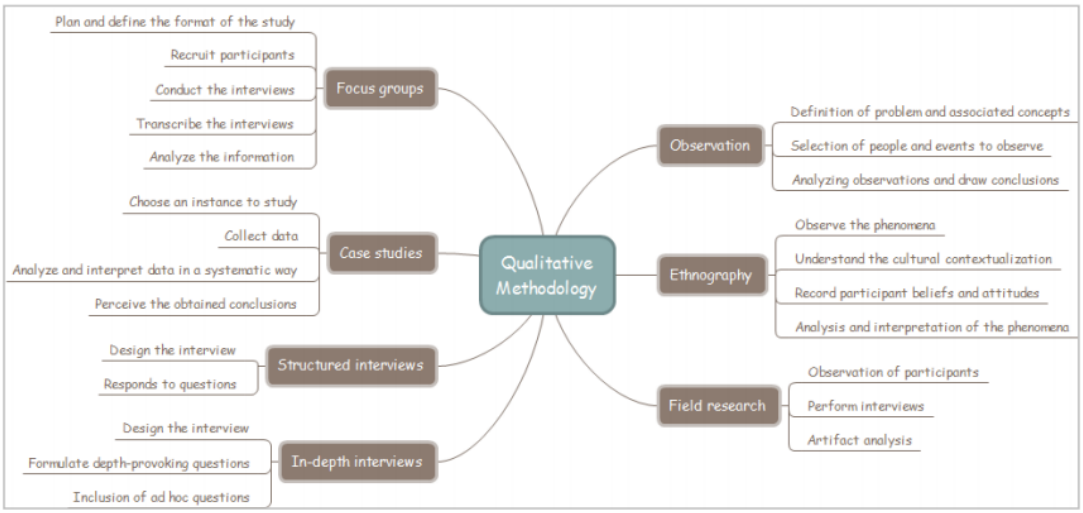


Figure 3-1 Mind map representation for qualitative methodologies (Queirós et al., 2017)

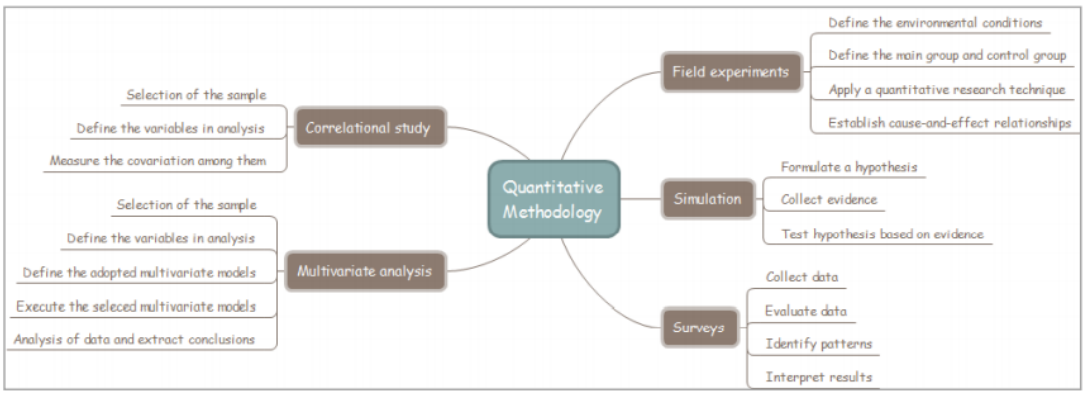


Figure 3-2 Mind map representation for quantitative methodologies (Queirós et al., 2017)

3.6 Research strategy

A strategy is a plan of actions to achieve a goal; different strategies are available such as experiment, survey, archival and documentary research, case study, ethnography, action research, grounded theory and narrative inquiry (Denzin and Lincoln, 2011).

Experiment: related more to the natural sciences and are often considered as laboratory-based research. It studies the impact of changing an independent variable on a dependent variable to test hypotheses (Queirós et al.; 2017). The following Table 3-6 summarise the advantages and disadvantages for the field experiments.

Table 3-6 Experiment method advantages and disadvantages (Queirós et al.; 2017)

Method	Advantages	Disadvantages
Field experiments	Works in a natural setting - Larger scale research - The observations of the experiments do not influence subjects	Difficult to control variables - Difficult to replicate the same conditions of the study - Ethical problems can arise

Survey: more common in business studies and usually linked to a deductive research approach. It uses questionnaires, structured interviews, and structured observations to collect standardised data designed to identify how people behave or think about the research subject. Surveys are a research technique that allows collecting data directly from a person through a set of questions organised in a specific order. It is one of the most used quantitative techniques, since it allows obtaining information about a given phenomenon, through the formulation of questions that reflect the opinions, perceptions and behaviours of a group of individuals. Surveys offer several benefits – they can provide high representativeness of the entire population, and are a low-cost method compared to other alternatives. On the other side, the reliability of survey data depends on the survey structure and the accuracy of the respondents' answers (Queirós et al.; 2017). The following Table 3-7 summarise the advantages and disadvantages for the surveys.

Table 3-7 Surveys method advantages and disadvantages (Queirós et al.; 2017)

Method	Advantages	Disadvantages
Surveys	Low development time -Cost-effective - Easy data collection and analysis using statistical methods - Can reach high audiences - High representativeness - Not affected by the subjectivity of the researcher	Reliability of data is very dependent on the quality of answers and on the survey' structure - The rigidity of the structure - Do not capture emotions, behaviour and changes of emotions of respondents

Archival and documentary research: depends on accessing archives and analysing available documentaries. The archives might include communication between individuals, diaries, minutes of the meeting, calendars, agreement, policy, plans, reports, and media sources. As most of these data are not initially created for the research purpose and considered secondary data; extra precaution needs to be applied to analyse the information and draw relationships.

Case studies: can be referred to a person, group, event, organisation, association, or as many other case objects. It is vital to select the right case to be studied and understand its boundaries and context. Understanding the real-life setting and context helps reduce threats of misinterpretation of the results, and reduces the number of variables (Yin, 2014). Case studies have been criticised based on the misunderstanding that the results are very attached to specific conditions, and the contribution to knowledge cannot be generalised for a full benefit (Flyvberg, 2011). However, case studies provide a means to investigate complex situations with multiple variables under analysis and are particularly appealing for advancing a field's knowledge base. They are very popular in applied sciences in the areas of social sciences, education and health.

Case studies offer an opportunity for innovation and challenge current theoretical assumptions. They can also be a good alternative or complement to the focus group method. However, it can be challenging to establish a cause-effect connection to reach conclusions, and it can be hard to generalize, mainly when a small number of case studies are considered (Queirós et al.; 2017). The following Table 3-8 summarise the advantages and disadvantages for the case studies.

Table 3-8 Case studies advantages and disadvantages (Queirós et al.; 2017)

Method	Advantages	Disadvantages
Case studies	Provide detailed information about individuals - Offer an opportunity for innovation and change current theoretical assumptions Can be a good alternative or complement to focus groups	Difficult to establish cause-effect connections - Hard to generalize from a small number of case studies - Ethical issues, especially of confidentiality, may appear - Difficult to create a case study that suits all subjects

Ethnography: is one of the earliest qualitative strategies used to study the culture of a social world of a group. Ethnography consists of observing a situation and conducting interviews with its participants. In ethnographic research, the researcher attempts to interpret the situation being observed from the participants' perspective. According to Nurani (2008), two fundamental characteristics of ethnography can be found: (i) the observation takes place in a natural setting, and (ii) researchers must understand how an event is perceived and interpreted by the people in a community. Observation and ethnography are very similar methods. However, Charmaz (2006) stated that in ethnography, the researcher must have a more holistic view, where the researcher should examine the details of all the aspects available.

The most significant advantage of ethnography is that the researcher can have in-depth knowledge about the analysis situation. On the other side, ethnography requires a considerable

investment in the researcher's time and the results produced by the study can be very diverse and can become challenging to extract precise and targeted conclusions. The main challenge with this strategy is the quality representation to the group behaviours and storytelling which depends a lot on the researcher's prior understanding (Denzin and Lincoln, 2011). Queirós et al. (2017) summarise the advantages and disadvantages of the surveys in Table 3-9.

Table 3-9 Ethnography advantages and disadvantages (Queirós et al.; 2017)

Method	Advantages	Disadvantages
Ethnography	Based on observation and interviews with the direct-involved authors - Provide in-depth findings - Suitable to explore new lines of research	Very time consuming - Challenging to get concise and precise conclusions - The researcher needs to have an in-depth knowledge of the problem domain

Grounded Theory: It provides a systematic approach to collect and analyse qualitative data and then produce a theory grounded to this data that can be widely used in a broader business context. It is suited to qualitative studies to conduct stage analyses before moving to the next stage. This strategy is emergent, but this emergence is also considered one of the limitations due to the increased time required to undertake (Charmaz, 2006).

Narrative Inquiry: is associated with a small and purposive sample, and draws a conclusion that can be explained using a sequence of events to convey a meaning to the researcher. Narrative Inquiry is a story that interprets events as a participant is a narrator. In-depth interviews are used as the primary data collection to collect stories; the researcher's mission is to analyse the relationships and construct explanations that derive theory (Cassell and Symon, 2004).

Action research: an iterative process designed to create a solution to a real problem in a specific organisation through participation and collaboration. The outcome of the study can be generalised and implies the organisation and participants beyond the research project. Coghlan and Brannick (2014) identified five themes (purpose, process, participation, knowledge, and implications) for a successful action research strategy. Action research is about 'research in action rather than research about action'; it focuses on exploring and evaluating different solutions and promoting change within an organisation. Participation is crucial in action research, and the quality of discussion and sharing of knowledge is the most significant success factors. It works in two ways: the researcher transfers knowledge onto the organisation; and the organisation participants share issues, experiences, reflect on data, and generate solutions. As the solution is developed collaboratively, the organisation generally shows more ownership for implementation and improvement. Thus, action research is well known as a useful

technique for organisation change management. The researcher acts as a facilitator in knowledge sharing workshops to support quality discussions, which are often considered intensive and can become one of the main challenges. Therefore, action research can be more suitable for part-time students who research their organisation (Saunders et al., 2016). As part of action research, the strategy implemented in this research has incorporates both quantitative and qualitative strategies to achieve the research aim.

3.6.1 Time horizon and techniques

The time horizon is an essential element in the research methodology; data collected over a snapshot in time is known as cross-sectional, whereas a serious of snapshots as a representation to events over a given period is known as a longitudinal study. It depends on the researcher's research time constraints, but cross-sectional studies typically utilise a survey strategy and focus on the relationship between two or more variables. It is also possible to use other qualitative methods in cross-sectional investigations, such as interviews conducted over a short period. Longitudinal research provides control for the researcher over the variables being studied as the long period of gathering and analysing the data provides the capacity to study concepts in depth (Saunders et al., 2016).

3.6.2 IAPS research approach

This research project aims to develop a framework for IAPS implementation that delivers sustainable and consistent performance and spread over many companies in different countries belonging to a GC. The research approach should be standardised and applied to all operating companies. Having discussed different research philosophies, the IAPS framework research chosen a pragmatism philosophy dealing with ontology assumption and objectivism. The research focussed on organisation effectiveness, and the relation between different elements to deliver improved results through the IAPS framework. The research also deals with flux concerning inadequate processes, different working, practices, and different level of experiences. The reflexive tool “Heightening Awareness of Research Philosophy (HARP)” designed by Bristow and Mark Saunders, was used to explore the research assumptions and values and insight into related philosophy. The tool is a questionnaire consists of 30 statements in which the researcher answer in different ranges starting with strongly agree and end up with strongly disagree. There is a specific score for each statement, and the tool summarises different scores with regards to different research philosophies.

The research combines both qualitative and quantitative methods; which a pragmatic approach suggesting that using a single method might not be comprehensively taking the nature of IAPS

framework development. The research is evaluative and focused on how well the existing IAPS system worked. The evaluation contains questions relating to what, how, and why to test an organisation's effectiveness concerning the integration of planning and scheduling activities. The IAPS framework research uses the Action Research strategy due it being the most appropriate strategy to study a real and known problem and develop a solution within the organisation. The strategy utilised the depth of knowledge and wealth of experience in the organisation to facilitate change management. The data gathering conducted in different companies and countries; hence a longitudinal time horizon was applicable. The data was mainly primary and collected through observation, interviews, questionnaires, and deep-dive workshops. The acceptance of the developed solution will require more alignment with IAPS SMEs and practitioners. The details of the fieldwork and deep-dive workshops explained in Chapter 4.

The researcher works in the GC head office; part of the global excellence team and has access to various companies' data belong to the GC. He is a certified lean six sigma practitioner, principal technical expert and certified change manager. He took the ownership and responsibility to conduct an industrial PhD to improve the GC business outcome by developing a comprehensive IAPS framework. The research used in-house expertise to understand what is not working in the organisation and support the research with learning from other literature and best practices worldwide. Such a solution is more natural to be adopted by the organisation and should be more aligned with the company overall improvements plan. The action research approach structured around four cycles: discover cycle; deep dive cycle; development cycle; and, test and learn cycle, which is illustrated in Table 3-10).

Table 3-10 Approach method and goal built on Action Research Strategy

Approach Method	Goal
Discover cycle	At a global level; discover the current challenges the GC faces in implementing effective IAPS and identify industry requirements to build the end-to-end IAPS framework.
Deep dive cycle	At asset/company level; conduct fieldwork and deep-dive workshops in case-study companies to verify pain points, confirm challenges and identify best practices in implementing effective IAPS process.
Development cycle	Take the fieldwork learning and develop the IAPS framework to address the GC challenges and fulfil its requirements.
Test and Learn cycle	Test in case-study companies the developed IAPS framework and learn from the deployment for further enhancement. Continuously improve the global model to achieve top quartile performance in all operating companies.

Discover Cycle: During the discover cycle phase, research was conducted at a high level (global level hierarchy) to review the current challenges the GC faces in implementing the

IAPS process. At this level, the research project elicited the GC requirements to develop a practical IAPS framework that reflects the industry requirements. Supporting knowledge was obtained through literature review, attending global seminars, reviewing international standards, and through discussions with partners in the same industry or outside the industry. The discovery cycle also captured learning about the most appropriate way to set up the project, the most appropriate approach for different operating companies (whether tailoring is necessary), and preparation for a solution pack.

Deep Dive Cycle: In this cycle, fieldwork and deep-dive workshops conducted in three case-study companies which considered representative to the GC business to elicit an understanding of the gaps and challenges at the operating company/asset level. This fieldwork provided insight and more in-depth knowledge of the organizational challenges to implement the IAPS process. The following criteria used for selecting the case-study companies to ensure they were broadly representative of the types of challenges associated with integrated activity planning implementation:

- They should be a critical asset/company to business;
- They should have a high schedule deferment or cost overrun (>15%); and,
- They should be facing challenges in IAPS plan delivery (<65%).

Structured deep-dive workshops were conducted, inviting the case-study companies practitioner, subject matter experts, and management. Through these workshops, data was gathered and analysed to group similarities between the case-study companies to develop a fit for purpose solution. A detailed discussion of this cycle outcome is included in Chapter 4.

Development Cycle: This was the focal point of the knowledge generation of the research; all learning from the previous two cycles for the GC level and operating company/level used to develop the end-to-end IAPS framework. In the development cycle, insight on best practices was gained, which were considered to be worth replicating internally within the group or externally from the same industry or different industries. In this cycle, visits were planned to map out how the IAPS process has been implemented in some of the acceptable IAPS performance assets within the business and capture learning and critical success factors. These learning allowed refinement of the approach for testing and deployment.

Test and Learn Cycle: This cycle focussed on the three selected case-study companies. A researcher from the GC headquarters and local case-study companies team was set up to test the IAPS Framework effectiveness in addressing the identified gaps during Cycles 1 and 2. The learning from this phase used to develop an improved global standardised process guide

and deployment plan with implementation resources to improve efficiency and reduce cost. The learning part focussed in continuous improvement and continue deploying the framework in the GC. This final part is outside the scope of this research, as the implementation in all assets estimated to take a minimum of eight years.

The goal of the end-to-end IAPS framework for the GC was to deliver improvements in business performance in HSE, production, and cost. It was expected that this research would transform the organisation to a process thinking mindset, taking the enterprise as a priority, and develop competent planning organisation that drives integration, challenges various stakeholders for better optimisation, and highlights risks/opportunity for informed decision using strict change management.

3.7 Quality of research

A scientifically, rigorous approach used to mitigate threats and ensure the quality of the IAPS framework research. Reliability, consistency and validity are essential measures of research quality. The quality of research is crucial to ensure the designed IAPS framework is valid to be deployed in all companies belong to the GC. The IAPS framework research criteria for quality are:

- Reliability: the research design is replicated in different countries and achieve the same findings; the same level of quality is obtained wherever it is applied. Reliability of the IAPS framework design will be checked through the three case-study companies. The aim is to develop a standard deployment design.
- Consistency: the findings are consistent or aligned and inclusive with framework elements. Each of the three case-study companies will have their in-house expertise. This will be a real examination for consistency as different individuals in three different case-study companies are applying the methodology, and the aim is to find consistent findings.
- Validity: where the measures are appropriate, analyses are accurate, and findings are generalisable. The three case-study companies will examine the validity of the research design. The IAPS framework intended to be a single framework addressing integrated activity and scheduling challenges in the GC, and hence accuracy of analyses and generalisability of findings is crucial to establish a comprehensive framework.

Developing a comprehensive framework to address all GC problems in IAPS and improve business performance is challenging. The efforts spent in this research and the detailed workshops conducted in the three case-study companies explained in the next chapter.

Chapter 4 FIELDWORK DEEP DIVE

This chapter discusses the Deep Dive cycle, which conducted from March to September 2016. This cycle aimed to elicit the gaps and challenges at the operating company/asset level and undertake various workshops to deep dive in data and establish why the integrated activity planning procedure implementation has failed to deliver the level of performance expected within the asset. Three case-study companies were selected using the GC agreed on criteria: a critical asset/company to business; high schedule deferment or cost overrun (>15%); and facing challenges in integrated activity plan delivery (<65%). The case-study companies were named: Company-A, Company-B, and Company-C.

Within the Discover Cycle, a workshop was conducted at the GC level with several subject matter experts of the IAPS process from different countries, to frame the problem statements. The workshop started with considering current performance data for both the GC and integrated activity planning procedure in different countries. It then analysed the main challenges faced by the subject matter experts in their companies to implement integrated activity planning procedures. The workshop revealed the following challenges in implementing the integrated activity planning procedure in the GC:

- There was no clear direction setting by top leaders: the business goals were visible at the upper management level, but the transfer to lower and execution levels was missing. The company vision was not translated into an operational sense by building affordable plans.
- Lack of some leaders' ownership of functional and integrated plans: many did not attend meetings and did not hold people accountable for planning performance. The lack of leadership support resulted in unsolved conflicts, abused and unrealised opportunities, and sub-optimum resource management.
- Planning done in silos due to limitations in the existing integrated activity planning procedure: the existing procedure was very high level and not sufficiently explicit to guide functions and asset planners to follow a stepwise process, which would, in turn, lead to a different interpretation and application. There was a lack of understanding of the procedure. The procedure was also not fully integrated with other strategic asset planning, business planning, maintenance execution, turnaround, material management, and logistics management.

- Insufficient medium-term planning led to the lost value of optimisation in the long term: analysing the current gaps in the GC upstream operations integrated planning performance, indicated that many companies executed integrated activity planning in the short-term (90 days) horizon only, and with the single objective of minimising deferment.
- Inadequate management of change to ensure robust risk management and a trade-off between different opportunities: the safeguarding of plan delivery is paramount, and performance should be protected through standardised management of the change process which was not currently available. Each discipline, function, and asset used different procedures and requirements, which resulted in scattered information and practices, and a loss of a straight line of sight to the number of changes accommodated every month.
- The activity readiness check is not being followed to mature activities: activities should be screened using a pre-defined activity readiness checklist in different plan horizon gates to ensure readiness for execution. The functional planners typically indicated that their activities were mature and ready for execution most of the time, whereas, in reality, they were not and subsequently resulted in late cancellation during the execution phase and impacted the overall business performance.
- Poor functional plan credibility: most of the function's plans were not linked to current business priorities; they contained low levels of activity definition or detail, and occasionally one functional plan negatively influences another making it sub-optimal.
- Inconsistent application of a standard toolset: each company belong to the GC selected different software applications to build an integrated activity plan; there is no consistency across the companies belong to the GC. The software applications were not fully integrated and did not support each other resulting in intensive manual data entry and repetitive work.
- Inconsistent documentation of risk and opportunity: The plan did not document all reviewed risks and opportunities, and did not provide an auditable trail for further improvements. Such a transparent register helps manage risks in executing plans and generate discussions on how to improve the quality of plans.
- Non-standard reporting of integrated activity planning Key Performance Indicators (KPIs): not all companies were currently reporting integrated activity planning

KPIs, and some use different sets of KPIs. The existing performance dashboard highlights the planning process performance only without linking these performance indicators to business performance, which undermines the necessary improvement to enhance business performance.

- Competency of Role: assets lacked competent planners in process and systems and an understanding of the roles within the process. There was no clear training and coaching strategy with agreed targets. The succession planning was weak, and planners felt that they had reached the end of the road in their career.
- Continuous improvement plans are missing: a root cause analysis of plan performance was not undertaken consistently, and a feedback loop was not established. There were inadequate sharing of best practices across the different companies belonging to the GC and sub-optimal knowledge sharing, which slowed the group's improvements.
- Insufficient integration of resources: integrated activity planning maximises the business value when it is fully integrated with logistics, materials management, and maintenance. It should create a single integrated process that enables assets and functions to develop well-aligned forward-looking, integrated plans in all-time horizons that support decision making for shared resources utilisation and optimisation to achieve business outcomes.

At a deeper level (i.e. company/asset), these challenges must be elicited and verified. The following section explains the workshop structure (input) and the 2nd section explains the workshop outcome (output). The 3rd section analyses the collected data and summarises the outcome.

4.1 Deep dive workshop structure

The next stage was to investigate the challenges the operating company and asset level with the discover cycle outcome established. **The Deep Dive cycle** approach was developed as a series of seven structured sessions and workshops, as illustrated in Figure 4-1 and discussed below.

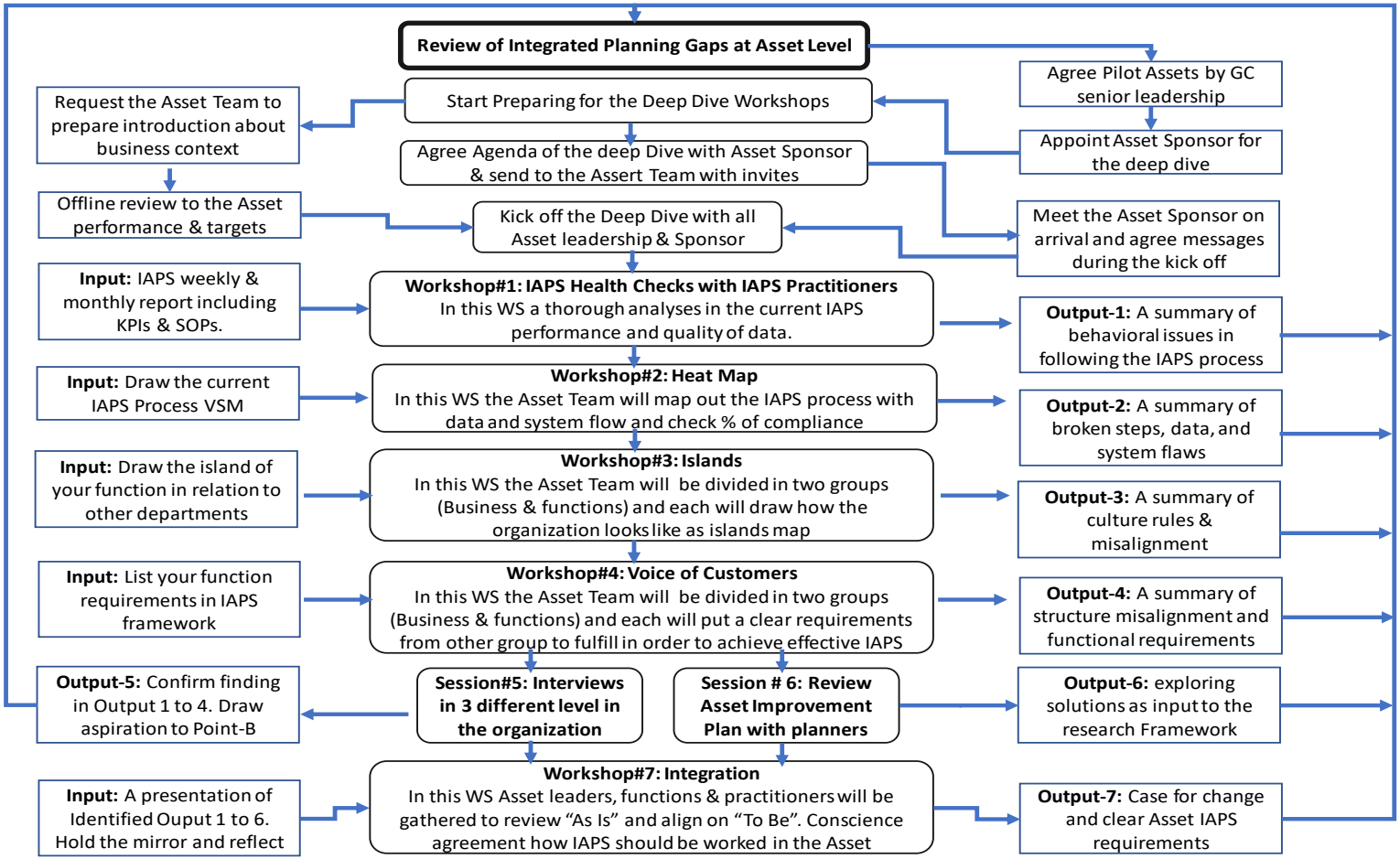


Figure 4-1 The Deep Dive cycle approach.

The deep-dive workshops conducted using three case-study companies in-house practitioner, subject matter experts, and asset management. Through these workshops, data gathered, as illustrated by the outputs within Figure 4-1, and analysed to identify similarities between the case-study companies to develop a fit for purpose solution. The approach adopted for these deep-dive workshops was:

- Assign a host from the case-study company for the review and implementation. It was established that the host should be a senior leader, with a clear understanding of the IAPS process, and is influential on the asset. Hence it was vital that they were committed and typically can be assigned as the future process owner of IAPS in that company.
- Organise the deep dive workshop agenda, which is typically planned over five working days, and involves three subject matter experts from the global team, as well as a wide range of asset IAPS practitioners, functional planners, operations and maintenance leaders, drilling and projects leaders, finance, contracting, and supply chain management. Such a broad range of disciplines/people is essential to cover all functions challenges in IAPS to obtain different views of what good looks like from functions' prospective.

The agenda included the following items:

Day-1: Started the deep-dive program with a meeting with the asset sponsor to agree with messages and confirm the workshops' anticipated outcome. It is crucial to agree on messages on the value of IAPS in the company performance, the importance of the deep dive in the asset to understand challenges, expectation from participants during various workshops, and anticipated outcome and way forward. A clear message from senior leader helps in conducting efficient deep dive and accelerate integration between participants. After meeting the asset sponsor; a deep dive workshop would start with an introduction by the leadership team to provide an overview of the company operations, challenges, business context, goals and targets. Such overview helped the researcher understand more about the company and consider the local content such as regulations, influential stakeholders, and dynamics during the IAPS deployment.

After the introduction presentation; **Workshop#1** commences the deep dive for the IAPS process health check, and focusses on reviewing process performance, planning systems integration, plan transparency and quality, data ownership, and meeting terms of reference and effectiveness. The input to this Worksop is the IAPS weekly & monthly reports including KPIs and the output is a summary of behavioural issues in following the IAPS procedure; refer to

Figure 4-1 The Deep Dive cycle approach. This session provided the basis for creating a shared and thorough understanding by the researcher and the IAPS SMEs particularly for those sensitive gaps such as comments about leadership support, colleagues competence, or behavioural issues that generally do not surface quickly without a focussed and structured discussion. The health check consisted of a series of questions and statements to measure the company's process effectiveness; refer to APPENDIX-B. Each statement was be ranked from 0 to 5, in which 0 is lowest, and 5 is the highest score; whereas three is average and regarded as minimum requirements. A high score was used to reflect that the process element existed within the asset, was implemented, and effective. The health check is discussed as a group and scored as a group. The scores summarised in xl-sheet and spider diagram produced to motivate discussion. The health check brought the more focused discussion on why an IAPS element was ineffective and what was subsequently required to be included in the new IAPS framework in order to improve. It also included some good practices for the other elements that were working effectively, which helped develop the IAPS framework.

The second item on the agenda for day 1 focussed on conducting **Workshop#2** the **Heat Map exercise** in which the asset team evaluate the implementation of the existing IAPS process with some discussion about data quality and systems used for each step (input) and the output is a summary of ineffective steps, data, and system; refer to Figure 4-1 The Deep Dive cycle approach. This workshop aimed to understand how the IAPS process was implemented in the asset and the pain points and ineffective elements. The ranking for the heat map exercise is counting the total steps in the company process and then assign a score of 1 point for a followed step (green), 0.5 points for a partially followed step (amber), and zero points for a not followed step (red). The total number of scores divided by a total number of steps in the process, and the result presented in %. The detailed process steps and the number of steps may vary from company to company. The GC existing integrated activity planning procedure consists of four high-level blocks (build functions plans, prepare for integration, produce integrated plans, and manage integrated plan) whereas left the detailed process steps to each company and supported with high-level description.

At the end of each day of the workshop, the core team focusses on discussing feedback from attendees and what can be improved the next day. The discussion is summarised in a flip chart or one slide and shared with attendees in the next day first in the morning intending to improve the workshop's structure and discussion dynamics.

Day-2: Two workshops are planned for the second day. **Workshop#3** the **Islands exercise** is conducted, which divides the asset team into two groups (business and functions), with each

drawing an illustration of how the organisation looks like an island map. The input to this Worksop is drawing the island of each function to other departments, and the output is a summary of cultural rules & misalignment; refer to Figure 4-1 The Deep Dive cycle approach. The island map was used to present the departments' integration element, communication gaps, dependency for information flow, and examine the trust between the team members. This exercise focussed on the soft cultural elements and organisation structure challenges.

The second agenda item for day 2 focussed on conducting **Workshop#4** to understand the **Voice of the Customer** which are recognised to be all functions in the company contribute to IAPS process and Voice of Business, represented by the IAPS team. The input to this Worksop is listing all functions requirements in the IAPS framework, and the output is a summary of misalignment (if any) and agreed functions requirement; refer to Figure 4-1 The Deep Dive cycle approach. This workshop consisted of a syndicate work and presentation by the two groups. This workshop aimed to establish an agreed-onset of requirements between all company functions on the most appropriate approach to implementing the IAPS framework and what is required to be delivered. The discussion focussed around answering three questions: what is the requirement for better IAPS performance; when is it needed; and, who should deliver it? The answers to these three questions were summarised in a table to promote a clear dialogue between the workshop participants. The researcher subsequently used these requirements to develop the new IAPS framework.

Day-3: Session#5 consisted of interviews (input) to verify the understanding of the researcher about the ineffective elements, and elicit priorities from the company representative, as well as opinion about how the gaps should be addressed (output); refer to —the set of questions summarised in APPENDIX-A.

The interview designed to consider three different levels in the organisation:

- Leadership (strategic): to understand aspirations, opportunities, main challenges, and expectation of what good looks like;
- Middle management (tactical): to understand challenges, requirements, quick wins, culture, and structure; and,
- Practitioners (planners) and executors (operational): to understand existing leadership, culture and competency gaps.

The outcome interviews and critical points were presented to the leadership on Day-5 during the integration workshop to check the validity and gain acceptance and commitment for a case for change.

Day-4: Session#6 focused on reviewing the company's ongoing improvements for developing the IAPS process (input). This review included an exploration of best practices and potential solutions to address these gaps. The informed good practices will be included in the solutions suite case used while developing the global end-to-end IAPS framework (output); refer to Figure 4-1 The Deep Dive cycle approach.

Day-5: Workshop#7 focus was to **Conduct leadership Integration.** The input to this Worksop is a presentation of identified output 1 to 6 from previous workshops, and the output is creating a case for change and agreeing in asset requirements in the IAPS framework; refer to Figure 4-1 The Deep Dive cycle approach. Such integration was considered as the most important day of the week, as the leadership awayday allowed the creation of alignment of thinking between the top leaders (company managing director, asset manager, finance manager, logistics manager, operations manager, subsurface manager, project manager, maintenance manager, contracting & procurement manager, exploration manager, wells manager, and human resources manager) in the company for the agreed gaps of the IAPS process. This alignment would allow the development of a case for change to implement the new end-to-end IAPS framework. In this workshop, the asset requirements for IAPS consolidated and considered as an input to the new framework design. Quotes from interviews at earlier points within the week presented to test if all the leaders recognised the current gap in their company, and to gain alignment on the way forward. The aim was to end the deep dive with a clear commitment to implement the proposed new IAPS framework and test it in the case-study companies to review its effectiveness.

The researcher's role was to facilitate the one-week review, encourage openness and transparency, and structure the discussion around the requirements for the creation of the IAPS framework. The outcome of these workshops and sessions allowed the researcher to discuss with IAPS SMEs to understand and agree on the IAPS requirements at an asset level and establish good practices as potential solutions. These requirements and potential solutions will be used to develop the end-to-end IAPS framework.

4.2 Case-study Company fieldwork

The following outcome is recorded for each company deep-dive sessions following Figure 4-1 The Deep Dive cycle approach. Seven outputs were receded from seven deep-dive workshops and discussed in the following section.

4.2.1 Company-A deep dive output

The following outputs reflect the results from the deep-dive workshops with Company-A. From **Workshop#1: IAPS process health check,** the radar graph illustrated within Figure 4-2 shows the distribution of scores amongst the IAPS process key elements. Around 45 participants attended the workshop and discussed the company performance in each element.

The score is a collective view of all participants. Company-A scored low in having a clear message to the importance of IAPS in the company within the following categories: leadership of process in asset/business; ranking and prioritisation criteria; change control; standard operating procedure; function's plans in IAPS; integrated plans; productive IAPS meetings; data governance and integrity; integration with work management systems; organisation structure; IAPS roles and responsivities; business strategy; direction and outcomes; and, performance management. Whereas Company-A scored high in developing a planning calendar, integrating third party activities in the IAPS plan and using IAPS system to manage the plan. These are considered best practices that will be added to the solutions suite and considered while developing the IAPS framework.

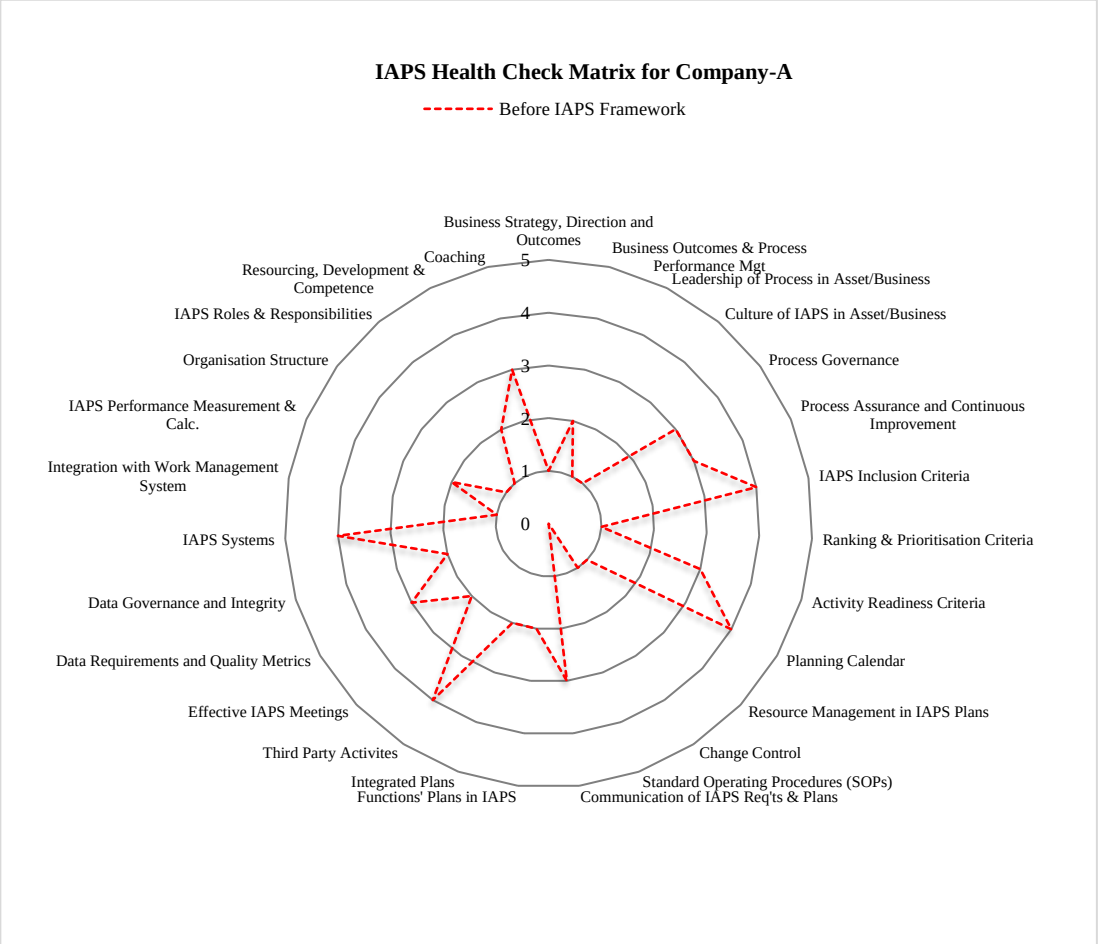


Figure 4-2 Company-A IAPS Process health check exercise outcome

From **Workshop#2: Heat map exercise** presented in Figure 4-3, there were 22 steps mapped in IAPS process used by the Company-A. Out these 22 steps; 6 steps were fully implemented, nine steps were partially implemented, and seven steps were not implemented. From the IAPS process, prospective “build functions plan” block and “prepare for integration” seems to be in fair shape. Company-A's most ineffective blocks were in “integrating plans” and “managing IAP” as there was no clear definition to inclusion criteria, activity readiness, or data requirements.

Through reviewing the heat map process, it became clear that sub-activities were not conducted by the team, causing a disfunction in producing a quality integrated plan. Discussing further by the group to understand the reason for not following these steps in the process; they were linked to the planners' low competence and inadequate training and development. The

overall score of Company-A in Heat Map was 47.5% as followed steps which mean 52.5% of the steps have not been followed or partially followed.

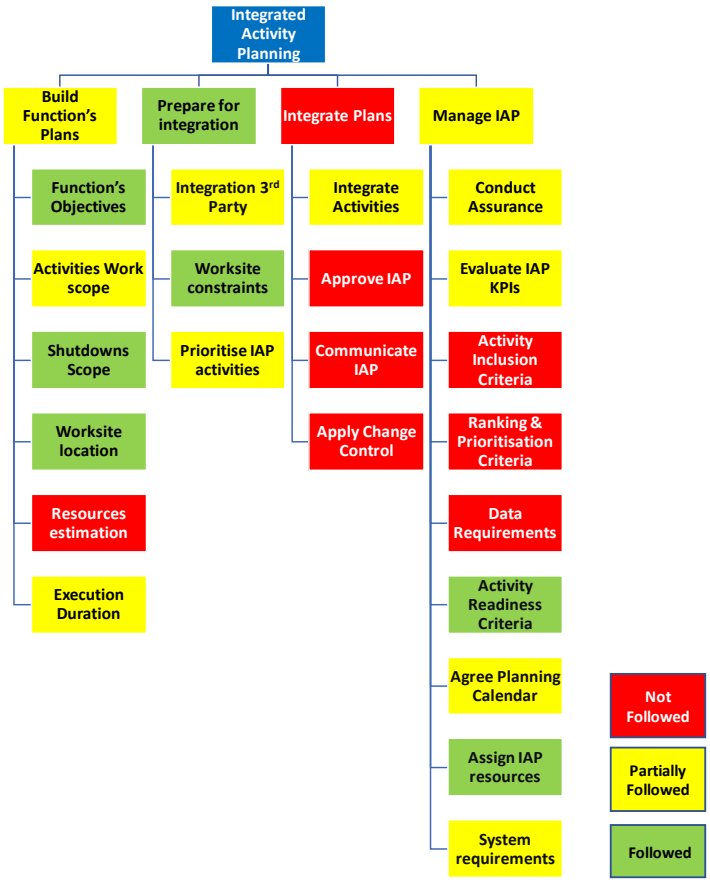


Figure 4-3 Company-A Heat Map exercise outcome

From the **workshop#3: island exercise,** it was identified that the demand for planning was mainly centred with the maintenance team. The island illustrated on the left of Figure 4-4 shows all communication and data flow arrows towards the maintenance team, which is a significant finding. It means that in Company-A, the maintenance team acts powerfully as the integrated activity planner. The central asset planners are almost non-existent, having a minimal role in Company-A.

In island illustrated on the right of Figure 4-4 indicates the isolation of different planning teams; each was located within a different island, dominated by the asset planners compared to the central planning team which they own a small portion of the island. All other functions planning team have their islands which indicate the silo mentality behaviour in Company-A.

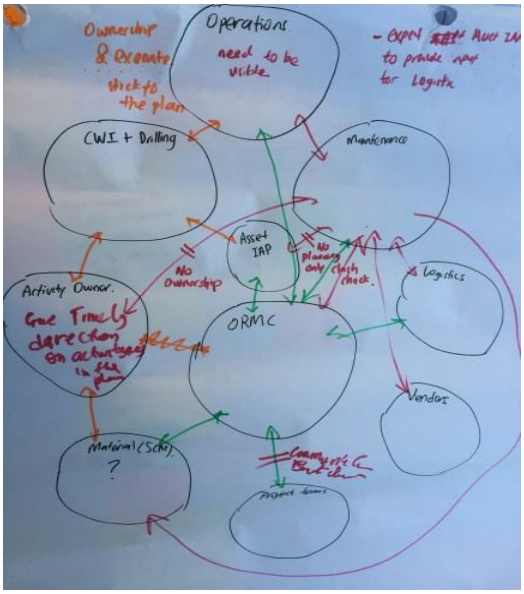


Figure 4-4 Company-A: Islands Workshop Outcome as described by the company-A team

From the **workshop#4: Voice of the customer,** the Company-A team, elicited their requirements which summarised in Table 4-1. The focus was defining inclusion criteria, capturing all IAPS activities in one system, creating IAPS data in one common database, agree to calendar meetings, change management process, develop prioritisation criteria, develop IAPS standard procedure, and agree to clear frozen windows to different plans horizons. The Company-A team believed that these requirements' satisfaction would directly lead to improvements with regards to building quality functional plans and implementing effective IAPS framework, which will reflect directly in improving the company performance.

Table 4-1 Company-A Voice of Customer requirements

WHAT	WHEN	BY WHO
Define the inclusion criteria for IAPS and activity readiness.	Before implementing the process	IAPS central team.
Capture all IAPS activities in one system.	During building functional plans	Functional planners.
Create IAPS data structure/common database.	Before implementing the process	IAPS central team.
Agree on calendar meetings.	Yearly	Asset IAPS teams.
Agree with change management process and authority.	During the implementation of the process	IAPS central team.
Agree on prioritisation criteria.	During the implementation of the process	Functional planners.

WHAT	WHEN	BY WHO
Develop IAPS standards and procedures.	Before implementing the process	Asset IAPS teams.
Clear frozen windows to different plans horizon (6 weeks freeze plan requested by functions).	Before implementing the process	Asset IAPS teams. Part of the IAPS framework.

The interviews in Company-A revealed a lack of trust between the different functions' teams, a lack of confidence in the IAPS process, and a weak understanding of leadership to the IAPS process. The following quotes were recorded from the interviews:

"I get no benefit from the interaction with the IAPS but badly want so, and all three assets are different companies."

"Do you think the planners will do a quality job if they know that the plan will be changed anyhow?"

"IAPS planners should have the skills to challenge data; they should hold the mirror to reflect reality."

"We are not putting the right KPIs to take an informed decision."

"IAPS stability is low because we do not plan very well, I should say NO more if only to change behaviours, but I do not do most of the time because I see it a low priority in my agenda."

"One of the assets planners' position has been vacant for more than a year. I tried to attract different staff to fill the position, but I failed. Our staff does not see the planner job attractive."

"Competent staff is one of the highest challenges in our company."

"We need to limit the number of changes and make them visible in impact/ value."

"Activity Readiness is not authentic and needs attention; most of the time is green and badly affect our performance."

After the interviews; the researcher reviewed the **ongoing improvement plan of Company-A** for the coming 12 months to improve IAPS effectiveness and found that all planned improvements focused on tool integration between SAP and Primavera P6. There was no evidence of any improvements concerning process, criteria, staff competence, or behaviour to integrate and follow the process. These improvement areas were not recognised previously by

the company-A team as a source of inefficiency. As a result; they were not included in the current improvement plan and will not be addressed. The deep dive workshop was an eye-opener for the Company-A local team to understand more about the inefficiency in their system, It was good to acknowledge the ongoing improvement and to add the missing elements when creating the new IAPS framework improvement plan.

Workshop#7: leadership integration formed agreement by the Company-A leaders for a strong case for change to improve the IAPS performance, confirming the previous deep-dive workshops' findings. The deep-dive workshops' findings were summarised in the presentation pack and presented by the Company-A local team. The leadership had gone through a detailed discussion in each output. They acknowledged the current reality of low oil prices, ageing facilities, business funding constraints, and the plan's high rate of changes. The leaders aspired to make the organisation more forward-looking, collaborative and decisive based on accurate data. The forward-looking means all future activities should be included in the plan, evaluated and fully prepared. Whereas the collaborative means all functions work as one team to deliver the Company-A business outcomes. The decisive is for the leadership to make the right decision at the right time, with no further delays based on accurate data & information. Figure 4-5 summarises Company-A leadership aspiration with an agreement to develop and test the new end-to-end IAPS framework.

Figure 4-5 Company-A Leadership Team Integration and alignment on the way forward.

4.2.2 Company-B deep dive output

The following outputs reflect the results from the deep-dive workshops with Company-B. From **Workshop#1: IAPS process health check,** the radar graph illustrated within Figure 4-6 shows the distribution of scores amongst the IAPS process key elements. Around 30 participants attended the workshop and discussed the company performance in each element. The score is a collective view of all participants. Company-B scored low in almost all of the criteria; the strengths of Company-B related to IAPS inclusion criteria; data requirements and quality metrics; data governance and quality metrics; and, IAPS systems. None of the criteria

received a maximum score. Company B functions used the Primavera P6 planning system to define their activities, but the activities were not integrated due to the planners' lack of necessary competence and coaching. It was clear through the discussion that the IAPS central resources of Company-B were in very short supply; there was only one IAPS planner, and one IAPS system engineer for the whole company, with more than 1,000 activities conducted per month. Such shortage added big load on the IAPS planner and as a result, could perform given tasks neither following the IAPS process. Whereas Company-B scored high in following inclusion criteria, change control, and data governance.

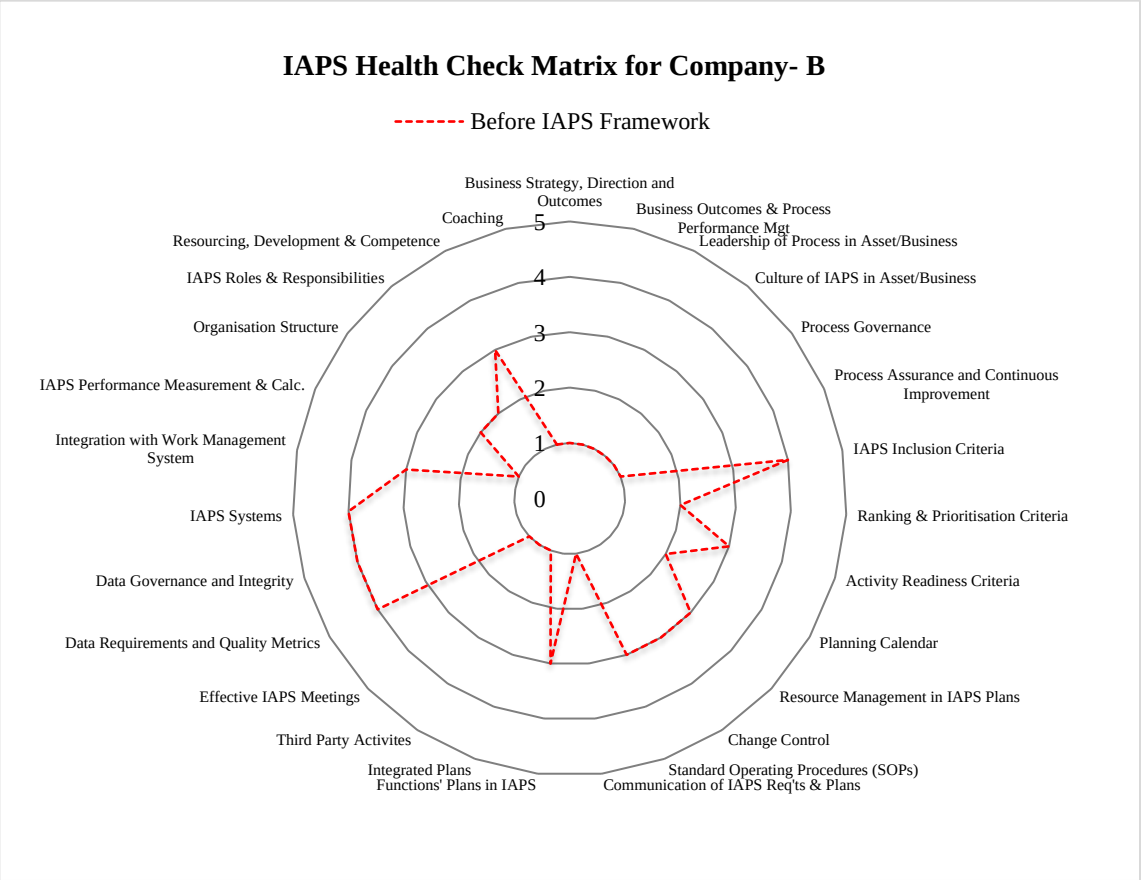


Figure 4-6 Company-B IAPS Process health check exercise outcome

From **Workshop#2: Heat map exercise** presented in Figure 4-7; there were 18 steps mapped in IAPS process used by the Company-B. Out these 18 steps; 2 steps were fully implemented, seven steps partially implemented, and eight steps not implemented.

From the IAPS process prospective, the Company-B biggest ineffective blocks were "prepare for integration" and "integrate plans". Almost all steps under these two blocks were scored red which means the Company-B team admitted that they were not using integrated activity

planning effectively. The company-B was also facing challenges in conducting productive IAPS meetings and communicating an approved plan for all company functions to follow. Company-B's functions put details of their activities in the planning system, but no integration for these activities was performed. Company-B did not recognise the IAPS planner's role and did not trust the planner's ability to challenge activities that are not ready to be included in the plan or question the duration takes to be executed. The heat map exercise marked all plan integration red which means such activities were not performed. The assurance step was coloured red which means it was not used. The assurance is generally recognised as one of the control elements in the GC. Company-B's overall score in Heat Map was 30% as followed steps, which means 70% of the steps have not been followed or partially followed.

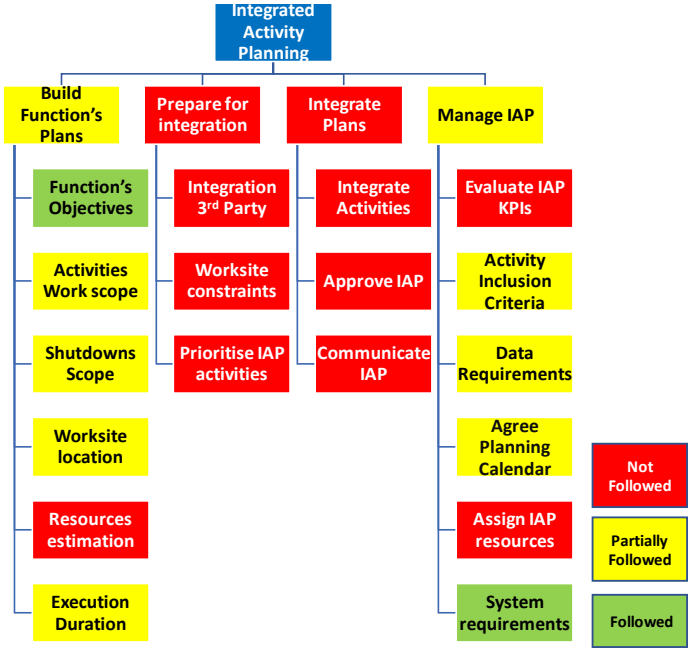


Figure 4-7 Company-B Heat Map exercise outcome

From the **workshop#3: island exercise,** the influence of IAPS planners, diluted to the point it did not exist within either of the maps. The more significant island indicated in Figure 4-8 is related to the dominant functions to the planning process such as wells drilling, well services, and engineering projects. The domination comes from influencing activities to get included in the plan and approved changes without proper control. The planning data is typically entered into the planning system by all functions; however, the data flows from one function to another without a central integration or optimisation hub to manage data flow. The role of IAPS in Company-B essentially did not exist. The island on the left of Figure 4-8 indicates much communication between the different functions, which is a sign of filling a gap of the IAPS

planner. All activities and changes request should go ideally to the IAPS planner to coordinate integration which is not the case in Company-B. The island on the right indicates a mix of communications between the function and asset IAPS planner. The circle's size also indicated the influence of wells, projects, maintenance, and logistics functions.

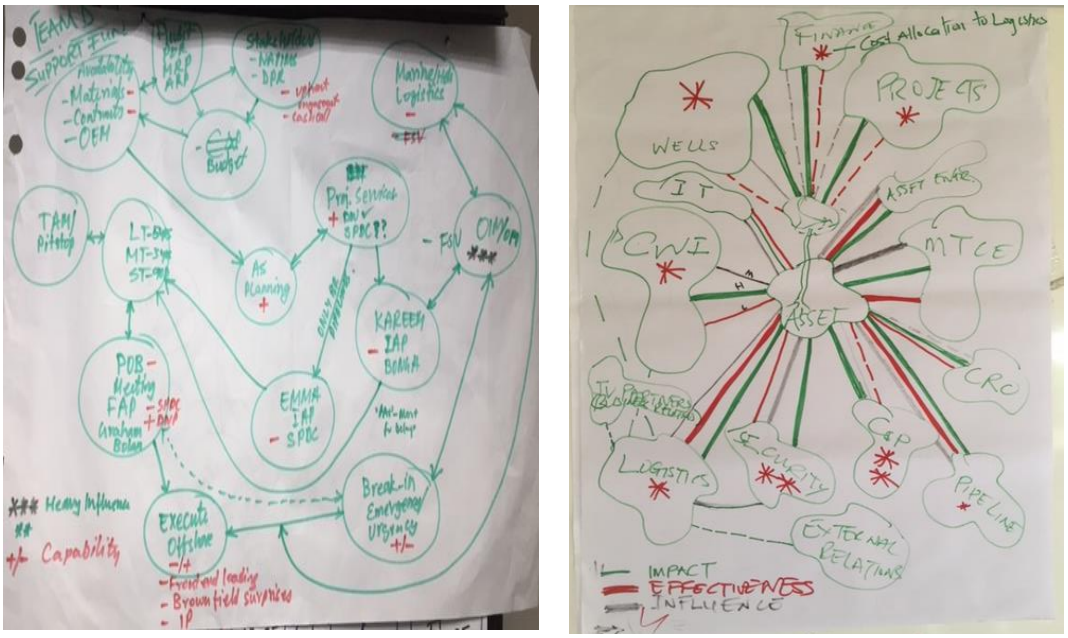


Figure 4-8 Company-B: Islands Workshop Outcome as described by the company-B team

From the **workshop#4: Voice of the customer,** the Company-B team, summarised their requirements in Table 4-2. The voice of customers required to have long Term and Medium-term plan with resource loaded covering all disciplines, the onsite resource loading plan is prepared, transparent change management process with feedback loops; detailed materials & logistics requirements, and stricter people onboard management. There was good consensus between the team members on how best to improve the company's IAPS process.

Table 4-2 Company-B Voice of Customer requirements

WHAT	WHEN	BY WHO
Long Term and Medium-term plan with resource loaded covering all disciplines We miss high-level insight into the maximum number of people required onsite The plans should also have visibility for the office-based staff and support resources. This should address not only fields but also the head office	3 -5 years business plan. Two Years medium-term plan.	Through a formal meeting at the leadership level Who: IAPS planner **Action:** Functions to provide detail

WHAT	WHEN	BY WHO
Short term plan 90 Day - till execution Resource loaded plans The onsite resource loading plan exists and is appreciated The plans should also have visibility for the office-based and support resources.	90 d plan, monthly meeting	Update Terms of Reference and Roles and Responsibilities Who: IAPS planner **Action:** Update TOR and add Minutes of Meeting
Clarity on Interdependencies and Priorities; If we cancel something not sure of the impact on others We do not know upfront what will get priority Interconnects will also show opportunities	All Plans horizons	Including in published plans (Currently: not reflected in Maximo) **Action:** Functions to provide detail
Clear Change management Process with feedback loops; The IAPS process shows resolving clashes but not experienced by all There is no feedback loop to all those who are affected	All Plans horizons	Implement the process for all horizons (currently no transparent process to all) **Action:** work with global
A planner preparing/ organising all the detailed requirements (Materials, logistics, requirements estimated.	All Plans horizons	Add a dedicated planner by function. **Action:** Create Case for Change
Stricter PoB management; We can put activities on the plan, but it all depends on who shouts loudest overrules and gets priority in the end	90 d plan, during execution	Apply discipline and adherence (currently: published but not adhered to). **Action:** Freeze and control plans

The interviews in Company-B revealed a good understanding about the value of IAPS and an opportunity to deliver improvements to the business results; however, the tendency is to ignore the IAPS planner as he was not explicit in IAPS requirements. This prospective indicated a lack of ownership at different organisation levels to create quality IAPS plan and execute activities. Planning was regarded within Company-B as a reporting tool rather than a mechanism for better integration and optimisation of activities and projects. Many interviewees highlighted the disconnect between the different plans' horizons (business plan, to medium-term plan, to short term plan). The following quotes recorded from the interviews:

"Planning should be planning, not reporting."

"Focus on IAPS is not as strong as it used to be or should be."

"Actual logistics utilisation needs improvement."

"We need to turn the ship around, fix it! So, we cannot tolerate nonsense."

"'Whatever piece of the puzzle people deliver, if they do not realise that it is part of the bigger puzzle, then we will not achieve our business objectives."

"Ensure we are not fooling ourselves with the wrong KPIs/ measurements."

"IAPS planners should ideally tell us what to do!"

"We need to know where we will put the gas when we get it."

"There are cost optimisation opportunities through pulling and sharing [logistics] resources."

"IAPS is the backbone of the company. Let us move away from being reactive and towards being predictable through planning."

"IAPS is a key mechanism to drive this business into top performance."

"The decisions we take are affecting profitability, contributing to the overall picture and leverage commercial opportunities."

After the interviews; the researcher reviewed the **ongoing improvement plan of Company-B** for the coming six months to improve IAPS effectiveness and discovered that all improvements were focused on logistics resources optimisation. This was identified as the biggest challenge facing Company-B. There is no clear action plan to make IAPS driving the logistics cost optimisation; in fact, the logistics team started their integration huddle away from the IAPS agreed meetings.

On day-5 the **workshop#7: leadership integration** workshop conducted on which the Company-B leaders agreed that there was a strong case for change to improve the IAPS performance and confirm the findings of the previous deep-dive workshops. The deep-dive workshops' findings were summarised in the presentation pack and presented by the Company-A local team.

The leadership had gone through a detailed discussion in each output. The leadership team realised that the shortcomings of the current reality of a culture of firefighting; declining production rates; and not positioning IAPS as the central tactic to drive business plan targets. The leadership team aspired to achieve top quartile performance by instantiating a forward-looking and integration between the company's different functions. The forward-looking means all functions review future activities required to deliver the company business outcomes and thoroughly prepare for execution. The integrations mean all functions work together and support each other by sharing critical resources to deliver business targets. Figure 4-9 summarises the Company-B leadership aspiration with an agreement to test the new end-to-end IAPS framework.

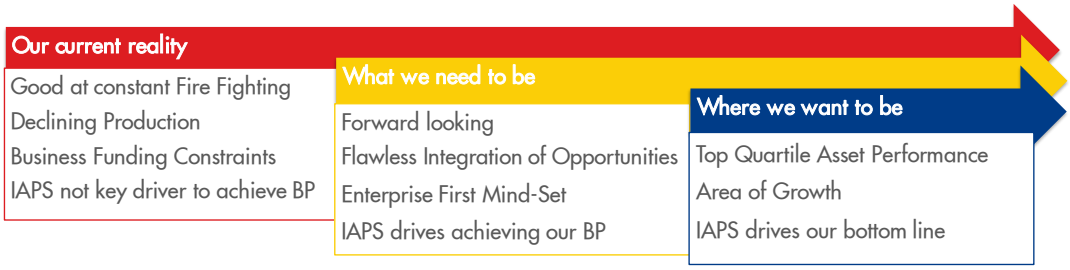


Figure 4-9 Company-B Leadership Team Integration and alignment on the way forward.

4.2.3 Company-C deep dive

The following outputs reflect the results from the deep-dive workshops with Company-C. From **Workshop#1: IAPS process health check,** the radar graph illustrated within Figure 4-10 shows the distribution of scores amongst the IAPS process key elements. Around 40 participants attended the workshop and discussed the company performance in each element. The score is a collective view of all participants. Company-C scored low in following inclusion criteria, checking activities readiness, applying prioritisation matrix and developing a meeting calendar for all IAPS plans discussion. The poorly-performing Company-C elements are typically process-related, Primavera P6 used as the IAPS tool; however, not all functions within Company-C were using it. In leadership, the company scored low as the IAPS planners were suffering from a clear sponsorship to take a decision during various IAPS meetings. There was no transparent allocation of roles and responsibilities in Company-C. The data integrity was poor, which wasted the planners time to copy, amend, and improve. In comparison, the Company-C scored high in integrating third party activities in the IAPS plan and following IAPS KPIs with transparent integration with other processes such as logistics function.

From **Workshop#2: Heat map exercise** presented in Figure 4-11; there were 15 steps mapped in IAPS process used by the Company-C. Out these 15 steps; 6 steps were fully implemented, seven steps were partially implemented, and two steps were not implemented.

From the IAPS process prospective, the Company-C biggest ineffective block was “manage IAP” as no clear activity readiness criteria used and no agreed ranking & prioritisation criteria between different functions. The data set was not standardised following the system agreed architecture across all functions, and many did not use the IAPS planning system (Primavera P6).

The similar finding was identified in the previous workshop. The planning systems were not appropriately integrated, which resulted in increased effort related to manually copying data from different planning systems and inputting it into Primavera P6.

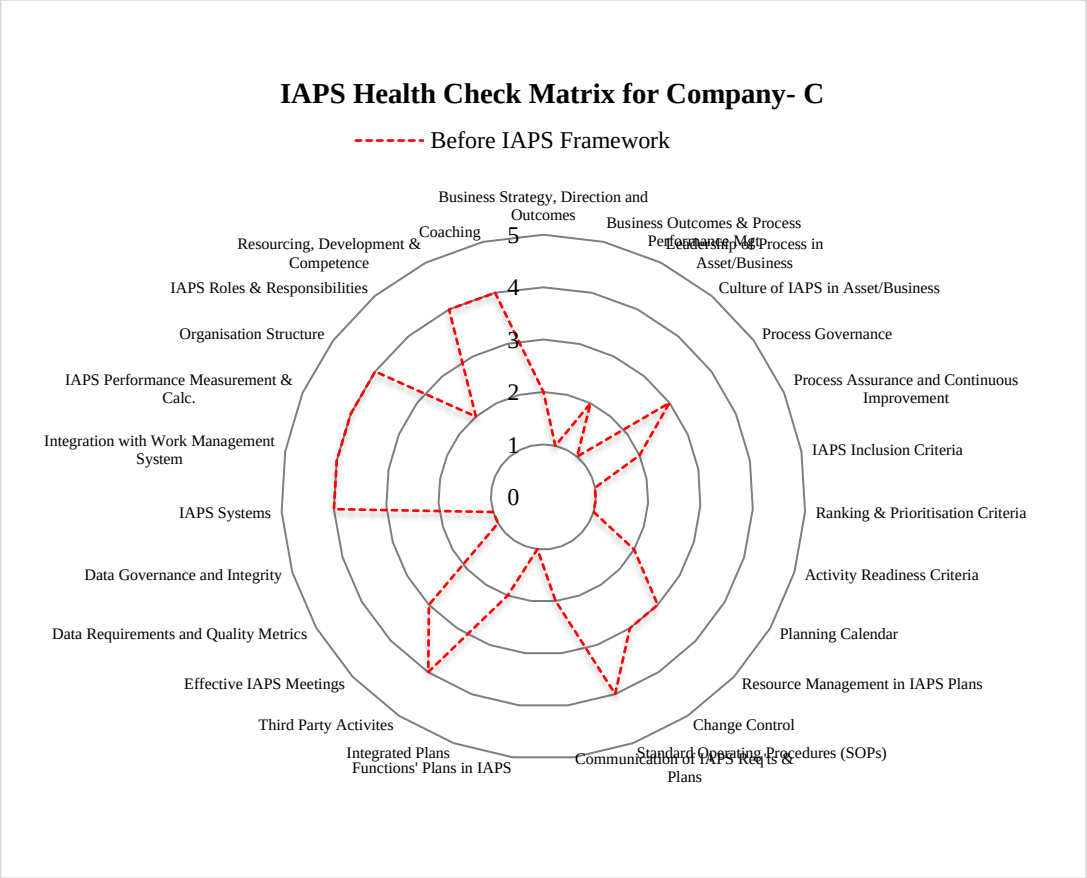


Figure 4-10 Company-C IAPS Process health check exercise outcome

Company-C was producing a short-term plan for activities occurring in 2 weeks which is considered short forward-looking. The progress tracking of plan execution was weak as the daily huddle to highlight progress was not conducted. There was no structure behind the daily, weekly, or monthly performance reviews. The block of "build the function's plans" scored green which means most of the steps were followed. According to the Company-C team, although most of the steps were followed from a process perspective, activities were not integrated into the plan and were not sent in a standard data format for the IAPS planner. The overall score of Company-B in Heat Map was 63.5% as followed steps which mean 36.5% of the steps have not been followed or partially followed.

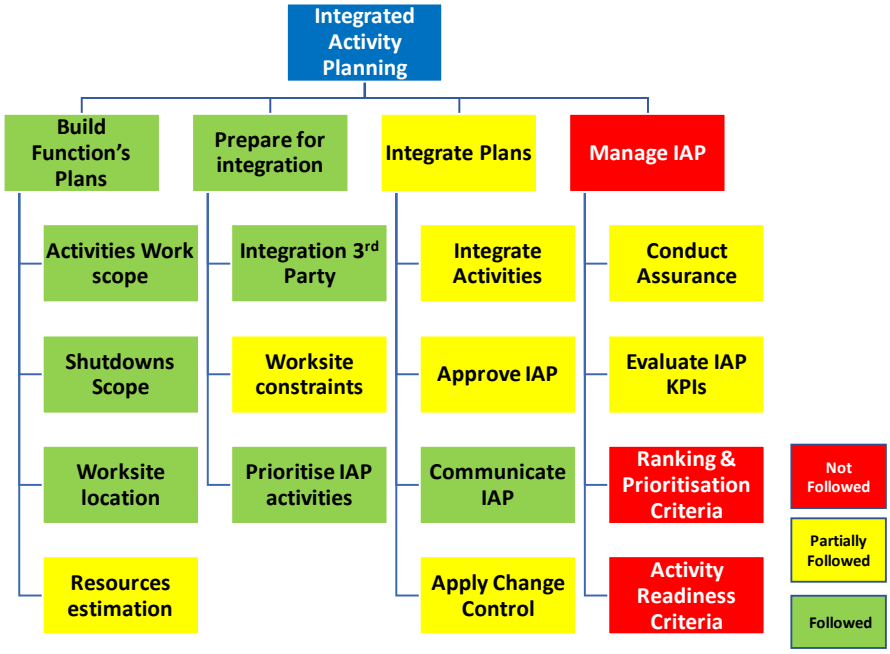


Figure 4-11 Company-C Heat Map exercise outcome

The **Workshop #3: island exercise,** indicated a clear map of an ideal situation in which all functions should send their plans to IAPS planners to integrate all activities, and then send these integrated plans to asset management for approval. The second step was to aggregate and integrate assets IAPS plans at the company level. The illustration on the left of Figure 4-12 describes the data flow from functions on the left to the logistics planner, and then to the IAPS planners. Company-C's unique structure involves IAPS planners and logistics planners being at the same level, and the functional plans, therefore, are sent to both for integration. This structure shows some inefficiency in the system, as an ideal world would involve the IAPS planner integrating the activities based on resource availability, and then sending an approved plan to logistics for execution.

Another low point; the Wells drilling function works on their own, whether their activities included in IAPS or not. The wells drilling does not adhere to the IAPS process, which creates increased inefficiency in the system. The illustration on the right of Figure 4-12 shows the missing communication loop between the planners and execution team such as material, contracts, and field teams. The contracting and procurement team is considered a "black hole" as there was no visibility of the material availability.

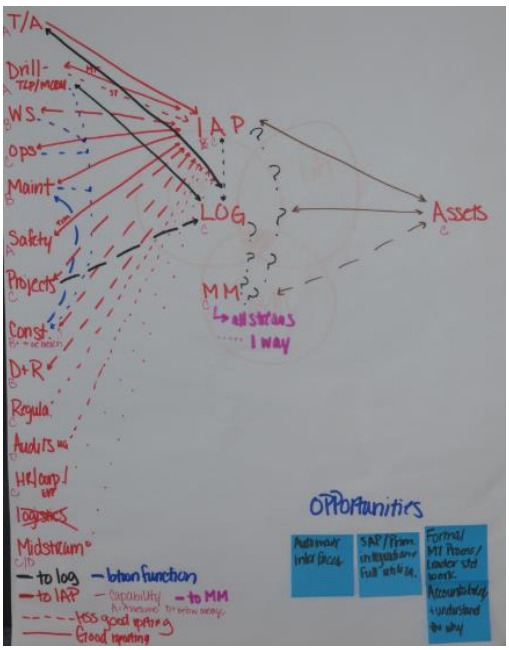


Figure 4-12 Company-C: Islands Workshop Outcome as described by the company-C team

From **workshop#4: Voice of the customer,** the Company-C team, summarised their requirements in the following table. There was a reasonable consensus between the team members on how best to improve the company's IAPS process.

Table 4. 1 Company-C Voice of Customer requirements

WHAT	WHEN	BY WHO
All IAPS relevant activities are in one plan for at least a 2 yr rolling window refreshed quarterly	Quarterly.	Functional Planners and IAPS Planners
Functional plans include Logistics requirements with a clear indication of (Inclusion Criteria)	At the beginning of each plan	Function Planners Input directly into Primavera P6
Proper participation in IAPS meetings/identifies functional planners	As per IAPS meeting schedule	Asset Manager Meeting structure, ToR, resource assignments
Weekly visual plan progress against the activity readiness criteria	Weekly	IAPS Planner Portal/ Primavera P6
Clear lines of power for decision making	Before implementing the IAPS framework	Asset Manager with IAPS manager
Clear activity prioritisation and ranking matrix	Before implementing the IAPS framework	IAPS team A ranking tool to be developed
Demand profile for logistics (short term – look at actual PoB)	Before finalising the Plan	Logistics Planner Input directly into Primavera P6

WHAT	WHEN	BY WHO
Clear activity progression through stage gates/ milestones (move to next stage only when all preparation is done)	At each plan's horizon	IAPS planners Input directly into Primavera P6; MT/ ST stage gate meetings
Appropriate data in the functional plans provided as per the data standard	Before implementing the IAPS framework	IAPS team Part of the IAPS framework
Training for functional planners	Before implementing the IAPS framework	IAPS team Part of the IAPS framework
Clear IAPS Process with Clear rules and responsibility with actionable KPIs	Before implementing the IAPS framework	IAPS team Part of the IAPS framework

The interviews in Company-C revealed a consensus of what IAPS could deliver to the business, and how it could improve company performance. It was clear that the organisation understood the various challenges and possessed a desire to make IAPS work. The expectation was high about the new IAPS framework, and through these interviews, it was proposed to make it comprehensive to address all ineffective elements. The importance of connecting IAPS with logistics planning was a discussion point during many of the interviews. The leaders wanted to embrace IAPS KPIs and make it visible to change behaviours. Holding the function accountable for their plan's performance and activity execution was also considered necessary. The IAPS planners required more coaching to challenge function leaders to deliver the plans' targets. The following quotes were recorded from the interviews:

"Logistics is becoming less flexible (limited resources on the ground) in order to deliver we need to plan better."

"Planning process should articulate business value and drive a culture of business results."

"We need to have ONE plan delivering ONE predictable outcome."

"We need to deconstruct old ways of working, make people uncomfortable by challenging what they used to do in the past. Inject a sense of urgency in driving the change via disciplined planning."

"Embrace the red KPIs and makes it visible to the organisation what is the reason for non-delivery."

"Stop toleration of noncompliance, change the mindset from accommodating any activity without proper planning."

"Coach the IAPS planners to engage better and reflect reality and ask for support."

After the interviews, the researcher reviewed the **ongoing improvement plan of Company-C** to improve IAPS effectiveness and found some first attempts to improve the IAPS process flow diagram which can be used by the researcher and build on it with subject matter experts of the GC.

On day-5, **workshop#7: leadership integration** conducted in which Company-C leaders volunteered to be the first company to pilot the new IAPS framework and were eager to improve the IAPS performance quickly. The deep-dive workshops' findings were summarised in the presentation pack and presented by the Company-A local team.

The leadership had gone through a detailed discussion in each output. The aspiration was to generate more income and reduce the number of resources within the Company-C through better planning and integration, as illustrated in Figure 4-13. A silo mentality and strong functional agenda drive over company agenda culture were recognised by the leaders who agreed to change and make it different. The leaders would like to instil disciplined execution, commercial mindset, and a culture of business results in the organisation. The disciplined executions mean a commitment from all to plan the work and work the plan. The commercial mindset means to deliver more for fewer resources and optimise. The culture of business results means to focus on company overall business outcomes more than functions individual targets.

Figure 4-13 Company-C Leadership Team Integration and alignment on the way forward

4.3 Analysis of workshop output and shaping the IAPS framework

A workshop was conducted in the GC headquarter, inviting the IAPS subject matter experts to go through the outcome of the deep-dive workshops in the three study-case companies. The researcher adopted a similar approach of Chevron (Charles et al., 2014), REPSOL (Erena, 2002) and Kuwait Oil Company (Figarella and Al-Mezel, 2012), in which the three companies

built a programme management office to resolve the integrated planning challenges on their companies, and utilised capable in-house personnel to develop and implement the required solution. Chevron formed a project team from different disciplines supported by a steering group to guide the project (Charles et al., 2014). REPSOL, a multinational energy company in Spain, used in-house expertise to develop a standard process to overcome their planning's challenges (Erena, 2002). Their approach started with conducting internal and external benchmarking, to determine "best practice" approach. They created a centre of process development and improvement, using capable in-house personnel, to meet the goals set within a continuous improvement culture. They aimed for process standardisation across all their refineries, supported by the same organisation structure (Erena, 2002). The Kuwait Oil Company launched integrated planning and performance management, supported by a programme management office, to successfully implement a strategy to ensure alignment, promote the implementation of change management, and achieve strategic objectives (Figarella and Al-Mezel, 2012).

The identified challenges to implement IAPS in the three case-study companies were discussed, and asset-specific requirements were incorporated. The researcher with the subject matter experts grouped all of the findings regarding the organisation effectiveness requirements. These findings were grouped under 'element title' to start framing the elements required in the IAPS framework. For example; a slowness in taking a decision is labelled as "leadership" and lack of planning software integration as "systems". The analysis of the outcome from each workshop in each of three case-study companies in three companies is summarised as follows, which will be considered while developing the IAPS framework:

Company-A deep dive results were:

- Business drivers were not linked to IAPS (Direction Setting).
- Company's growth ambition was not embedded in the organisation (Direction Setting).
- The team's composition is imbalanced concerning the expected output (Organisation Structure).
- Various planning teams exist across the company without clear roles and responsibilities (Organisation Structure).
- Training and succession plan was not clear to all staff (People).

- Competencies and experience misaligned with some roles and no functional planner (People).
- Lack of integration of functions with planning and other processes (Process)
- No long term and medium-term planning exist for functions and logistics (Process).
- Low quality and not integrated plans (Process).
- The interface between IAPS software and functional plan software is missing (Data/Tools/Systems).
- Inadequate planning data could lead to a wrong decision (Data/Tools/Systems).
- The planning system (Primavera P6) not used to the full capacity (Data/Tools/Systems).
- Leaders were rewarding firefighting attitudes; instead of encouraging a disciplined process execution (Culture).
- Lack of recognition and consequence management (Culture).
- Plan change control not followed, and no adherence to plan execution (Leadership).
- Lack of empowerment to the team and inadequate focus on end to end value chain (Leadership).

Company-B deep dive results were:

- The value of integrated planning was not communicated across all organisation levels (Direction Setting).
- Roles and responsibilities were not clearly defined and understood (Organisation Structure).
- Functional planners have insufficient understanding of the integrated planning processes (People).
- Lack of integrated planning process (Process).
- Existing planning tools not used to the full capacity and are not interfaced (Data/Tools/Systems).
- A silo mentality environment; planning was not seen as a high priority (Culture).
- Lack of accountability and consequences management (Leadership).

Company-C deep dive results were:

- There was a disconnect between the strategic plan and the medium-term plan (Direction Setting).
- There was no clear direction in working towards one plan in the asset. The value from IAPS was not promoted, and strategic intent was not clearly embedded throughout the organisation (Direction Setting).
- Planners' roles and responsibilities in functions and assets were not clearly defined (Organisation Structure).
- There were no clear roles and responsibilities for IAPS and functional planners (Organisation Structure).
- The existing planning organisation structure did not support company integration (Organisation Structure).
- Functional planners lacked a good understanding of the IAPS process (People).
- More effort was required to bridge the gap in competence and experience (People).
- There was a lack of integration between functional planners and other processes (Process).
- Other functions, such as logistics and material management, were missing in the integration process (Process).
- No standard planning system to enable integration (Data/Tools/Systems).
- No integrated demand profiles; resources management was missing (Data/Tools/Systems).
- Silo mentality; rewarding fire-fighters (Culture).
- No disciplined process execution; appreciation was more for ad hoc problem solving (Culture).
- Lack of empowerment for decision making and inadequate focus on end-to-end value chain (Leadership).
- Planners not seen as enablers to achieve business outcomes (Leadership).

Based on the above analysis; it was identified that there is a similarity in challenges across the three different companies. The missing or the ineffective elements in the IAPS framework are:

Direction setting was missing in making IAPS part of the business context. IAPS was not taken seriously in the assets, and most staff did not recognise its importance or the impact in the business if not executed correctly. There was no clear message sent from senior leaders to explain the pathway and importance of IAPS, or how it should be followed in the asset.

The organisation structure was suboptimal and different in each company. There was no standard approach in designing the planning organisation structure, and in many cases, the organisational structure did not support integration, creating silo thinking within functions, rather than integrated thinking. The roles and responsibilities were not defined.

People development was a common pain point. There was an apparent demand for a training matrix to ensure competent planners carry out critical planning activities.

IAPS Process needs to be standardised and adequate. All assets detailed IAPS process was quite different. The heat map demonstrated how each asset followed a different number of steps. The data owner was missing, and data quality did not follow a precise protocol. Also, the planning systems were different in each asset, and the integration between tools was missing.

Each company had its own culture. The similarities between companies were in firefighting and rewarding reaction rather than proactive measures. Such acts encouraged the wrong behaviour, with the planning team feeling that they had been left behind. The focus was more in production rather than quality planning.

Leadership lacked clarity in decision-making regarding planning choices, and most of the time did not attend the IAPS meeting. Such behaviour sent the wrong message: that IAPS meetings were not necessary. There was no clear guidance about managing planning meetings and who the chair of the meeting was.

Based on the previous cycles, the researcher and based on findings reached a proposed IAPS framework to address ***direction setting, organisation structure, people, process, data, system, culture, and leadership.*** All these elements are required if the GC expects to improve IAPS in its companies and deliver improved business performance. This also builds on Strasunskas et al. with the "Integrated Operations framework" dimension, which was the process, people, technology and organisation with associated KPIs (Strasunskas et al.,2012). The new IAPS framework adds five new dimensions relating to direction setting; organisation structure; data; culture; and, leadership, and strengthens the other dimensions of Strasunskas's model by making it explicit with guidance to help the GC to ensure effectiveness.

An illustration of these elements of the end-to-end IAPS framework is provided in Figure 4-14. The proposed framework is intended to address the identified poorly performing elements in the current Integrated Activity Planning and scheduling system, and provide a standardised means of working across 65 companies in the GC. There was an explicit requirement to address these elements, and each of the elements of the IAPS framework addresses a clear gap in the GC implementation as follows:

- **Direction setting**: state the desired future state and objectives of what the business wants to achieve using an integrated activity planning process, and what the business has to do to achieve it. The objectives are a set of communicable and measurable business outcomes and communicated to all organisation levels. Direction setting should also state the governance and the business models to refer to for clarity of focus and organisation alignment. This will constitute what defines success in terms of the business results, and how strategic choices or trade-offs are made.
- **Structure**: describes the appropriate organisation model in which people should be organised to execute integrated activity planning tasks; how people should be grouped into teams, departments, business functions, and, how coordination occurs across these organisational boundaries.
- **People**: defines the talent management aspect of organisation capability, and explains the training and succession planning strategy to equip people with the right knowledge and skills in the right locations to deliver business outcomes. This is a standard process but required to be explicitly mentioned in the framework to bridge identified gaps in the GC.
- **Processes**: develop a standard IAPS process which can be executed by different companies belong to the GC. All identified sub-processes must be tested, fixed and integrated.
- **Data**: state the specific data required to be entered into the planning system to integrate the activities. It provides a standard set of data to ensure consistency across all functions and enable software integration.
- **Systems**: ensure fit for purpose, aligned and interfaced IT systems support integrated process execution in all Assets and Functions.
- **Culture**: setting up the right environment to influence behaviours and address the human component in terms of how people perform, and the underlying attitudes, beliefs and organisational norms that shape and define acceptable behaviours in the

GC. Culture is "the way we do things around here" and the simple system that dictates the desired results. It is also what leaders instil in their people; one that reflects the value of the organisation.

- **Leadership**: states how the leaders at all levels should behave to motivate and inspire others to pursue the organisation's vision, strategy and objectives. Leaders were responsible for setting direction and making choices that enable the organisation to be successful. The team roles and responsibilities should be well understood, and the right behaviours should be recognised and rewarded.

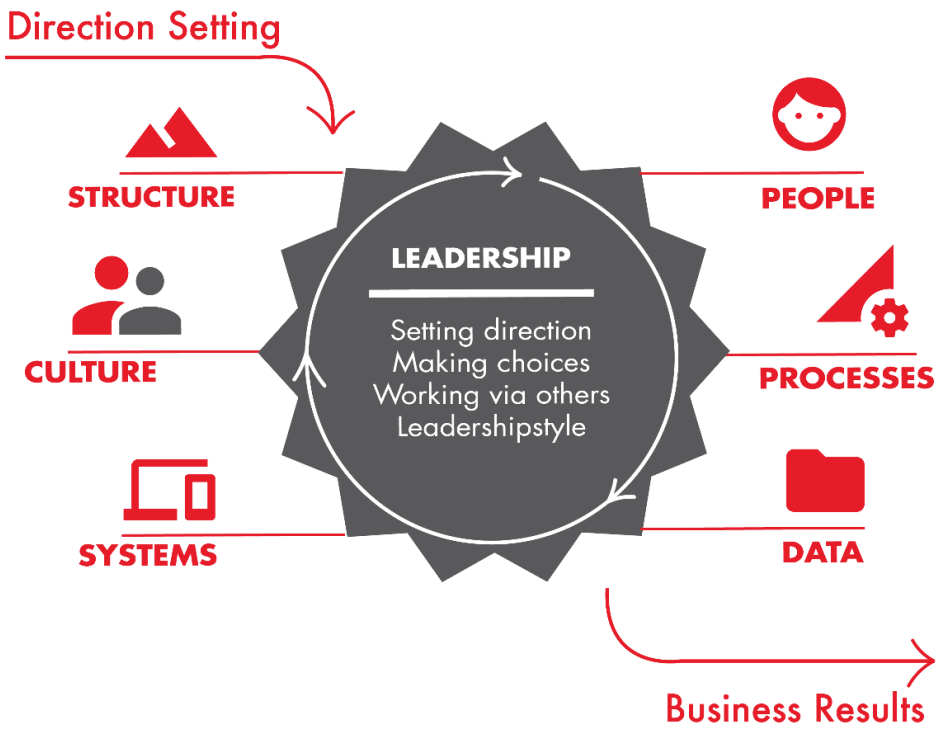


Figure 4-14 Proposed IAPS Framework built to address the GC requirements

The eight elements are interconnected, and the organisation cannot achieve the optimum delivery without having all elements fixed and working in harmony. The company vision is the desired future state of what the business wants to be in which objectives are set & communicated; measurable goals are expressed, governance & business model are agreed to drive focus and organisation alignment of what constitutes success in terms of business outcomes and how IAPS support the company vision (Direction Setting). How people organized to execute their work and how people grouped into teams, departments, functions, and how coordination occurs across these organizational boundaries is required for the IAPS planner to deliver their goals (Organisation Structure). However, staff needs a development in

which the talent management aspect comes to the surface; do we have the right people, with the right knowledge and skills in the right locations to deliver on the strategy (People). Once the vision is understood with clear message and expectations, the organisation structure is set up, and people are trained to deliver the task; the next is to have a clear process describes the activities that make up the work we do, including the tasks and targets that will deliver the results (Process). These processes required clear data set and systems to enable those results (Data & Systems). The company is a community, and each community create its own culture; the way things are done, which influences behaviour. It is the human component of organizational behaviour in terms of how people perform, and the underlying attitudes, beliefs and organizational norms that shape and define acceptable behaviours (Culture). Without creating the right culture to support IAPS plan delivery; the company will miss targets and leader's role become crucial to motivate and inspire others to pursue the organisation's strategy and objectives. Leaders are responsible for setting direction and making choices that will enable the organisation to succeed (Leadership). IAPS needs all the eight elements to be implemented in order to deliver the GC aspiration.

Sletbakk Ramstad et al. suggested a framework for successfully implementing integrated planning by considering the organisation as a system composed of different functions working as subsystems. He emphasised the importance of a clear process framework to define system goals, control operation, and clarify the interaction between subsystems (Sletbakk Ramstad et al., 2010). The proposed IAPS framework should provide a clear definition for each element of the framework and establish a coherent integration between these elements.

In the following chapter; a detailed explanation for each element of the IAPS framework is presented. Each element illustrates a guideline for the GC to follow to address the current gaps.

Chapter 5 INTEGRATED ACTIVITY PLANNING and SCHEDULING FRAMEWORK

5.1 Introduction

In this chapter, the 3rd cycle: development of the IAPS framework is explained in detail. This cycle reflects the core of the research and the main contribution to knowledge; learning from the previous two cycles GC level and operating company/level and the literature review outcome, are used to develop the end to end IAPS framework. In this cycle, the researcher will use the practices and critical success factors discussed during the deep-dive workshops to be included in the IAPS framework. The output of this chapter will be tested in three case-study companies to review the IAPS framework's effectiveness, which will be explained in the next chapter.

The researcher with the GC subject matter experts analysed all findings and grouped them under different elements to map the main characteristics of the IAPS framework. The required IAPS framework elements are more than a process's element; it was established that the organisation pillars needed to be addressed: '***direction setting, organisation structure, people, process, data, system, culture, and leadership'.*** The IAPS framework should address the gap in each element and provide guidance to be followed. Each of the elements should be equipped with a tactic or protocol to ensure effectiveness. The elements are described within the following subsections. In was intended that the IAPS framework would address all shortcomings; any ineffective element would jeopardise the overall excellent performance of the IAPS framework in the GC.

5.2 Direction setting

As identified through the deep-dive workshops, most of the GC asset organisation are suffering from the lack of a clear message from the asset's leaders that IAPS is a vital process of the asset management system and should be followed. The companies within the GC use Business Process Models (BPM) to simplify and standardise their processes. The Business Process Model is typically supported with a feedback loop to ensure continuous improvement (Dombrowski and Hennersdorf, 2009). Asset leaders are required to clarify the strategic requirement to their teams on the importance of IAPS for delivering business results. Highlighting success stories from the industry can help deliver this. For example; Du Pont noted that a polymer facility could reduce working capital from $160M to $95M due to

integrating planning and scheduling (Verderame and Floudas, 2008). A similar achievement was obtained by Exxon chemical, reducing operating inventory to 20% and operating cost to 2% annually as a result of integrating planning and scheduling (Verderame and Floudas, 2008). Finally, the lack of an integrative framework for planning and scheduling leads to poor chemical plant resources (Verderame and Floudas, 2008).

It is essential to set a clear direction for the organisation based on the context of the company business targets, and this direction should include the company leadership's expectations in terms of how to manage the company business. Arvizu (1996) described planning in the Air Force, which starts with transforming Strategy-To-Task, then moves to decide Task-To-Need, then develops a plan to convert Need-To-Concept (Arvizu, 1996). The integrated planning is a core element that describes how the company aims to operate assets in the future – effective integrated activity planning and scheduling is necessary to translate an asset's strategy to executable activities at the optimum time with the optimal use of resources. The strategy is subsequently transformed into executable work and plan objectives, and targets should be set by the company leadership and communicated to all organisations. Planning sets the goals and resources and scheduling details the activities in a set of operation sequences with assigned comprehensive resources as explained by (Váncza et al., 2004). Small and Yasin (1997) justified the importance of integrated planning to address an increasingly complex and competitive global and national business environment (Small and Yasin, 1997). Ineffective scheduling may waste resources and inhibits the full execution of an approved plan where the inadequate plan will prevent organisations from meeting their strategic intent (Váncza et al., 2004).

Kuwait Oil Company (KOC) launched integrated planning and performance management to successfully implement the 2030 strategy to ensure alignment, promote the implementation of change management, and achieve strategic objectives (Figarella and Al-Mezel, 2012). The aim was to develop an integrated plan which delivered the business targets. It is recommended that leaders start communicating their direction for the organisation with clear business outcomes to be achieved by IAPS in which will link IAPS to the company vision and strategy. The GC set three primary business outcomes: Health Safety & Environment (in which proper planning prevents personal and process safety incidents), Production (integrating different activities would optimise the time and hence reduce the facilities downtime), Cost (through the integration of resources). Planning involves the setting of goals and objectives with regards to the company business aspirations. It defines the activities to accomplish goals and objectives. It also involves a review of safety, constructability, maintainability and operability of the plant.

It formulates the strategies to achieve them, arranges the means required, implements, directs, and monitors all steps in their proper sequence (Váncza et al., 2004).

The IAPS framework proposes three planning levels: strategic, tactical, and operational (refer to Table 5-1), which is aligned with Engel (2000) that planning should begin from a strategic level then be decomposed into the tactical and operational level to achieve an economical and profitable business (Engel, 2000). Nourelfath et al. also support the view that tactical planning should bridge the strategic planning level (long term) to operation planning (short-term). The proposed plans durations are one week or less for operational planning, one month or more for tactical planning, and one year or more for strategic planning (Nourelfath et al., 2010). Bello et al. suggested using three-time horizons planning, the medium-term planning with two years cycle, the short-term planning with 90 days cycle, and the very short-term planning representing seven to 28 days schedule (Bello et al., 2011). The short term and very short-term focusses on operational execution, while the medium-term reflects tactical planning and focusses on activity integration and resource alignment. While the definition created by Bello et al. (2011) is the closest to the IAPS framework time horizon, the IAPS framework expands each planning horizon with more details on objective, review cycle, and level of details required for each plan. The following table summarises the three-planning levels with specific plan name and time horizon.

Table 5-1 Plan types and durations

Level	Plan Name	Planning Horizon
Strategic	Strategic Asset Plan	Field Life
	Business Plan (incl. 5-year Integrated Turnaround plan)	5 Years
	Function's Long-Term Plan	Field Life or as required
Tactical	Medium Term IAPS (MT IAP)	2 Years minimum
	Function's Rolling Plan	2 Years minimum
Operational	Short Term IAPS (ST IAP)	90 Days minimum
	Integrated Schedule	14 Days minimum

The plan's horizon proposed within the IAPS framework is quite different than what was suggested by Hasanzadeh et al. that tactical planning is one year (macro), short term planning of three months to weekly (micro) to a minimum of two days planning horizons (Hasanzadeh et al., 2009). Based on deep-dive workshops, the researcher discovered that the one-year tactical plan is very short as its entering the current year delivery, and tactical requires to look forward at least two years in advance to ensure the organisation is ready to deliver next year business targets. The oil and gas business plan contains complex projects, and the plan window

exceeds five years. The plans included in Table 5-1 are discussed within the following sections.

5.2.1 Strategic Asset Plan (Long Term Plan)

The Strategic Asset Plan aims to maximise asset value through an integrated assessment of all internal and external factors, which may impact the asset's performance throughout its life cycle. The Strategic Asset Plan is a dynamic document, which should describe how the asset should be managed strategically to realise its full potential and aspirations, and how it should deliver value over the remainder of its life. It should describe the decision-making rationale, the assumptions, and selected scenarios to develop and operate the asset and represent the principal planning tool by which assets are managed effectively and efficiently.

The Strategic Asset Plan should present a long-term integrated view of pertinent interpreted data relating to all aspects of assets such as Field Development Plans including projects and modifications, Maintenance Reference Plans and the Operations Strategy. It should provide the basis for long-term production commitments, contracts and organisation and capability requirements. The threats and triggers should be captured within the Strategic Asset Plan which could result in strategic changes to the asset, and it should confirm that the business and functional planned activities are appropriate for managing opportunity and risks for the remaining asset lifetime.

The Strategic Asset Plan's activity component should reflect long-term plans of key events, which impact the development, production, and operation of facilities over their field life and are compiled from the various functional long-term plans. The activities are typically at an early stage, e.g. major projects, new developments or significant maintenance/turnaround activities, when they are to occur, funding/budgets and highlights their contribution to achieving the Asset Strategic Objectives.

The Strategic Asset Plan should be prepared by the Business Planner or equivalent and owned by the Asset Manager or equivalent. It should be reviewed, updated and issued annually to capture any changes in shareholders' directives.

5.2.2 Business Plan (BP)

The annual Business Plan should detail the asset's (or equivalent) production, capacity, and Capital Expense (CapEx) and Operating Expense (OpEx) targets, covering five years of the Strategic Asset Plan. While the Strategic Asset Plan should encapsulate assets over the whole life cycle, the Annual Business Plan should describe an asset's production over the next five years (one-year fixed and the remainder rolling) and define and manage its direct costs. The

focus here is on reducing costs while safeguarding the integrity of facilities. An up-to-date Activity-Based Cost Model should be in place and include current activity and cost data with planning assumptions and deviations. The business plan's activity content should be constructed directly from a combination of the Strategic Asset Plan and the MT IAP while considering screened and evaluated options and risks.

The integrated planning process should be used to prioritise, schedule, and assure all business functions' activities, including facility turnarounds and allocation of critical field resources, e.g. flotels, rigs, lifting equipment, & personnel. The objective of prioritising, scheduling and assuring activities is to allow all relevant roles to be able to compare the added value of all the activities in their area of responsibility. They can then be confident that the activities under their control are optimised.

The Business Plan should be prepared by the Business Planner or MT Planner or equivalent, and be owned by the Asset Manager or equivalent. It should be reviewed, updated and issued yearly. Any changes and deferrals from the Business Plan should be captured and approved by the Asset Manager.

5.2.3 Medium-Term Plan (MT IAP)

The MT IAP encapsulates most of the money-making integration decisions in the two-year time horizon. Due to activity lead times, and the negative impact of late changes, most opportunities for change will have passed when the short-term is reached. In addition to optimising activity timing for optimal safety, production and cost, the MT IAP should be an input for the Business Plan and its scheduled deferment is an input to production forecasting to support the Latest Estimate (which is an indication how the company will close the year in production volumes). Additional activities from the Strategic Asset Management Plan may be introduced into the plan where appropriate, which may, in turn, extend the time horizon. The Long-Term Turnaround (T/A) Plan is an excellent example of this. The MT IAP should reflect a rolling, (minimum) two-year time horizon and should optimise the Functional Plans in terms of:

- Safety consideration;
- Major turnaround windows;
- Resolving conflicted activities;
- Alignment with offtake commitment and onstream dates for new production capacity;

- Availability of accommodation/personnel on-site limits, resources and site access; and,
- Any emergent activities such as corrective maintenance, engineering modifications or well interventions.

Bello et al. suggested reviewing the medium-term plan every quarter and integrating it with the production forecast to identify clashes between different activities and allocate the right resources. During the proposed stage, each business function creates an activity plan spanning two years. This plan involves all activities integrated from exploration, projects, well drilling, well services, modification, hydrocarbon maturation, maintenance, and operations. In the fit stage, all functional activities are integrated into an asset plan to determine the best fit and optimise the shutdown windows. At the agreed stage, the various asset plans are integrated at the corporate level and discussed within the leadership team for final endorsement (Bello et al., 2011).

The MT IAP should be prepared by the MT Planner or equivalent and owned by the Asset Manager or equivalent. Activities in the plan should be reviewed, updated and issued quarterly. The changes should be authorised by the Asset Manager and be following the Manual of Authority.

5.2.4 Short-Term Plan (ST IAP)

This plan should cover a (minimum) three-month horizon with monthly updates. The MT IAP should be based on campaign and project level, and the ST IAP focus is based on resource and work pack level. The ST IAP is based on the MT Plan windows but has more detail and includes activities that satisfy IAPS inclusion criteria. The process of constructing the ST IAP should have the following outputs:

- A short-term (minimum 90-day) Integrated Activity Plan for the Asset in the form of a Gantt chart that illustrates the agreed execution windows, i.e. start and finish dates with a supporting histogram or table of workforce requirements;
- A frozen month with clear commitments to scheduled deferment and IAPS relevant activities; and,
- Clear communication of approved changes to the plan.

The ST IAPS should be prepared by the ST Planner or equivalent and owned by the Operations Manager or equivalent. Activities in the plan should be reviewed, updated and issued monthly.

Any changes should be authorised by the Operations Manager and following the Manual of Authority.

5.2.5 Integrated Schedule (IS)

The Integrated Schedule (IS) should include all business functions' schedules. Each function is still required to develop its functional schedule; however, the integrated scheduler should optimise and package the activities to ensure optimal use of field resources, craft, operations support and facility readiness, e.g. permits, isolations, worksite inspections, and resource availability.

The IS should be prepared by the Integrated Scheduler or equivalent and owned by the Site Manager. It should be reviewed, updated and issued weekly. Any changes to the IS should be authorised by the Site Manager and following the Manual of Authority.

5.2.6 One Plan Concept

The One Plan Concept should be communicated; the benefit of planning will only be obtained if the different plan's horizon is linked and translate strategic intent to operational. IAPS includes all activities that impact field operations and use shared resources such as personnel, equipment, contracts, or material. It also applies to where there are potential clashes of activities at the worksite which impact the safety of personnel, production or cost. The first two years of the business plan targets are included in the Medium-Term plan targets, and then subsequently evaluated to determine whether all functional plans would achieve or surpass company targets. The handover process and the One Plan Concept allow the MT Planner to issue an accurate two-year plan derived from a five-year business plan, and handover to the next ST window in the first three months which is maintained by the ST Planner and consequently handover the ST plan to the 14 days SI which is maintained by IS Scheduler.

The One Plan concept means that all three-time horizon's plans from 2 years to 90 days to 14 days are for 'one plan', but the details of activities differ from one plan horizon to another. Plan integration should be performed as shown below in Figure 5-1 to produce one IAPS for the asset. The Strategic Asset Plan is the long-term plan from which the Business Plan is derived. The Medium-Term IAP activities (MT IAP) will be aligned with the activities mentioned in the first two years of the Business Plan. The Short Term IAP activities (ST IAP) will detail the activities occurring within 90 days. The Integrated Scheduler will use the ST IAP as the basis to further detail all activities occurring in the two-week schedule.

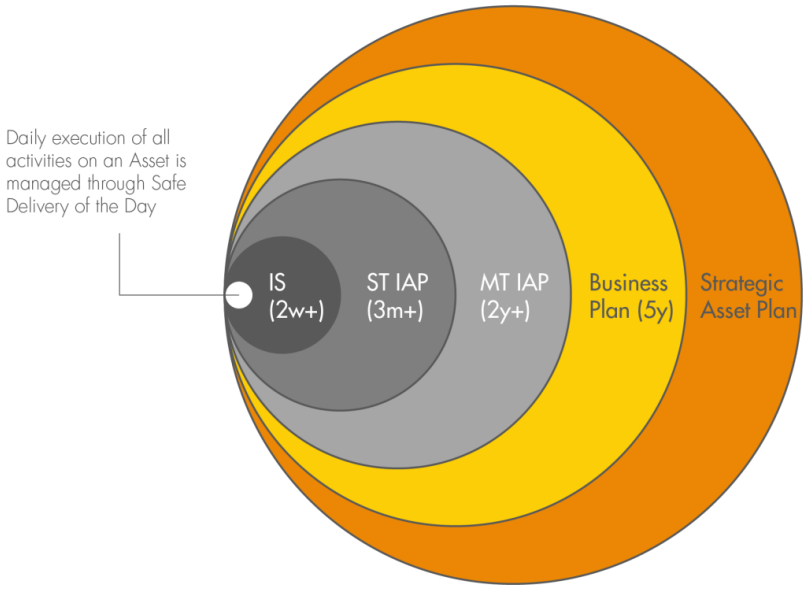


Figure 5-1 Hierarchical Relationship Between Plans 'One Plan Concept'

Verderame and Floudas (2008) suggested using a forward rolling plan horizon. The forward rolling plan means successive scheduling periods are addressed in detail while the rest is addressed by planning, and this proved more effective in demand management as the beginning of the planning horizon contains the most accurate forecast (Verderame and Floudas, 2008). Cellular manufacturing planning processes designed to plan at macro and micro levels hierarchical through different time horizons. Macro process planning is the long-term planning exceed one year. Micro process planning focuses on optimisation at the feature level and is considered very short-term planning (Hasanzadeh et al., 2009). According to Verderame and Floudas (2008); planning occurs in the long time horizon, and scheduling occurs in the short time horizon and determines the resources allocation to different tasks. The One Plan Concept is aligned with previous research and is complimentary with further details based on fieldwork and the practical needs as demonstrated during the deep-dive workshops.

The One Plan concept explained using two examples of activities (compressor resize activity and Well Reservoir Management restoration activity). These activities become mature through different plans horizon as illustrated in Table 5-2. The compressor resizes activity will start with high-level planning in the MT plan by defining the compressor model, prework duration, compressor shutdown duration, and post-work duration. This information should highlight the total number of resources required. The same activities should be detailed further in the ST plan by including specific activities to scaffolding, cabling trenching, and bundle change out. In IS the same activity is described in greater detail and stages of work, by detailing the day

by day activities and resources required. This level of planning is called level-5 planning. The greater granularity of planning data increases the robustness of resource integration, which in turn contributes to producing the IAPS framework and delivering business results.

Table 5-2 Examples of IAPS Activity Levels

Plan	Level	Activity detail	Example 1	Example 2
Long-term (e.g. ESAMP)	Level 0/1	Project title	Compressor resize	WRFM Restoration
MT IAPS	Level 2	Execution phases/ Campaign window	Compressor resize -5d pre-work, 3 PoB -9d shutdown work, 8 PoB	Well 11 Re-perforation -14-day work, 5 PoB
ST IAPS	Level 3	WO/Resource level	Compressor resize - 2d scaffolding, 4 PoB - 3d cable pulling, 2 PoB - 1d isolation SD, 2 PoB	Well 11 Re-perforation - 3d Install CT Tower, 5 PoB - 2d install test separator, 6 PoB
Integrated Schedule	Level 4+	Operation/Worklis /activity-steps	Compressor resize - day 1: offload mat, 2 Ops - day 2: install scaffold, four scaffold - day 5: isolate compressor,	Well 11 Re-perforation - day1: clear top deck; 2 Ops - day3: offload mat, 2 Ops - day3: isolate well, 1WS

In summary; the goal of direction setting is to send a clear message to all stakeholders. Based on the plan management described above, the IAPS framework proposes for the GC leaders to use the following:

- IAPS is the mechanism to deliver the business target; it translates the strategic plan to execution, and it is in the core of the company business framework.
- The Strategic Asset Plan and Business Plan should be developed and kept updated.
- The Medium Term (2 years minimum), Short Term (90 days minimum), and Integrated Schedule (14 days minimum) are in place and are linked to the Business Plan and Strategic Asset Plan and reflect business optimisation decisions.
- The plans are organised, updated, reviewed by relevant stakeholders, and approved by the Plan owner. Ensure that the appropriate level of leadership attends IAPS meetings to make timely decisions in the meetings to maintain speed and simplicity.

- All owners of major activities that impact field operations should have functional activity and services plans and participate in IAPS to optimise resource deployment and maximise production facilities' availability.
- The functional plans must have consistent detail within the planning database at each level in the planning hierarchy. Projects and activities included in the Integrated Activity Plan should align with the Asset Plan and Asset Road Map.
- Asset IAPS Lead is empowered to change the IAPS and provide insights into plan risks and opportunities. The IAPS lead is a member of the Asset Leadership Team.
- Mandate that work does not happen in the field unless it is in the IAPS.
- Require that the IAPS forms the primary basis of the activities submitted as part of the Latest Estimate process and challenge the Functional Plans' assumptions as required based on input provided by the IAPS Lead.
- Challenge activities that are not ready for execution when they enter the Short-Term IAPS (90-days out). When an activity that will not be ready in time can proceed as scheduled, ensure that the decision is made at the organisation's right level.
- Establish and communicate the critical Asset priorities to ensure that the team has a consistent basis for assessing opportunities throughout the IAPS process.
- Periodic baseline snapshots of the plan will be made in line with the agreed baseline process and compliance and change to plan shall be tracked, analysed, reported and improvement actions produced.

Having the above direction setting clear in the organisation, helps the IAPS team carry out their mandate and integrate, optimise, and execute all activities per target date, cost, and allocated resources.

5.3 Organisation Structure

The research covered within the literature review is sparse concerning an ideal organisational structure for IAPS. The deep-dive workshops in case-study companies revealed different organisation structures in each company belong to the GC, and there was no standard approach in creating a planning organisation structure (refer to section 4.3, structure element). Each company has its unique structure, complexity and challenges, and it was necessary to highlight that there was no single planning organisation solution that fits all. The IAPS framework provides a recommendation, as seen in Figure 5-2 of an organisation model based on the

outcomes of the deep-dive workshops and discussions with IAPS subject matter experts in the GC and after consulting the GC HR team. The proposed organisation was built based on the GC organisation principles and HR standards. This proposed organisation model should bridge the gap and ensure IAPS planners have single-point accountability for the IAPS plan and control changes to it. The proposed organisation model also allows the function planners having single-point accountability for updating their respective Functional Plan. Such clear responsibility and reporting lines would help to trace accountability to the right level. The exact numbers of staff, the deployed organisational structure and reporting lines should be tailored to the company's needs. Assets may choose to split the responsibilities between the IAP Planner and Integrated Schedulers differently, but in all cases, there should be clear roles and responsibilities defined and communicated for IAPS.

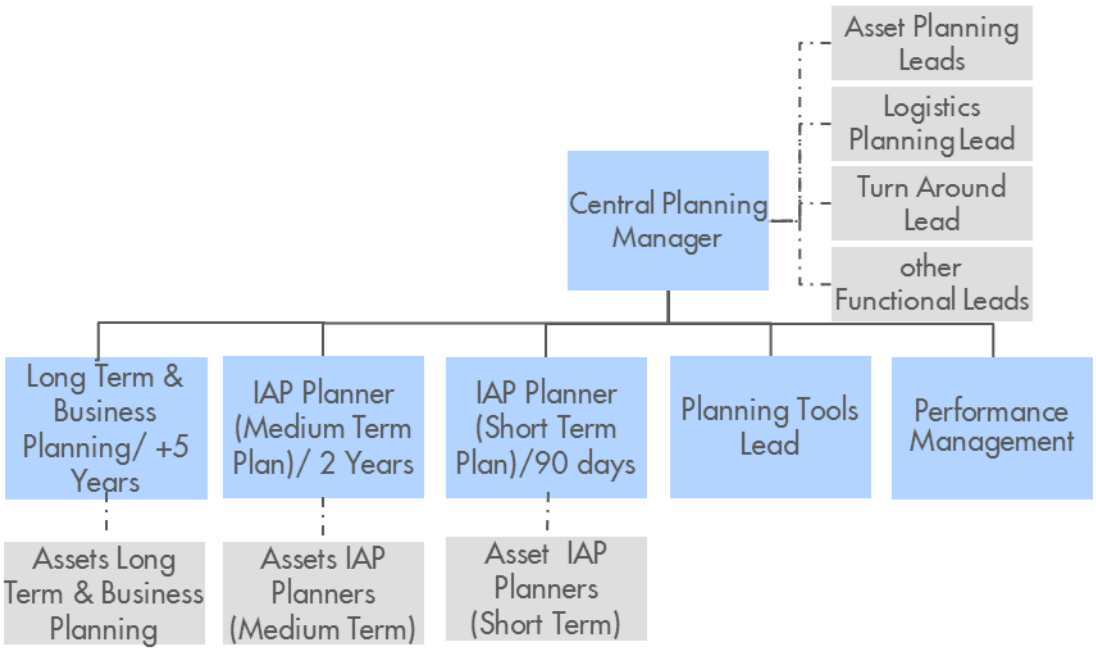


Figure 5-2 Proposed Central Planning Team organisational structure

In Figure 5-2, the blue boxes represent the core central planning team's structure with direct line reporting reflected with the solid line. The grey boxes indicate other roles outside the core central planning team with indirect reporting (dashed line) to ensure integration. The essence of integrated planning is to integrate all activities, and hence the reporting from roles outside the central planning team should be highlighted in the organisational structure. The Central Planning team consists of a Planning Manager who has oversight of the company integrated plan. This includes the strategic long term to five-year Business Plan; the two-year Medium-Term Plan; and the 90 Day Short Term Plan and the 14 Day Integrated Schedule. Five key

roles support the Central Planning Manager: the Long Term and Business Planner who has responsibility for the company's overall long term and business plan for a minimum of five years; the Medium Term Plan IAP Planner who has responsibility for integrating the two-year activities; the Short Term Plan IAP Planner who has responsibility for integrating the 90-day activities; the Performance Management Coordinator who has the responsibility to track IAPS KPIs; and the Planning Tools Lead who has responsibility for the IT systems used in the company to perform IAPS.

Within smaller companies it may be appropriate to consolidate all planning resources under one role to optimise interface efforts; however, this would be challenging in more substantial companies which typically would have many assets to manage, and would be beyond the capacity of a single role. Therefore, the organisational structure illustrated in Figure 5-2 could be reproduced for each asset and report to the central planning team in the company.

5.3.1 Roles and Responsibilities associated with each plan Horizon

The One Plan Concept explains that all plan levels, from strategic to operational, are fully integrated, and activities flow from one planning level to another with greater detail as approaching the execution time. The Project Portfolio and Field Development Plans are the basis for the strategic plans, and it is necessary for the IAPS Team to regularly review these plans and portfolios and discuss changes to scope with the activity owners to adjust the following plans MT, ST, and IS.

Roles and responsibilities have been sparsely researched, and the three case-study companies' teams demanded during the deep dive workshops for a clear ownership description for each plan (refer to Section 4.3). The IAPS framework proposes a relationship between plan ownership and responsible parties summarised in Table 5-3. The framework explains each plan's horizon, frozen window (i.e. the window is closed after approving the plan and no more changes are allowed without following a specific change request process), output plan, owner of the plan and change authority, the purpose of developing the plan, scope, and frequency to review the plan.

Table 5-3 IAPS plan definitions with roles and responsibilities

	Long Term Plan	Business Plan	Medium Term Plan	Short Term Plan	Integrated Schedule
Governing Process	Execute Strategic Asset Management Plan	Develop Business Plans	Manage Integrated Activity Planning and Scheduling		
Time Horizon	Asset Lifespan	BP 5 Years	Min. 2 Years	Min. 3 months	Min. 2 weeks schedule*
Frozen Window		OP: 2+1 Years	1 Year	1 Month***	1 Week
Output	ARP	BP, OP	MT IAP	ST IAP	Integrated Schedule
Owner and Change Authority	Asset Leader or equivalent	Asset Leader or equivalent	Asset Leader or equivalent	Operations Manager or equivalent	Facility/ Installation Manager or equivalent
Purpose	Plan strategy for asset over field life	Define agreed financial and business targets	Prioritise optimise and integrate agreed activities, specify Shutdown Windows. Underpin the business plan submission and basis of latest estimate	Integrate and align agreed activities to avoid clashes and minimise shutdowns. Update latest production estimate and ensure effective use of shared resource.	Prepare, package, optimize and confirm work for execution. Ensure operations and facility readiness and effective use of shared resources
Scope	Level 0/1 All Functions' Long-term plans e.g. MRP, Turnaround strategy and Project funnel	Level 1 The next 5 years plan to support the ARP, incl. budget cash flow, production versus cost	Level 2/3 execution windows for Functions' activities and resources, e.g. lifting equipment, personnel, etc.	Level 3/4** execution windows for approved functional activities and production impacting events	Level 5 work packages and work orders for approved scheduled work
Frequency	Reviewed at business checkpoints and issued yearly	Reviewed, updated and issued yearly	Reviewed, updated and issued quarterly	Reviewed, updated and issued monthly	Reviewed, updated and issued weekly

* Recommended: 6 weeks. ** Recommended Level 4 for month 1. ***ST IAP: Activity Readiness checks recommended at 90d and 4w/ 6 w.

The asset leader owns the Strategic Plan, Business Plan, and Medium Term Plan, while the Operations manager owns the Short Term plan, and the site manager (facilities or installation manager) owns the Integrated Schedule. Each plan owner should chair the respective plan meeting and ensure activities in the plan meets the gate criteria (which will be explained later in the next section) before it gets handover to the next plan owner. The site manager is accountable for ensuring all activities included in the integrated schedule are ready for execution. The IAPS performance coordinator with the activity owner should track progress for the main activities every week to review progress, ensure readiness, and timely execution.

5.3.2 The interface between IAPS and other processes

IAPS should not be treated in an isolated manner; there is a strong relationship between the IAPS process and key work processes in the company. It is possible that the IAPS process KPIs are good, but that the business targets are not met. For example, the HSSE target of achieving zero Tier-1 and Tier-2 events[2] can be affected if the material used for construction does not meet the fluid specification. The corrosion rate will increase with increase the losses of thickness, and hence more leaks will occur. The IAPS process will not be able to eliminate such situations but may support conducting a timely evaluation of the pipeline integrity and

[2] *A Tier 1 & 2 Process Safety Event is a Loss of Primary Containment with consequence. It is an unplanned or uncontrolled release of any material, including non-toxic and non-flammable materials, from a process that results in consequences as listed, per the API 754 Guide. A Tier 1 & 2 Process Safety event may involve significant actual or potential impacts.*

execute a timely repair. Said et al. stated that integrated planning is a necessary process linked to the production forecasting process (Said et al., 2014). Their research in ADMA-OPCO (a major offshore operating company) focussed on utilising an integrated planning process to manage the activities affecting the production forecasts. A study in the semiconductor industry conducted by Ekin (2018) demonstrated the importance of integrated maintenance and production planning with uncertain yield. Cordes and Hellingrath (2014) created a solution for ensuring the availability of spare parts while minimising inventory cost by using a tactical integrated planning model that aligned inventories, transportation, and activities demand. The fast-moving consumer goods industry has also used a hierarchical demand-driven planning framework to reduce waste, reduce inventory cost and avoid product return (Farahani et al., 2013).

The IAPS Process should interface in a structured way with other functions' business planning and delivery processes, including forecasting and turnarounds, which have a longer horizon. This also means that the IAPS team cannot only aggregate all Functional Plans and call them an Integrated Plan. In performing the integration of work, the approach typically involves the following steps:

- Aligning and scheduling the timing of packages of work per their logical sequence, interdependencies, budget, specialist and shared resource availability; and,
- Aligning work with agreed turnaround windows and capacity commitments.

Table 5-4 illustrates the inputs and outputs of IAPS and is used to ensure relevant stakeholders understand such relationships with appropriate focus given during IAPS work process execution, this, in turn, helps contribute to knowledge in producing IAPS framework. In this context; key stakeholders are IAPS planners, functions planners, IAPS leader, project managers, WRFM manager, supply chain manager, production planning manager, maintenance manager, TA manager, assurance manager, operation manager, functions managers, and asset manager.

For example; the turnaround process involves setting the turnaround window's duration, while the IAPS involves deciding when the turnaround will take place. The IAPS is about aligning execution windows on production facilities, not about engineering phases, e.g. design and fabricate. It focusses on the impact of work on production delivery, cross-function coordination and cost-efficiency. It is important in large Integrated Production Systems with multiple turnaround windows that the start dates of turnarounds are optimised in terms of production throughput and shared resource utilisation. The IAPS plan shows events that meet IAPS inclusion criteria such as maintenance campaigns and projects. The combined

turnaround process, project delivery process, and IAPS process would deliver excellent results if the integration worked out perfectly in the asset.

Table 5-4 Inputs and outputs of IAPS

Process	Inputs to IAPS	Outputs from IAPS	Key Stakeholder
Long Term Plan-Execute Strategic Activity Management Plan	Asset vision and priorities Credible path to Top Quartile Value Chain Opportunities	Integrated plans	Asset Manager Function Managers Vendors and Contractors
Manage Projects	Functional plans meeting IAPS requirements	Integrated plans	Project Managers Project Planner Vendors and Contractors
Perform Well, Reservoir and Facility Management	Approved WRFM Plan List of approved WRFM activities that meet IAPS requirements	IAPS plans and schedule	Wells Managers Wells Planner Vendors and Contractors
Manage Supply Chain	Resource requirements Materiel readiness Logistics plan and schedule	Supply chain demand within Rules of Engagement	SCM Managers SCM Planner Vendors and Contractors
Forecast and Plan Production	Production forecast	Planned production outages	Operations Managers Production Manager Production Planner
Perform Maintenance Execution	Detailed activity plans and schedule	Integrated schedule	Maintenance Managers Maintenance Planner Vendors and Contractors
Perform Turnarounds (TA)	Long-Term T/A Plan Pre- and Post-T/A schedules for work to be integrated with other activities	Scope of work from non-T/ A related activities Shared resource availability	TA Managers TA Planner Vendors and Contractors
Conduct Assurance	Status of controls and associated risks Effectiveness of management system Annual Assurance Plan Templates for Group assurance	Define control points and recommended Group, Regional, and company activities Planned Health Checks Process performance indicators and trends Learnings from other assets	Assurance Managers Assurance Planner Shareholders representative

In summary: the organisational structure and clear roles and responsibilities are vital in delivering effective IAPS in the GC. The IAPS framework guides the IAPS owner in the asset to:

- Establish a clear IAPS organisational structure aligned to the company business context, or use the IAPS framework model. The organisational structured should be communicated to all teams.
- Communicate the roles and responsibilities for each plan's horizon which should be understood by all relevant stakeholders;
- Ensure decisions are made in full knowledge of benefits and implications for the enterprise. A table of authorities is defined so everyone is clear about where decisions should be taken, e.g. which meeting and who is authorised to approve decisions at various business levels. The decision is based on impact, primarily on cost and production as per the Manual of Authority (MoA)[3].

In order to enable the execution of the IAPS framework, an organisational structure should be established for correct governance, and roles and responsibilities should be clarified. The correct integration of the plans requires a team of experienced staff with appropriate knowledge of operations, facilities, local constraints and the content of each business function's work. Consequently, a careful selection for the staff who should fill these roles should be applied based on the following section guidance.

5.4 People

Putting the right people in the right place with the right skills is essential, but not sufficient to ensure success and high performance (Walter and Werner, 2010). Collaboration in this context relates to valuing different perspectives, discussing opportunities, sharing enthusiasms and achieving more significant results (Derenzi et al., 2009). To ensure putting the right people in the right place and stimulating collaboration; the IAPS framework guides to focus on ***training, coaching, and succession planning*** under the people element.

Depends on individual planner development requirements; the IAPS framework proposes the following training program. The researcher with the GC IAPS subject expert and HR team discussed the current IAPS training programme and evaluated the case-study companies' feedback during the deep-dive workshops. The analyses showed a need for a more

[3] *The Manual of Authority (MOA) is a document in the GC stipulate the decision hierarchy in the company financially and legally.*

comprehensive training programme to cover a broader skillset and match this with staff experience. Training modules were designed for different skills levels, starting from awareness to knowledge to the superuser. The IAPS training programme was created to focus on developing IAPS process knowledge, using the IAPS planning toolset, and coaching and is illustrated within Figure 5-3. The training connected to specific roles and responsibilities and all courses will be conducted on-site (as per the case-study companies request).

The training starts at the awareness level, which is conducted face to face in a classroom. This course is one day and is targeting IAPS stakeholders who are not professional IAPS planners. The course provides a high-level understanding of the IAPS framework, eight elements. The 2nd level is the knowledge level, and three different courses will be conducted. It starts with the IAPS master class and simulation, which takes five working days and is conducted face to face in the classroom. This course goes more in-depth in the IAPS process and explains all steps in detail. The course includes simulation for conducting an IAPS meeting, resolving the dilemma, managing clashing activities, and challenging function planners for quality data. The 2nd course in the knowledge level focusses on building functional plans and extracting the plan from the GC ERP system (SAP). An interface software called Impress is used to transfer all requested activities from SAP to the GC's planning system and called Primavera P6 (planning systems will be explained in the next sections). The 3rd course in the knowledge level relates to training for the planning system's operation (Primavera P6) and is targeted at the IAPS planners. The 3rd level of training targets the skill level of the IAPS superuser. The IAPS framework training programme is intended to develop a superuser in each company for IAPS process, Impress system, and Primavera P6 system. The superuser course takes around six months of training and coaching supplemented with specific projects to demonstrate competence. The overall assessment is carried out by the GC IAPS and subject matter experts.

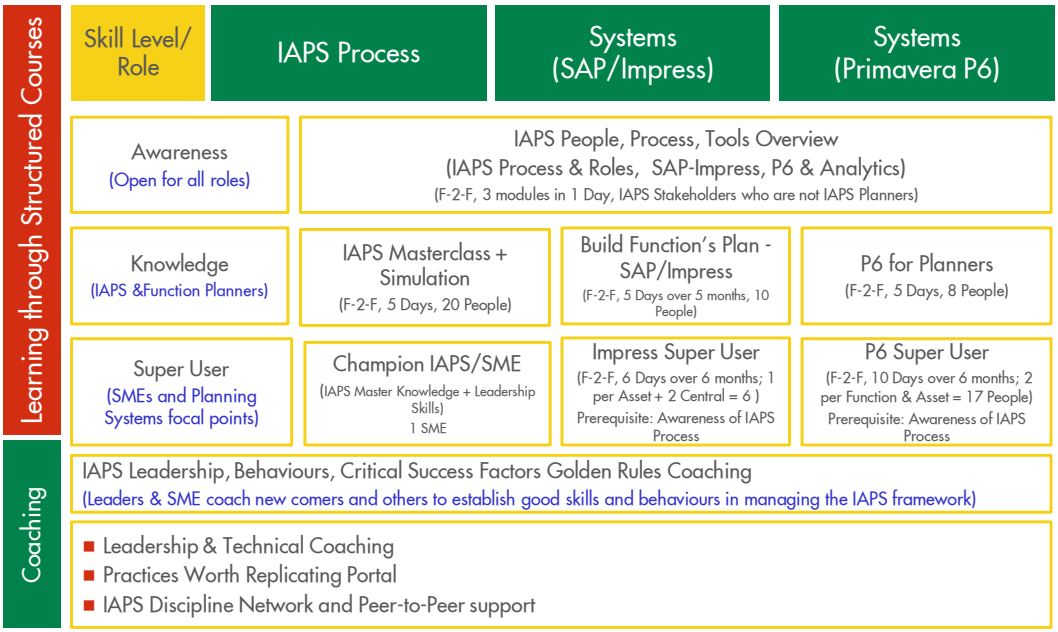


Figure 5-3 IAPS Training Programme

The coaching programme focusses on leadership and behaviours, which is crucial for improving collaboration. The Oil and Gas industry faces significant challenges in knowledge transfer within their organisations; there is a lack of governance and a holistic methodology (Saxby and Burridge, 2013). The IAPS framework provides guidance to use the company IAPS experts to coach planners on the job and encourage the planners to join the global planning discipline network in which a monthly meeting is conducted for all companies belonging to the GC to discuss challenges and share best practices.

Staff want to develop their skills, and there was an apparent demand from the case-study companies to manage succession planning using the IAPS Framework. The biggest challenge facing the GC was that there was not much staff that would like to take the planning role, as they did not see a bright future on it. Succession planning was an essential element within the IAPS Framework to provide a clear opportunity to progress, retain experts, and attract new talent. There is no specific tool for succession planning, as it is typically a continuous process, and depends on each company's individual talent management system. However, in the IAPS Framework, guidance is proposed to assign a high salary group (SG1) to the company's overall planning manager, and subsequently SG2 to the planning leaders, then SG3 and SG4 to the junior planners. Having such a salary structure is intended to encourage talented individuals to join the planning community. This salary structure was discussed with HR and agreed. The business leader, skill pool manager, and HR in each company should draw a succession plan to progress staff from one position to another in order to ensure continuity and avoid letting a

position become vacant for an extended time as it was experienced in the deep dive workshop. Moreover, the succession plan should be clearly communicated to the team to understand and buy into the development. The IAPS framework guidance proposes auditing the people element and the succession planning to ensure the senior leader fulfils it in each company.

Therefore, to address the people element, the IAPS framework guides to:

- The Company leader in facilitating the training matrix proposed in this IAPS framework and to resource the required fund to conduct the designed courses;
- The company leader to assign coaches with staff names and include the coaching element in the manager's annual performance evaluation report;
- HR to communicate the succession planning and recruit a competent staff; and,
- Ensure the IAPS job descriptions, job competence profiles and succession plan are accurately described, in place, and up to date.

5.5 IAPS Process

IAPS combines all functions' activities to be carried out on a facility and integrates them into one plan. It gathers, prioritises, integrates and optimises functional activity execution with their associated resources while maximising asset utilisation by preventing clashes, reducing overall costs and optimising resource utilisation. The plan's content should increase in detail as activities approach their execution date; therefore, integration should be performed over the field life. The integration of activities would ensure that all activities are prioritised and scheduled for execution at the most appropriate time, allowing the assets to set realistic safety, production and cost targets and deliver upon them. IAPS also involves managing changes to plans caused by unforeseen events such as failures and bad weather and any significant scope movement or growth.

The literature review highlighted that little research was conducted regarding the IAPS process (step by step action) or what is otherwise called a Standard Operating Procedure in the oil and gas industry. The IAPS process was mentioned as a concept, or within a high-level building block type diagram in most of the research reviewed. The additional contribution to the knowledge from this research, is the detailed step by step IAPS process, explaining how the activities gathered, integrated, optimised and produced as one plan for approval and execution.

The deep-dive workshops and specifically the IAPS heat map revealed of no consistency in following up one IAPS procedure across the GC, and many steps were disconnected within

the process. The IAPS heat map's average score for the three case-study companies was 46% (Company-A: 45%; Company-B: 30%; Company-C: 65%), which translated to roughly half of the process's steps not being correctly followed. The researcher with the GC IAPS subject matter experts using learning from different case-study companies, had reviewed the IAPS, and proposed the following four building block process which will be explained step by step in the next section and illustrated in Figure 5-4. These four building blocks were considered as the main pillars to produce an integrated plan. It started with each function building its Functional Plan and then passing these plans to the IAPS planner who integrated the plans and schedules for the three plan horizons (MT, ST, IS). The integrated plan would then be approved and communicated in which the last building block is monitoring the schedule execution and improve. The four building blocks were used to construct all three-time horizon plans starting with the two-year medium-term plan, to the 90-day short term plan, to the 14-day Integrated Schedule. There was no difference in the steps to be followed to develop an integrated plan be it MT, ST, or IS, as the process steps were created in a standardised manner regardless of the plan time horizon factor. This standardisation was considered novel in this research and additional contribution to knowledge.

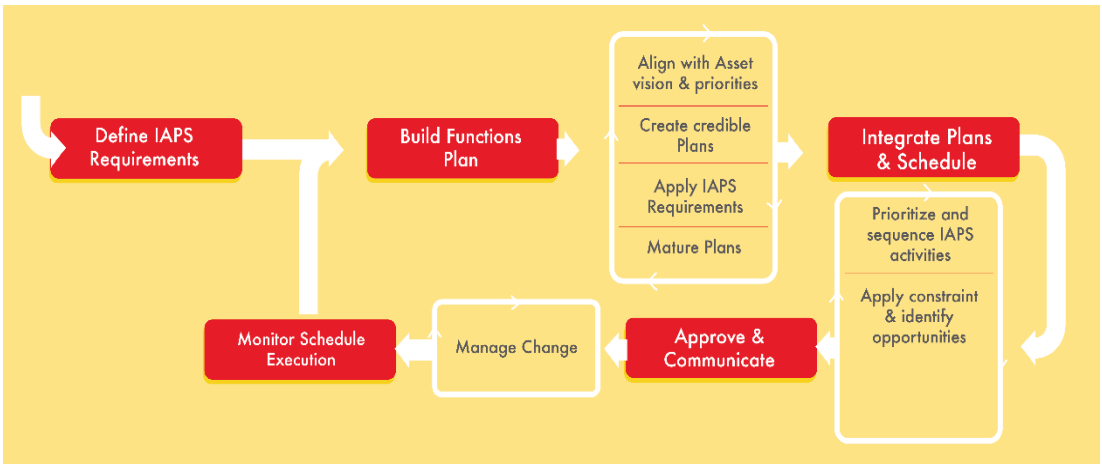


Figure 5-4 IAPS Process main building blocks

The fieldwork and deep-dive workshops exposed the primary pain points the case-study companies were experiencing and going back to the voice of customers workshop, a detailed set of requirements were created. Such requirements were discussed thoroughly with the GC IAPS subject matter experts and developed as part of the IAPS framework. The IAPS requirements (Inclusion Criteria, Activity Readiness Criteria, Ranking Criteria, Change

Control Criteria, Planning System, Performance KPIs, Data specifications, Organisation Rules and Responsibilities, Standard Operating Procedure, Planning Calendar, and Process Council) are all explained in this section. The IAPS requirements block is considered as the primary foundation for the IAPS process to work. It defines the requirements which are necessary due to the process being applied to a range of different assets and acts as a prerequisite check to review if the IAPS requirements are in place. The "Define IAPS requirement" block should be used to consider the adaptation and inclusion of future improvements, particularly after testing the IAPS framework.

5.5.1 Build Functions Plans

In Section 1.1, it was highlighted that the upstream oil and gas business consists of different functions and disciplines such as exploration; development; well engineering; well services; project services; operation; maintenance; turnaround; optimise recovery; and, logistics. Each of these disciplines has its sub-disciplines. For example, the maintenance discipline consists of mechanical, electrical, instrument, rotating, inspection, reliability, condition monitoring, and painting sub-disciplines. These disciplines form the Functional Plan, which is crucial to be developed to the right standards in order to be able to be integrated. The IAPS process explains the required standards. It starts with adhering to IAPS rules such as the timing of data transferred to the IAPS team, data field quality, inclusion criteria, and Activity Readiness (AR) coding are particularly important.

5.5.1.1 Align functions plans with company vision and priorities

Functional plans should be constructed in order to achieve the asset objectives as established in the Strategic Asset Management Plan and Business Plan. The functional plans should be developed using these documents as input, they should be aligned with the asset objectives by mapping each activity/project within the plan towards delivering these objectives, and they should be reconsidered if the asset objectives change. Business functions should review their plan assumptions and norms and ensure that the asset targets delivery. It should also be documented where work can be optimised with collaboration from other business functions, as well as identifying activities that could, in principle, contribute to realising the business objectives with other functions.

5.5.1.2 Create credible functions plans

The scope and content of the work to be undertaken are defined along with the Cost, Time and Resources (CTR) needed to execute it, taking into consideration constraints at the worksite location. The work's scope and content may include site preparatory work, system isolations,

production impacting activities, pre-commissioning, and start-up activities. The scope should also include a review of the impact of functional activities on the existing operation, for example, an assessment of the ability of operations to provide support for work execution.

The functions and asset planning process should forecast the levels of resource demand required to:

- Execute the work safely and efficiently at the worksite location;
- Secure people to develop and prepare the work in the required timescale;
- Ensure there is no commitment to deliver more than is achievable; and,
- Identify and order long lead time material.

The constraints associated with resources, such as cranes, vessels, transport, rigs, beds or accommodation and possibly deck space on offshore oil rigs, needs to be identified when scheduling activities within the plan. An early start, latest finish and duration should be established. The work execution duration and window should be planned for the defined work scope and work content with the known constraints. Once the constraints are defined a risk to plan execution should be analysed and managed proactively with the preparation of contingency plans if the risk becomes a reality. The risk management of the plan includes:

- A register of all risk and opportunities that are regularly maintained;
- All actions are listed and followed up;
- Contingency and mitigation plans are prepared; and,
- Pre-work is carried out in anticipation of such risks materialising.

As the plan horizons shorten, the level of uncertainty and risk to execution is reduced as more detail is added, and it is expected that the plan would mature as follows:

- The Strategic Asset Plan and Business Plan should detail the major activities to be executed on the Asset.
- For the MT IAP, further detail should be included in the functional plans in order to develop the work, monitor maturation, acquire and manage the appropriate resources and further define the scopes of work to ensure that activities at the worksite can also be integrated into greater detail.

- In ST-IAP, additional detail should be added to the functional plans in order to define how the activity should be executed, what resources are required for each task, and the impact the activities will have on the facility.

The defined activities should then be sequenced logically in a plan to deliver the business and plan objectives. The function is expected to set priorities and deliver one consolidated plan. The Functional Plan must be achievable in terms of cost (budgets available) and resources (equipment, materials and enough staff to prepare and execute the scope).

If required, the activity execution probability (P10 low probability, P50 average, P90 high probability for execution) is assessed to determine if it is possible to do the work following the plan, with specific scenarios and assurance in place. This review will also test the credibility, achievability, affordability and delivery of the plan against business targets. Plan and activity owners should confirm acceptance of the work's executors that they can do the work at the planned or scheduled time. The norms and assumptions used to build the Functional Plan need to be challenged and validated to ensure the latest and most accurate data is used. Mitigation actions are required to ensure that activities' execution is in line with the plan and need to be challenged for robustness.

If a change to activities in a Functional Plan is required, a change request should be initiated using the change control process. The change request will be explained in the next sections in detail but should include assessing the impact of change in safety, cost, and production.

5.5.1.3 Apply IAPS requirements

The business functions should apply the IAPS pre-requisites to their plans. All activities should be screened through Activity Inclusion Criteria and entered in the planning system as per the data standard specifications. This step will help the IAPS planner to be able to integrate all the activities within the functions' plans into one plan.

5.5.1.4 Mature plans

The plan should comply with the IAPS requirements, and mitigation actions should be communicated for the activities that do not meet the activity readiness criteria. The plan owner should ensure that activities in each time horizon of the plan are being developed, prepared, and matured by the activity owners to meet the plan's activity readiness criteria before handing over to the next plan horizon. If activity owners propose changes, the IAPS Planner should indicate conflicts with other functions.

Learning gained from the case-study companies deep dive highlighted those function managers do not own their functional plans, and they do not show ownership interest. To bridge such a gap; a step was included to hold a meeting chaired by the function leader, the activity owners/executors, and the IAPS Planner to go through the Functional Plan and approve it before entering the next block 'Integrate plans and schedule'. Function planning meetings with IAPS involvement reflects the cornerstone of the IAPS process. The function leader should sign-off the Functional Plan before submitting it for integration.

5.5.2 Integrate Plans and Schedules

At this stage, the assets' objectives, priorities and constraints are defined. The Functions Plans' activities should be prioritised based on asset ranking criteria (which will be explained in the next section) and evaluated for execution readiness before integration with the IAPS Plan. Constraints, operations readiness to support execution, impacts and priorities should be considered in this evaluation. The activities should be matured, prepared and delivered within a formal change control process applied to ensure plan stability. This should involve:

- Aligning and scheduling the timing of work packages according to their logical sequence, interdependencies, budget, specialist and shared resource availability;
- Aligning work with agreed turnaround windows and capacity commitments;
- Addressing and resolving clashes and constraints, minimising exposure to threats and creating the best conditions to capitalise on opportunities whilst meeting asset and business priorities;
- Reviewing, approving or rejecting change requests based on assessed impact/benefit; and,
- Ensuring that the plan meets the business targets to be achieved.

5.5.2.1 Ensure functions plans meet IAPS requirements and designated plan horizon

Before integrating the Functional Plans, the IAPS Planner should ensure that the activities meet the IAPS requirements and have been designated for MT, ST and IS IAP horizons for effective integration and performance monitoring. This step considered a second confirmation to the step mentioned under building Functional Plan to 'Apply IAPS Requirements' due to the importance of such verification. This was one of the main challenges derived from the three study-case companies' deep dive; the IAPS planner has not been able to integrate activities because functions did not comply with IAPS requirements and did not designate their MT activities ST and IAP horizons.

5.5.2.2 Apply constraints and identify opportunities for integration

The specific resource constraints affecting the asset, e.g. helicopter capacity, physical constraints local to the worksite such as People on Board (PoB) limits, deck space, and limitations for Simultaneous Operations (SIMOPS) should be established and quantified. The IAPS planners should establish any constraints by identifying the availability of shared resources with regards to activities collated from functions plans.

In collaboration with the activity owners, the IAPS Team should then integrate and align the functions' activity schedules to ensure optimal utilisation of resources and minimal impact on production. This should include:

- Checking to ensure all activities from the MT/ST or IS are aligned with the Functional Plan.
- Including new function activities in the plan if they meet the inclusion criteria.
- Identifying new production impacting activities that may not have been included in the turnaround scope or activities proposed to be taken out of the turnaround scope or other activities from third parties.
- Identifying availability of shared resources, e.g. equipment, accommodation, personnel, periods available for the outage, including third party, concurrent work restrictions.
- Separating clashing activities.
- Aligning activities where beneficial.

For all activities, the plan's best fit should be verified by considering interdependencies, other work, and ongoing plant operations. The IAPS Team should propose a clear opportunity, risk, or impact so that the plan owner can make a correctly informed decision.

5.5.2.3 Resolve clashes and propose scenarios

If changes to the Functional Plan lead to clashes with other functions, they should usually be resolved in the function planning or IAPS pre-meeting, by moving the activity to a window without a clash. If the clash cannot be resolved in the function planning meeting, it should be discussed in the IAPS meeting where the plan owner will decide on priorities based on business value. Complex changes are likely to require different scenarios to be developed by the IAPS Team. The scenarios should be evaluated based on business impact and presented to the plan

owner for decision making. Changes that need immediate resolution and those beyond the chair of the IAPS meeting's approval limits should follow the IAPS change process.

5.5.2.4 Confirm Activity Readiness

It is necessary to ensure clear gate criteria are used to progress activities from MT to ST to IS, or which Activity Readiness is critical. The IAPS Team should challenge function AR to ensure compliance to agreed criteria. The IAPS Team, in conjunction with Operations, highlights operations readiness, e.g. at the MT IAP level, Operations should confirm or otherwise, if it can support a complicated job. At ST IAP level, Operations confirms isolations, worksite inspections, and execution, for example. If any operations readiness gaps are identified, mitigation plans should be put in place to ensure the activity can be executed according to the plan.

5.5.2.5 Prioritise and sequence IAPS activities

There will often be times when two or more functions compete for the same resources or time slots. Ranking activities enables the asset manager to prioritise the work to deliver business outcomes where resource constraints exist. The competing activities should be prioritised based on their relative impact, benefit or risk to the business. The Supply Chain process should manage critical resources (trucks, helicopters) that should be shared by multiple activity owners. In most cases, these resources are constrained to maximise the utilisation. The IAPS Team should meet regularly with the Supply Chain Team to discuss changes to the critical resources to reduce risk on execution. The IAPS Team should provide the Supply Chain team with demand for resource requirement to execute activities over the coming two years, including risks and opportunities.

5.5.2.6 Integrate activities in each time horizon

Integration of activities is all about timing and resources. The timing factor is to reduce the overall downtime of facilities, while the resources factor optimises the use and not waste value. Therefore; all activities are scheduled to be executed in one facility, should be integrated under a one-time slot and sequenced if necessary. The number of activities to be executed depends on the facility space and the work gathered from the functions' plans after applying the site constraints. The integration can be conducted in view to:

- Integrating deferment activities;
- Resolving clashes;

- Establishing the preferred activity execution sequence, interdependencies and agreed priorities;
- Identifying work which can be done in series or concurrently (alignment);
- Scheduling the work within identified constraints, allocating an appropriate window for each activity;
- Aligning with activities on other assets, upstream, pipelines and downstream, whether owned by the company or external third parties (optimising); and,
- Aligning turnaround to ensure production impact is minimised, resources are available, and business values are maximised.

5.5.2.7 Propose 'draft plan/IS' for approval

A proposed 'draft' plan/Integrated Schedule with a list of required decisions, opportunities trade-off, and risk mitigation should be sent as pre-reading for all concerned stakeholders in preparation for the IAPS meeting for discussion and approval.

5.5.3 Approve and Communicate

The IAPS Team should ensure the plan owner approves the IAPS plans. The IAPS Team should communicate the plans to the stakeholders and manage change in line with asset procedures specified in the IAPS Framework.

5.5.3.1 Approve the plans

A large proportion of the management of IAPS should take place through a series of meetings as captured in the planning calendar. The IAPS meetings' objective is to highlight risks and opportunities to plan delivery, consider proposed changes, resolve clashes, and approve the plans. Functional planning meetings should also be captured in the planning calendar. Integrated Planners should be involved in these meetings, as that is where most integration issues can be resolved. If Business Functions do not have a planning meeting, the Integrated Planner should organise an IAP pre-meeting or IAP alignment meeting to achieve the planning objectives. A pre-reading pack should be issued a minimum of five days in advance of the meeting for MT, two days for ST and IS and should include:

- Actual performance vs plan (year-to-date business performance to be used as a scene-setter);
- A summary of the critical issues/clashes to be addressed;

- A table of proposed changes to the previous plan with reasons why and impact assessments;
- Performance KPIs and learnings;
- Open actions from previous meetings;
- A copy of the plan with associated resource histograms/S-curves (which is showing expected execution trend over time) including the production forecast; and,
- Scenarios/key issues/clashes assimilated with Business Plan impacts for which decisions need to be made using the agreed template.

Ensure Integrated Plans meet business targets and review plan performance

Before the plan's approval, the IAPS Planner should verify that the plan meets the agreed business outcomes/targets. If the Integrated Plan does not meet the targets, the plan should be escalated to the Asset Leader/Leadership Team for agreement on the prioritised activities that meet the business objectives. The business target should be made measurable in the plan. For example, if the target is to reduce logistics cost by 10%, the IAPS should measure if the plan's logistic resources are fewer than in last year's plan. The performance KPIs of previous plans should be reviewed to identify the lessons learned for better plan delivery.

Approve plan and schedule

The appropriate authority should approve the plan and any changes. Any outstanding actions and action parties should be documented in the minutes. If there is no update to the plan, the approval and sign-off should be done physically during the meeting. Where there is an update or changes to the approved plan, it should then be updated by the IAPS Planner and either signed-off physically by the plan owner or electronically by email.

Update Functional Plan

The approved plan should be updated to reflect approved changes to it and communicated to key stakeholders. The Business Functions should update their plans according to the approved changes before the Integrated Plan is updated.

5.5.3.2 Communicate the plans

Communication is achieved by issuing the plans and schedules to the functions and other stakeholders on an agreed distribution list and handover activities to the next Plan Horizon. The MT and ST IAP Planner should ensure that activity owners continue to mature their

activities to readiness to be accepted into the next plan horizon. The activities' maturation includes identifying the required vendors and specialised tools, closing-out actions and escalating issues/concerns regularly. Activities must meet the minimum requirements for the next plan horizon as per the activity readiness criteria. During the handover, all activities with an amber or red AR should be discussed, including mitigating actions. Other minimum requirements have also to be discussed in the handover, such as activity detail and data quality. For example, work orders should detail all elements of the activity and include all labour, materials, and service requirements.

5.5.3.3 Manage the Change

The objectives of change management are to apply a level of review, challenge and approval appropriate to the change's nature. Specifically, this requires that:

- Changes are not made to the agreed plan in an uncontrolled or unauthorised way that compromises safe and efficient operations or impacts production and business commitments;
- Any change is identified first as a proposal; then its impact is fully assessed and evaluated before any decision is taken;
- Any change is submitted as a thoroughly evaluated proposal to the appropriate level of authority to approve the change; and,
- The change is appropriately communicated to all affected parties on time.

All changes must be appropriately controlled; these changes to the approved plan activities should be implemented in a controlled manner and approved by the plan owner. Any change that does not have a clear assessment of risk and value impact should not be approved. The asset leader and IAPS Process Owner should define what frozen elements or windows of the plan require change control and how it is managed. Change control should be applied to minimise the impact of frequent activity changes on plan stability. Any change affecting the number of days for turnarounds, production impacting activities, or capital projects significant scope change or resources should be adequately managed through a structured change process. The framework proposed a structured change request process. The change process is useful for frozen month activities on which proposed activities changes should be dealt with immediately to devote resources to carry out a new activity and there is no IAPS meeting to discuss and approve the change.

Any activities that do not have a proper impact assessment should not be approved. Changes to the plan should be kept to a minimum but may arise for several reasons, including for example a high producing well trip and requires a workover rig to be mobilised which was not included in the approved plan. Change control is required when there is a change to an IAPS Plan activity that impacts the set targets. These activities affected by the change are regarded as 'frozen elements' of the IAPS Plan. Frozen elements in the medium-term are related to Business Plan promises or Strategic Asset Plan commitments such as:

- Production outage windows for turnarounds and other scheduled deferments;
- Number of budgeted Coiled Tubing Clean-Outs (CTCO); or,
- The end date of a rig contract.

The fixed element in the short-term is the frozen month. The activities below should be undertaken for change control based on the IAPS change request process.

Understand the change

Gather change request information: The change requestor should gather the required information about the change to understand its full extent and impact. Once this information has been analysed, the requestor should then validate the need for the Change Request (CR), i.e. if it meets the business/Asset's CR criteria and gets support from the CR stakeholders. The change requestor should be responsible for completing all the discussions and for gathering the information required to start the CR formal submission process. As part of this step, the following information is required:

- CR scope, readiness to execute and achievability;
- Impact of the change on activity duration and change in timing of the activity, i.e. start/finish dates;
- Impact value of the change, i.e. cost, production, HSSE, integrity, People on Board for the activity as well as overall impact value of the change; and,
- Impacted parties/functions and supporting parties/functions.

Validate impact and value: The change requestor should complete the initial validation of the change's impact value in consultation with the Finance team (costs/financial gains) and Operations or the business/Asset team responsible for managing production volumes and deferment. The change requestor should be responsible for confirming the initial estimates for the impact and value with the relevant teams.

Obtain functions' support: The change requestor is responsible for obtaining support from the function's leadership for the proposed change. The level of support required depends on the impact and value of the change and the Manual of Authority (MoA) guidance.

Obtain value impact (budget) approval: Before the change requestor submits any proposed changes to the plan, the proposed change's value impact should be endorsed and approved by the relevant Business Leader in line with the MoA.

Verify if change request needed: The change requestor should liaise with the Asset IAPS Planner and, based on the CR criteria, e.g. fixed element listing, confirm if the CR is needed and that the necessary value impact (budget) approvals have been secured. If the change is approved, the change requestor proceeds with the CR process. If the change is not an IAPS CR change, then the change should be managed within the function or the necessary value (budget) approvals secured.

Prepare and Submit Change

Draft change request: The change requestor should use the IAPS CR Tool, where available, to draft the CR. All the mandatory fields should be completed.

Submit change request: One the CR has been drafted, the change requestor should submit the completed CR to the Asset IAPS Planner for review.

Review and Approve

Review CR: The asset IAPS Planner should review the draft CR. The IAPS Planner may send the CR back to the requestor for further updates or rejects it if it is not compliant with the IAPS CR criteria. If the CR rejected, the IAPS CR process ends, and the draft CR should be deleted. The rejected CRs are not included in the IAPS CR KPIs. If the CR meets all the criteria, it is forwarded on to the impacted/supporting parties for review and comments.

Review and add impact: The impacted/supporting parties such as material, contracting, or logistics should review the CR and include any additional impact information that the change requestor may have missed or that needs to be corrected. The CR is then forwarded to the Asset IAPS Planner.

Review collate overall impact and update: The IAPS Planner should collate all the review comments and assess whether the estimated impacts are correct. The IAPS Planner should then forward the CR to Finance and Operations or the Asset team responsible for managing production and deferment, for validating the overall impact of the change. If the information submitted is incorrect or incomplete, it is appropriate for the IAPS Planner to return the CR to

the change requestor and impacted parties. The IAPS Planner can also reject the CR and, if necessary, stop the CR process at this point. If the information is correct and complete, the CR should then be forwarded on to the next step.

Validate impact, value and support: Finance should review and validate the value of the overall impact concerning cost, budget availability and if needed, the benefits (Net Present Value) of the proposed change to the Asset IAP. This step should only occur when the Asset IAPS Planner has reviewed and consolidated comments from impacted and supporting parties and made a decision for Finance review and support.

Review and approve/reject: The assigned approver or plan owner should then approve or reject the CR. The approval decision outcome (approved or rejected), is communicated to everyone involved in the CR process. Based on the CR criteria within the business/asset, the approver can be either the: OIM, Operations Manager, Asset Manager, or Function Manager. The approval of the IAPS CR could be undertaken either before or during the IAPS meeting.

Log, Communicate and Update Change

Log change request decision: The Asset IAPS Planner logs the CR outcome decision (approved or rejected) and can use the CR Tool.

Communicate change request decision: The Asset IAPS Planner is responsible for informing all the relevant parties about the CR outcome decision using the CR tool if its available in the asset. The function planner should update the Functional Plan in line with the approved CR, and the impacted and supporting parties will also need to update their plans to reflect the approved CR. The Asset IAPS Planner should then update the IAPS Plan.

Analyse and improve

Generate IAPS CR KPIs, analyse and report: The Asset IAPS Performance Analyst should generate the agreed IAPS CR KPIs. The report will be analysed and sent to the IAPS CR approver for decisions and guidance on the CR's impacts on the plan activities and targets.

Review IAPS CR performance and decide improvements: The IAPS CR approver should review the IAPS CR performance to identify improvements to the process, system, data or people.

Execute improvements: The improvement decisions taken during the KPI reviews should now be implemented/executed and monitored on-site or through the different IAPS meetings to ensure improvement targets are achieved.

5.5.4 Monitor schedule execution

The IAPS planners should monitor the progress of activities in the schedule and mark up the completed activities in order to be able to ***produce a performance report***. Activities that have started should be progressed in the schedule (adding actual start, percentage complete and actual finish). The GC decided to use Primavera P6 as the planning system, which can produce a performance report for completed activities, deferred activities, or in progress activities according to the update carried out by the IAPS planner. The IAPS Planner should regularly check with the facility authority, (likely the Facility Manager), if the activities are progressed as scheduled, and performance reviewed weekly. Another aspect of monitoring is ***sustaining performance***. The first step of sustaining performance should be to assess the health of IAPS. A gap assessment aims to answer questions such as "where are we now, where do we need to get to, and by when?" The IAPS process health check, which was used during deep-dive workshops in the three case-study companies, can be used again in order to assess the IAPS framework effectiveness. The assessment should determine if the company is implementing the IAPS framework and verify:

- The Integrated Plan being linked clearly to business outcomes and driving continuous improvements in HSSE, scheduled deferments and cost;
- A standardised way of working being in a place with improved planning processes in the function to optimise high-cost resource utilisation, demand planning and phasing;
- A robust change control process that is applied consistently is in place; and,
- There is sustained improvement with capacity and capability build-up of the IAPS organisation through coaching, training and knowledge transfer.

The company leadership should agree on the Improvement Plan. The function leadership should also review and improve the function planning process to improve quality and remain focused on the business objectives. This is complementary to Hennersdorf et al., who advocated using a continuous improvement approach through specific indicators and produce a common platform enabling people to participate effectively in managing one plan (Hennersdorf, 2009). For the improvement plan to be effective, it should be adequately resourced and progressed. Any improvements to the functions' planning process should be communicated to the key stakeholders (activity owners and function planners) and includes updated norms, standards and assumptions, and business and functions targets/objectives.

The IAPS framework provides guidance by recommending setting clear governance to manage the IAPS framework and improvement journey in assets. Although the training was provided, implementing improvements requires a higher authority to ensure learning is captured. It is recommended to establish a Process Council to govern the IAPS improvement in assets. The Site Process Owner should set up process governance that collectively takes accountability for the health and outcomes of the IAPS process. This Process Council will coordinate and drive an integrated approach to process improvements in the business. The Process Council should include senior leaders from different functions, who can help align with other processes. The Process Council proposed composition illustrated in Figure 5-5.

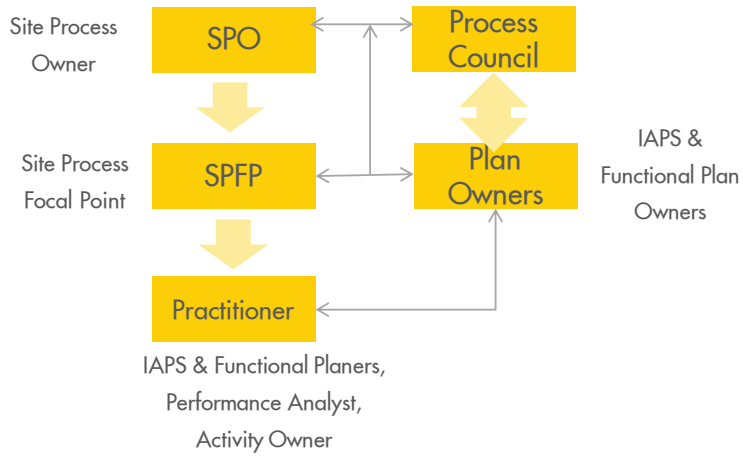


Figure 5-5 Asset IAPS Process Council

The Site Process Owner (SPO) reports directly to the IAPS Process Council. The Plan Owner is accountable for delivering the plan contents to meet the business objectives and is the ultimate decision-maker. Functional Plan Owner is a single point of accountability and ownership for delivering the respective Functions' Plans across all plan horizons. IAPS Lead Planner and IAPS Planner are responsible for creating the integrated plan for different time horizons (Medium Term, Short Term and Integrated Schedule). The Functional Planning Lead and Functional Planner are responsible for creating the Functions' Plan of their respective Function(s) covering all time horizons. The IAPS Performance Analyst should monitor and evaluate the IAPS business and process performance, including identifying improvement opportunities within the Asset. The Activity Owner is responsible for managing and delivering the detailed activity work plans for the function or business.

In order to help the assets, the following Terms of Reference illustrated within Table 5-5 is proposed which would help in delivering better contribution to knowledge in the feedback loop and continuous improvement:

Table 5-5 IAPS process council terms of reference

IAPS Process Council Terms of Reference	
Timing and Frequency	Formal meeting: Quarterly
Chair Meeting	Asset Manager
Authority	• Approve the proposed changes to the IAPS framework. • Select and prioritise the deployment of improvements. • Support the identification and selection of resources to support the changes and improvement activities. • Drive relevant data and metrics alignment and integration.
Purpose	Governance body that locally directs the deployment of the IAPS Framework in the asset to improve the NPV value of the assets over the operating lifecycle.
Objectives and Responsibilities	• Ensure maximisation of the NPV business value of assets by the optimised deployment of the IAPS Framework and replication of good practices. • Achieve top quartile performance to external competition in specific IAPS metrics. • Ensure continuous improvement by reviewing Asset business metrics and IAPS process performance in the assets, share learnings and make intervention decisions.
Attendees	• Chair: Asset Manager. • Facilitator: IAPS Process Owner. • Scribe: IAPS Lead. • Council Members: Nominated Asset Managers from different functions (Production, Maintenance, Project, Supply Chain, Wells, Development, Turnaround, finance).
Ground Rules	• The Council must represent the full scope and interests of the asset. • Membership is reviewed annually to take into account organisational changes and ability of members to balance their IAPS Council responsibilities with their line roles. • Members are expected to be able to speak on behalf of the Functions that they represent. • Commitments between Council members and Asset top leadership are necessary to enable full implementation to the decision taken by the council. • If not able to attend, voting rights need to be delegated to another Council member or delegate with full voting right sent. • A minimum quorum of 60% of full-time members is required for any decision to take place and be binding. • Agenda to be circulated a minimum of seven calendar days before the meeting. • Pre-read to be circulated a minimum of three working days before the meeting. • Decisions or awareness topics to be highlighted in pre-read.

IAPS Process Council Terms of Reference		
	• For non-sensitive topics, the agenda, pre-read, slides, and minutes are available to all on SharePoint or email. • Decisions and Actions will be documented in the Minutes of Meeting/ Action Log.	
Behaviours	• Be professional with high energy and ambition. • Focus on Solution, Value and Delivery of Targets. • Clear and open communication and ask each other for help. • Leverage each other's networks and transfer knowledge between members. • Be a role model for the desired leadership behaviours (take accountability, show genuine interest in IAPS, enable IAPS practitioners). • Challenge the Green, Support the Red.	
Standing Agenda	• Introduction and HSSE – five minutes • Review Year to Date Asset business and process performance • Review outstanding actions • Update on Process design/improvements • Review improvement projects performance and milestones • Review Risks Opportunities and issues • Handle decision Points (based on pre-read) • Recognise achievements • AOB – five minutes	
Process/ Configuration Management	• Presentations • Seek steer and agreement • Decisions and agree on actions	• SharePoint • Email
Inputs / Outputs	• Minutes and actions from the last meeting • Pre-read and presented material • Business and Process KPIs • Improvement projects KPIs/dashboard	• Minutes • Actions • Decisions/steer

The overall IAPS process steps and sub-steps are summarised in Figure 5-6**.**

Figure 5-6 IAPS Process Building Blocks and Steps Flow Diagram

Figure 5-6 summarises all IAPS process steps to be followed by the IAPS planners. It considered a standing operation procedure with a description included in this section. The IAPS process steps have been developed to combine different interfaces and encourage a collaborative working environment to promote an integrated and coordinated activity execution between onshore and offshore daily. The developed integrated plans should describe the objectives, targets, assumptions, risks, uncertainties, and alternative strategies for asset management. The integrated plan should present the activities that must be performed, what impact they have, who is responsible for each activity (activity owner, activity executor), and when each activity must be started and completed. The integrated plan should also include the resources (time and money as well as people, equipment, specialist tools, helicopter seats) allocated to each activity, and how the activities relate to one another. Such information is crucial for rigorous execution and delivery of business targets. It also bridges the gap discovered from the deep-dive workshops of lack of robustness within the plans and problems with data accuracy.

The implementation of the IAPS process will be dependent on the other elements of the IAPS Framework in order to be successful. These dependencies between the IAPS process and the other pillars suggests that it cannot deliver the aspired business outcomes on its own, and the other pillars need to be in place with a management commitment to ensure appropriate execution. Staff training and coaching is particularly crucial for success. The timely deployment of specific planning systems, tools and applications before the IAPS process in operation is another success factor. The data and systems elements are explained in the next section.

5.6 IAPS Data for the planning system

The data element of the IAPS Framework is defined as the information required for each activity to be entered by the activity owner and function planner into the planning system and enable the IAPS planner to sort out, classify and validate resources profile for each activity. The literature review did not reveal much about the standard data field that should be used for each function; primarily because these data are linked to each company's business context. During the case-study companies deep-dive workshops; there was an apparent demand for IAPS data to be explicitly defined to allow planners to include the accurate description of the activity. As the GC decided to use Primavera P6 as the planning system; this section will focus on the Primavera P6 data requirements. Failing to enter all necessary input data in any planning system will fail to provide a beneficial outcome; this was one of the GC's main pain

points. The activity data fields assist in determining the activities that need to be optimised based on resource constraints. The IAPS Framework guides in terms of standard data fields that can be used by functions and IAPS planners. Table 5-6 and Table 5-7 reflect the proposed minimum data fields used to build an IAPS plan in the Primavera P6 system at project and activity levels.

Table 5-6 Minimum project codes for inclusion in IAPS

Field	Used for:
Project Name	Will be visible in the IAPS Portal
Project Status	Must be "Active" for inclusion in IAPS
P – Asset	Defines the Asset hierarchy in the IAPS Portal
P - Project Type	Defines the function responsible for the execution

Table 5-7 Minimum activity codes for inclusion in IAPS

Field	Used for:
Activity ID	Will be visible in the planning portal
A – ShowInPlan	"ST" or "MT" if an activity should be included in the IAPS as per Inclusion Criteria
A-AR ST or MT	Activity Readiness of the activity as per AR Criteria
Activity Name	Activity/task description to be included in the IAPS
Start	Start date of the activity
Finish	Finish date of the activity
A – POB	Number of workers on-site (onshore and offshore)
A – Comments	Comments for inclusion in IAP
A-Activity Owner	Name of the activity owner or sponsor of the activity
A - Functional Location (Level 1)	Name of the facility where the activity is executed

By having the above data entered for each activity in Primavera P6, the system is capable to mine and integrate large volumes of data from different sources with the focus of supporting the IAPS planner to take the right optimisation decisions. The standard data fields allow the IAPS planners to merge Functional Plans with IAPS plans and check misalignment quickly and efficiently within Primavera P6.

5.7 IAPS Planning systems

Shankaran et al. (2009) emphasised the importance of planning and scheduling in Distributed Real-Time Embedded (DRE) systems where input workloads and resource availability are dynamic and need to be continuously managed (Shankaran et al., 2009). The authors advocate the use of sophisticated software applications to support end-to-end planning and resource management. Drabble (1998) illustrated some available intelligent planning technologies such

as SAP/R3, ILOG, Red Pepper, i2, SRI/SIPE, and DARPA/Rome. These technologies were successfully and widely used in different industries for integrated planning and scheduling and provided real-time planning to ensure meeting operations targets. The SAP/R/3PP-PI system was used for integration and resource management (Drabble, 1998). In the GC a Primavera P6 system is used in which the IAPS framework suggests using it as a standard planning system across all companies. Primavera P6 is an enterprise portfolio management application that can be operated by multiple users simultaneously. Primavera P6 as a planning system is well known and used within the GC; however, the IAPS framework emphasises its use as a standard system across all companies as the software is well recognised in the business and proved its capability to integrate complicated plans. Every Primavera P6 roll-out in any company of the group will have a similar structure to store planning information. Functions have a Functional Activity Plan (FAP) area were functional plans are stored, and the IAPS team has an IAPS area to store the relevant integrated activity data.

During the case-study workshops; the main gap that was identified was in managing interfaces between ERP and Primavera P6 in which a lot of time and resource is wasted. The case-study companies were explicit in their needs for the IAPS KPIs portal to be fully automated using Primavera P6 data. The IAPS KPIs portal helps to visualise IAPS performance and support discussion with all the functions' leaders. With a large number of changes being requested on a daily basis; the IAPS planners requested for an electronic tool to minimise the paperwork and improve change history. Based on such findings and requirements from the case-study companies deep-dive workshops, the IAPS Framework advocates using the following associated systems to be used in addition to the Primavera P6 system to help the GC to ensure integration and enable the IAPS planners to manage requested changes to the plans:

- Impress: A tool to manage the interface between ERP (such as SAP) and Primavera P6;
- IAPS Change Request Tool: A workflow tool based on Primavera P6 activity data and accessed through a web-based view to manage all change requests to the plans; and,
- IAPS Portal: A KPI generation application based on Primavera P6 activity data and programmed as per the IAPS framework KPIs definitions.

5.7.1 Impress

The IAPS framework created the needs for integration solutions between the GC ERP (SAP) and Primavera P6. Impress application is selected and used to integrate SAP with Primavera

P6. Figure 5-7 illustrates the integration mechanism. Impress can access the Asset Register data in the ERP and can retrieve the required data from SAP and load it up in Primavera P6 automatically. The application is available for any company to use; IAPS framework strongly proposes such integration for smooth IAPS execution. Lv et al. proposed integrating planning and scheduling tool with an Enterprise Resources Planning (ERP) system. This integration would help the planning function to achieve a more efficient level in optimising the resources (Lv et al., 2009). Such automated data flow helps the IAPS planner and reduces the time and effort to copy the required data and enter them manually in Primavera P6.

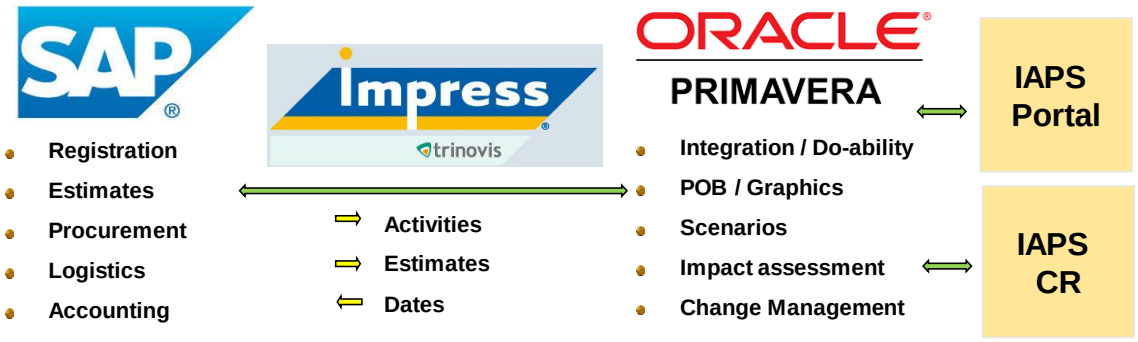


Figure 5-7 Planning systems integration

The IAPS Framework recommends having a two-way integration between Primavera P6 and SAP to foster efficiency and eliminate discrepancies. The IAPS Planners should have "write access to the IAPS activities" and only "read access to the Functional Plans activities". For function planners, it is the other way around. This access authority segregation will allow the IAPS to view and extract IAPS relevant data from the Functional Plan and update the IAPS plans, without disturbing or changing the Functions' Plans. The Function Planner cannot also make changes to the IAPS Plan, which is essential from a data security point of view and ownership. If the plans are not aligned, the IAPS Team and Function Team should decide on the best way forward. This is considered another advantage of adequately structuring the Primavera P6 and Impress permissions.

5.7.2 IAPS change request tool

The change request tool is an electronic system used to manage a large number of changes requested to change the IAPS plans, which leads to reduced rework and optimised resources. The researcher has used the GC internal capability to develop an electronic system based on discussions with the IAPS subject matter experts and requirements gained from the case-study

companies. A need was identified for a web-based IAPS Change Request System to be deployed quickly across all GC. The change request system was developed based on the IAPS process: manage change block (refer to IAPS process section) in which the system was created to follow the process steps and illustrated in Figure 5-8. The system can work as a stand-alone application and takes activity data from Primavera P6 via the IAPS Portal; this will be one of the most primary advantages to automate the workflow and keep the human intervention to a minimum.

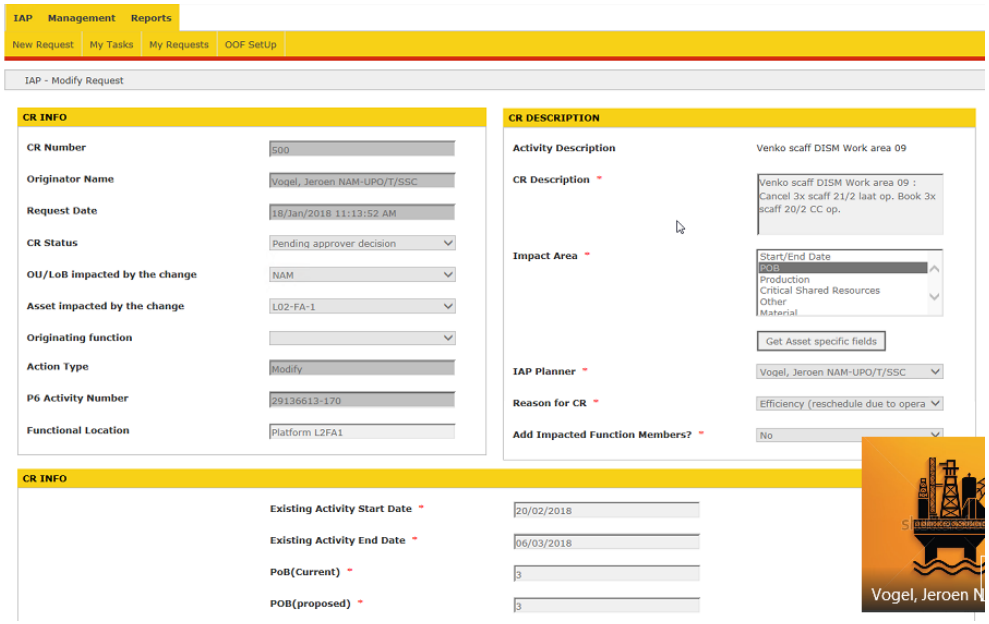


Figure 5-8 Web-based IAPS Change Request System

Due to the significance of plan change request within IAPS, it is recommended that a change request system is a standard component for IAPS planning. However, the same change request template (form) is also available for use by any company if opted not to use the electronic system.

5.7.3 IAPS portal

All plans should be kept in a secure and controlled place to ensure data integrity. One of the findings through the deep dive sections was the requirement to store all approved plans, provide access to contractors to view and follow plans, monitor execution, and report KPIs. All of this could be done manually and in a conventional manner. However, the researcher took the lead and developed the IAPS Portal for all the GC companies. This portal was

connected to Primavera P6 and used to transfer all approved plans from one area providing a single source of truth. The portal also generates IAPS relevant KPIs and allows viewing of Primavera P6 data for non-Primavera P6 users.

The IAPS Framework proposes using an IAPS portal to reduce cost and optimise resources. As such, the portal provides:

- A centralised database for all approved IAPS;
- Easy sharing and access granted to contractors and subcontractors;
- Timely KPIs calculation underpinned with leading and lagging indicators; and,
- Changes in the plans that are correctly tracked and monitored.

The above systems should be supported from the global function; the companies belong to the GC should get direct access to the global SMEs to deploy these planning systems at cost level. The same version should be provided across the GC. For the planning systems to work well together and maximise the work efficiency, experts within the organisation must be identified who have a detailed understanding of each application.

5.8 Culture

Oil and gas companies have remained functional for many years with performance based on a robust functional structure, using experienced people to run field operations in a hierarchical organisation (Walter and Werner. 2010). All functions have different activities planned with allocated resources specific to their domains. However, having many separate plans leads to a "silo functioning" organisation with little ad-hoc integration between different functions (Sletbakk Ramstad et al., 2010). Silo thinking is a challenge in big organisations where controlling different departments and functions can lead to sub-optimal result (Rødseth et al., 2015). Collaboration is not by putting different people in one room with state art of technology, but by valuing different perspectives, discussing opportunities, sharing enthusiasms and achieving more significant results (Derenzi et al., 2009). The deep-dive workshops revealed poor collaboration between different functions. There is a misconception that IAPS performance is the sole responsibility of IAPS planners, and functions are not accountable. This cause a lack of ownership of the integrated plan's performance.

The deep-dive workshops in the three case-study companies highlighted two critical aspects in which the IAPS framework aims to improve: "transparent performance using KPIs to adjust people behaviour", and "a collaboration between different functions through structural

meeting and celebrating success as one team" in order to create a positive culture in the GC to manage the IAPS effectively.

5.8.1 Transparent performance IAPS KPIs

Putting the right people in the right place is essential, but not good enough to ensure successful and high performance (Walter and Werner, 2010). Narayan focussed on making the performance data visible to adjust people's behaviour, leading the organisation to successful business results (Narayan, 2012). Key performance indicators (KPIs) are one of the tools to monitor organisational performance supported by continuous improvement models such as Plan-Do-Check-Act (Rødseth et al., 20150. In order to drive a culture of performance, it is necessary to define what KPIs are to be reviewed, how the IAPS Process KPIs are linked to business KPIs, and how the KPIs should be used to support continuous improvement. The IAPS framework provides guidance proposing to use a set of leading KPIs (indicators which explain how the performance is going on and in which direction is heading) and lagging KPIs (indicators which summarise the performance after a complete cycle of time) for the IAPS process linked to the company strategic business KPIs. Figure 5-9 illustrates a visionary picture for interconnected KPI structure. The left side represents the leading indicators, which measure the MT IAP robustness, ST IAP stability, and Activity Readiness. Such indicators are crucial to measuring the robustness of the IAPS plan before approval and during execution. They represent a gate criterion to either accept the plan or to reject it. The indicators clearly define the expected results of the execution phase. As a result, a secondary level of KPIs developed, which indicates integrated schedule delivery performance and are considered the lagging indicators. These indicators are the final IAPS process KPIs, which explain if the company achieved a good plan or not. They are used to measure the execution of activities as per the plan; the better the plan's quality and fewer changes will lead to better execution and vice-versa. The KPIs do not stop with the IAPS process lagging indicator but links the IAPS performance to business outcomes. The higher the extent to which the organisation delivers the agreed activities, the better the business outcome in which the organisation achieve its aspired strategic goals.

Figure 5-9 Leading & Lagging IAPS Process KPIs relationship

The leading and lagging IAPS KPIs are defined in Table 5-8. Each indicator has a specific reason to measure the IAPS work process performance against the desired outcome. The IAPS planners should prepare management progress and performance report, which should be shared, discussed and issued regularly to the Asset Leadership Team. Such transparency in performance should manage some behaviours of the teams; no one likes to be in a position to explain the poor performance. The open discussion between the different team members and leadership will help identify critical areas of improvement and help the team proactively take corrective actions to improve performance in the next plan.

Table 5-8 IAPS leading and lagging KPIs

KPI Category	KPI Description	Leading / Lagging	Industry Best in Class	Reason for Metric
MT Plan Robustness	MT Plan Robustness: % of changes to the plan which negatively impact Business Plan targets	Leading	10%	To measure the stability of the MT Plan against aspired Business Plan targets
ST Plan Stability	ST Plan Stability: % of activities in the ST plan that remains unchanged	Leading	90%	To measure the stability of the ST Plan and increase the likelihood of execution
Integrated Schedule Delivery	IAPS Activities Delivery: % of IAPS activities executed as per plan in the current month	Lagging	90%	Track IAPS execution versus plan and identify improvement areas
ST Activity Readiness	ST Activity Readiness: % of activities which meet the readiness criteria	Leading	90%	This provides a forward look at activity readiness for execution and helps mitigate last-minute changes within the frozen month

Producing a common platform enabling people to participate effectively in managing one plan is crucial (Hennersdorf, 2009). The IAPS KPIs will also create a thriving cultural atmosphere in which the team would like to continue achieving high performance and celebrate success. The company IAPS KPIs will be shared at a global level, and every month, a performance review will be conducted across all companies belonging to the GC.

The Medium-Term Plan Robustness, a leading KPI, measures the stability of the MT Plan against aspired Business Plan targets should be reported during the quarterly MT meeting chaired by AM. It enables the asset to understand their medium-term plan value and probability to move to the next plan horizon short term, before being transferred to the integrated schedule for execution. Figure 5-10 illustrates the way this KPI is monitored across all assets:

- Element-1: New Activities - the activity does not exist in any planning window but has been executed within the frozen plan, e.g. Break-ins and Emergency work;
- Element-2: Cancelled Activities - an activity initially planned to be executed in the frozen plan window but for whatever reason has been cancelled and removed from the plan. Use A – Change Control Flag to identify cancelled activities;
- Element-3: Change of Duration - activities having a significant change in duration that impacts business plans; and,
- Formula: 1- % [(Total Number of activities) - (New Activities+ Cancelled Activities+ Activities with change of duration)}/Total Number of Activities] .

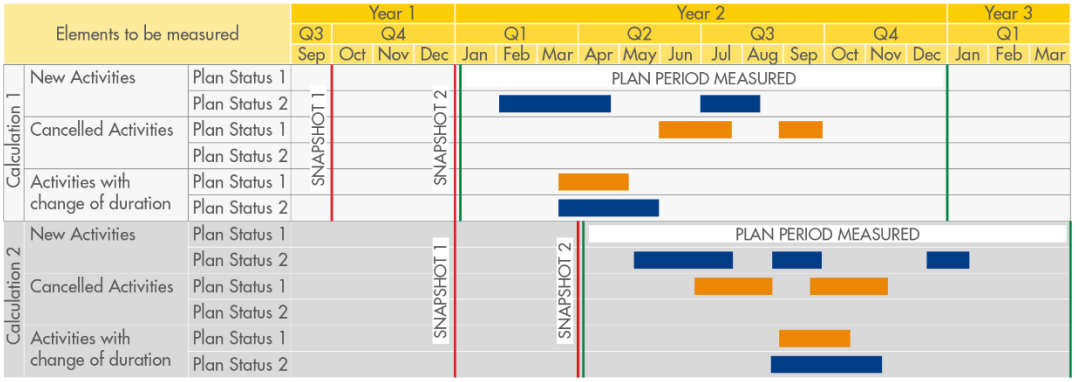


Figure 5-10 MT Plan robustness KPI

As shown in Figure 5-11, the Short-Term Plan Stability is a leading indicator to measure the stability of the ST Plan over the rolling three months period. In which should be reported during the monthly ST meeting chaired by the Operation Manager:

- Element-1: Activities that remain in plan or Activities executed as per plan;
- Element-2: Activities Brought Forward;
- Element-3: New Activities;
- Element-4: Activities Deferred/Delayed;
- Element-5: Activities Cancelled; and,
- Formula: Element ((1+ 2)/Element (1+2+3+4+5)) *100.

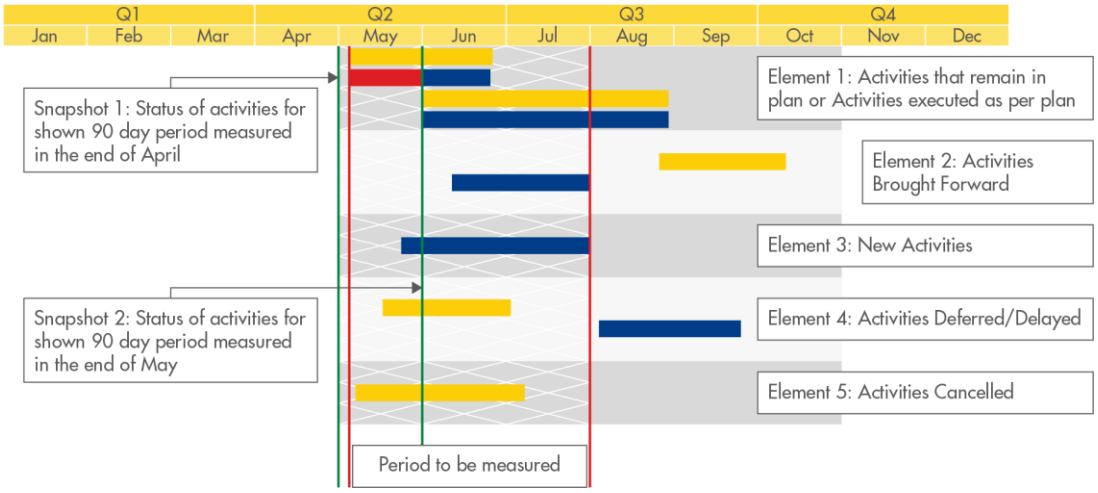


Figure 5-11 ST Stability KPI

The Short-Term Activity Readiness (AR) compliance is used to manage schedule risk in the IAPS plan to ensure activities are prepared and ready for execution. It is a leading indicator that tracks the readiness of activities for execution in the ST IAPS window in which should be reported during the monthly ST meeting chaired by Operation manager.

- Formula: (No. of Green Activities/ Total Number of Activities) *100

Integrated Schedule Delivery: This is a lagging indicator for process effectiveness to measure the actual execution for the approved Integrated Schedule activities, as shown in Figure 5-12. The Integrated Schedule Delivery performance is measured against the following elements:

- Element-1: Activities that remain in plan or Activities executed as per plan;
- Element-2: Activities Brought Forward;
- Element-3: New Activities;
- Element-4: Activities Deferred/Delayed;

- Element-5: Activities Cancelled; and,
- Formula: Element ((1+ 2)/Element (1+2+3+4+5)) *100.

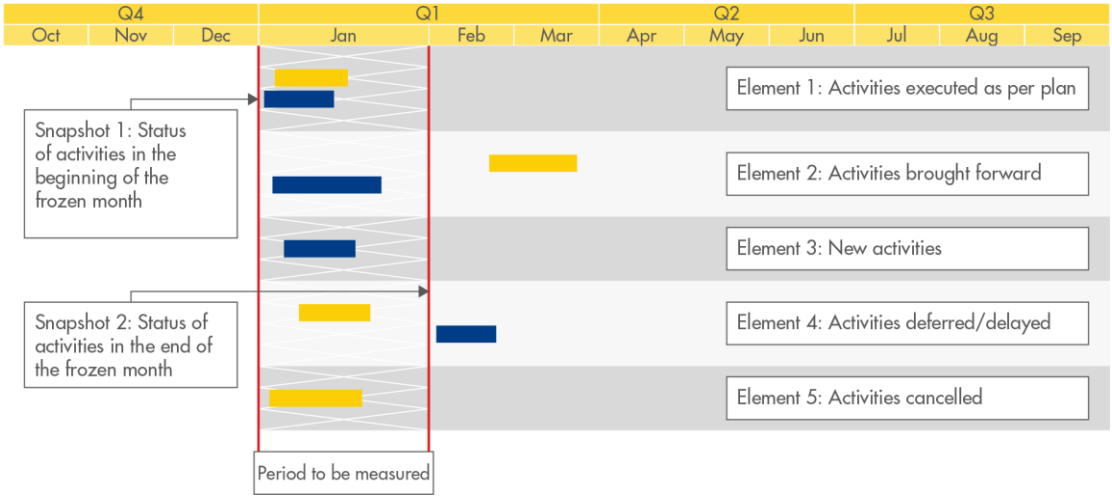


Figure 5-12 Integrated Schedule Delivery KPI

All the above KPIs will be linked to the global dashboard, which should enable the cultural change by creating a competitive environment between different companies belong to the GC to score high in improving IAPS performance. The standardised KPIs calculation (formulas above) with IAPS toolset will generate one dashboard for the GC and will make all IAPS plan horizon KPIs visible to all leaders at different levels. Such performance transparency will help the leaders to continue driving improvements in IAPS performance and create a culture of ownership.

5.8.2 Collaboration through structured meeting and celebrating success

Plans can be acknowledged as a tool to improve communication and coordination and creating a shared understanding of a situation at hand and enterprise big goals to be delivered (Sletbakk Ramstad et al., 2010). The IAPS framework guides with respect to the frequency of structured meetings. The objective of the meeting calendar is to structure various functions and IAPS meetings to review the plan performance with respect to the plan time horizon. The planning calendar indicates when the functions should submit their plans to the IAPS team and when the IAPS team should submit the integrated plan and call for a leadership meeting to discuss and approve. This continuity and linkage of all the plans helps to avoid rework and manages the review of performance. Most of the IAPS team's discrepancies and other functions observed during the deep-dive sessions indicate a lack of clarity of when IAPS meeting was

conducted and what outcome was expected. Not all functions adhered to the deadline for the IAPS plan delivery dates. Part of the dispute related to the buy-in of the functions on the proposed calendar. Therefore, one of the critical improvements was that the calendar should be created jointly between the IAPS, Production Function, and other Technical Functions. The target dates for delivering each plan should be agreed upfront, and asset plans must be the standard referenced documents. Duplication of information on separate asset and Functions' plans must be avoided.

The IAPS meetings should have clear terms of reference, explaining the participants and their role, agenda, and meeting objectives. The IAPS framework guides using the following:

- IAPS meetings for three different plans at different timing (MT in quarterly bases, ST in monthly bases and IS in weekly bases);
- Function alignment meetings timing and scope; in which should be conducted at least two weeks before the IAPS meetings for MT and ST;
- IAPS submission dates should be aligned with approval timing of company business plan; and,
- Terms of reference for these meetings to avoid any confusion in future

The IAPS framework recommends measuring the meeting effectiveness scorecard as described below in Table 5-9.

Table 5-9 Meeting effectiveness scorecard

		Meeting Effectiveness Score Card	Points
Mechanics of Effective Meeting	A	"Meeting Preparedness:	30
	1	Were the meeting pre-reads (including the IAPS Plan) focused on decisions at hand, needed steers and circulated in advance (>5 days) before the meeting? Did all participants review the pre-reads?	10
	2	Have the relevant meeting stakeholders (Plan owner, Activity Owners, Function leads) been briefed on the critical areas for discussion and decisions pre-meeting?	20
	B	Managing the Meeting and Outcomes:	170
	3	Was there a standing agenda and clear objectives of the meeting? Was it followed? Did the meeting agenda reflect the priority items for discussion in the plan?	10
	4	Did the meeting start and finish on time? Were all the required attendees (or delegates) per the meeting ToR, present and on time?	20
	5	Was the previous action log reviewed and were the actions completed on time? Was there a clear commitment to close remaining open actions demonstrated? (<50% = 0; <75=5; >75%=10).	10

		Meeting Effectiveness Score Card	Points
	6	Were the new action items reviewed, assigned to owners and due dates agreed? (% of actions satisfying the criteria)	10
	7	Were meeting objectives met? Did the meeting/plan owner control and managed time effectively? Did the owner hold the meeting attendees accountable for their actions in the meeting per the ToR? Were side topics and discussions in the meeting closed off when they arose?	20
	8	Were the plan vs actual variances in performance and root causes already addressed before the meeting and clear improvements articulated through the usual business processes?	30
Behaviours to Win	9	Did the meeting/plan owner actively chair the meeting and demonstrated ownership of the plan/meeting? Did the meeting/plan owner manage activities into and out of the plan? Did the owner prioritise activities when competing for the same constrained resources?	20
	10	Were the required decisions are taken (with value, trade-offs, scope, risks +/-, stakeholder needs) and clear steers provided? Were the discussions properly closed out (and if required, with an agreement on how to follow up - time-bound actions with action parties)? Were there any surprises?	20
	11	Collaboration and effective meeting dynamic: Was there a clear demonstration of a "Player's mindset vs Victim's mindset"? Were the participants proactively reaching out to 'play to win' as one team? Was there a balance between challenge and inquiry to drive to the surface concerns and dilemmas?	20
Inclusiveness	12	Did the meeting owner encourage active participation and appreciated inputs from everyone (including new and unconventional ideas)? Were the attendees fully prepared and participated effectively (able to provide full updates and progress, not checking mobiles/emails, people leaving)?	20
Total:			200

OVERALL MEETING EVALUATION	Highly Effective Meeting	185 - 200 Points
	Effective Meeting	160 - 184 Points
	Marginally Effective Meeting	120 - 159 Points
	Ineffective Meeting	0 - 119 Points

The Meeting Effectiveness Scorecard is available for the use of meeting owners to review each meeting and identify areas for improvement. It is considered good practice to use the meeting effectiveness scorecard to coach the plan owner and drive continuous improvement as illustrated in the IAPS SharePoint. The meeting effectiveness is based on the mechanics of behaviour and inclusiveness factors of quality of decisions made. Its recommended to considered meeting effectiveness scores as part of the IAPS KPIs dashboard.

5.8.3 Create a culture of rewarding and ownership

To support team motivation and encourage the team to be more proactive, the IAPS leadership should recognise their commitment and contribution. Such motivation could be achieved

simply by saying “thank you”, by recognising the staff effort publicly in a meeting, by rewarding the staff with a certificate, or could go further and provide some monetary benefit. Different forms of recognition are possible, and company leadership has the right to choose what is best for their business environment. The IAPS framework advocates celebrating success as a team to be away from individual pride to team pride. IAPS is about collective efforts to deliver one plan and not about one function success. The deep dive analyses show that GC lacks active performance culture; there is inefficient rewarding and consequence management. The IAPS framework advocates celebrating success and rewarding and proposes that the leaders hold the functions and IAPS managers accountable to deliver an effective plan. Both rewarding and consequence management should go hand in hand to manage behaviour. Managing staff performance is a standard management practise; however, the IAPS framework emphasises on a documented face to face discussions to understand the facts behind not following the IAPS framework, which leads to poor performance. These meetings aim to support the planners to do a better job and resolve any challenges during the IAPS framework implementation. The following protocol is proposed to coach and support a low IAPS performance:

- 1st occurrence of low IAPS performance: A meeting/discussion between the function/IAPS planner and line supervisor to understand the reason behind such low performance or not following agreed practices as described in the IAPS framework. The meeting's outcome should help the line supervisor provide the necessary support to resolve any issues. A commitment should be received from the function/IAPS planner to improve with respect to the issues identified. It should involve explaining the importance of the IAPS framework and the impact on business, highlighting the benefits of IAPS rules for the individual and organisation, and seeking support to improve and comply.
- 2nd occurrence of low IAPS performance: A meeting/discussion between the function/IAPS planner and line supervisor to follow up on agreed commitment from the 1st occurrence discussion. The supervisor should document the meeting discussion and clearly state a target date for delivery.
- 3rd occurrence of low IAPS performance: A meeting/discussion between the function/IAPS manager and leadership to understand the challenges behind delivering a well-integrated plan from a behavioural aspect. It includes any negative attitude from staff towards following the IAPS elements and approved Golden Rules.

Such structured coaching will create a learning and improving the environment, which will support any systemic issues causing the repeat defects to follow IAPS process.

5.9 Leadership

Leaders create culture and systems and should challenge the IAPS performance and support the team to deliver improvements. Leaders should be the primary facilitator who brings together the various functions to ensure collaborative delivery of the asset strategy and improvement plan. In an ever-changing environment, leaders should have access to the right information at the right point in time to make well-informed decisions (Charles et al., 2014). The rational decision aims to optimise and select the most appropriate future activities considering given limitations and constraints (Sandmeyer et al., 2004). Coordination and control aim to keep the system within an agreed performance envelope and reduce uncertainties (Sletbakk Ramstad et al., 2010). Business continuity depends on proper planning and ensuring that organisations survive unexpected disasters (Dey, 2011). Arvizu explained the tool of decision tree to include communication between three parties; decision-makers, decision illuminators, and decision executors (Arvizu, 1996).

The deep-dive workshops highlighted the need for explicit leadership attributes with regards to:

- Leaders creating a productive planning culture;
- Leaders creating the system to have access to the right information; and,
- Being a decision-maker and taking an informed decision.

The IAPS framework proposes the tactics described in the following sections to improve the above three attributes.

5.9.1 Leaders create a culture of planning

To help the GC leaders to create a planning culture; the researcher developed seven critical success factors which should be in place for the IAPS Framework to meet its objectives and shown in Figure 5-13. These critical success factors are crucial to ensure proper implementation.

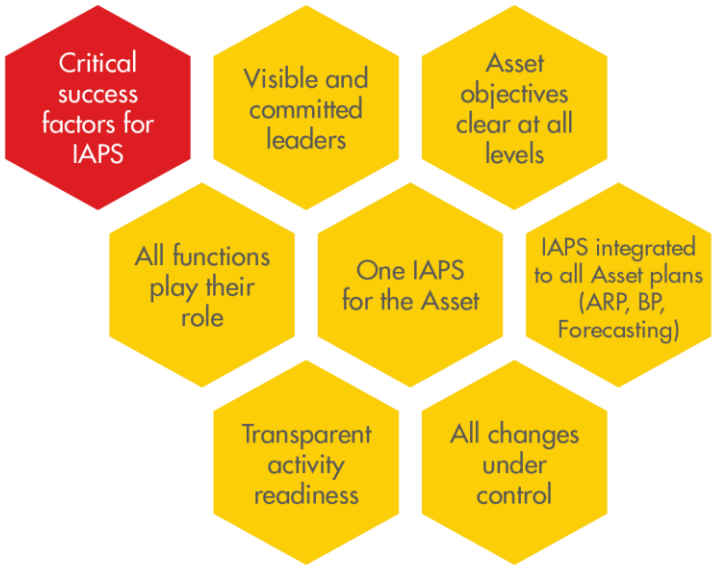


Figure 5-13 Critical success factors for productive IAPS culture

Visible and committed leadership support is essential in ensuring effective application of the IAPS process and, hence, in meeting its objectives. Each time horizon of the plan has a different owner accountable for its delivery supported by a function leader. There are several ways in which leaders can show their visibility and commitment. The leader should chair the IAPS meetings and ensure full attendance, particularly by activity owners. The leader should observe the work, ask the right questions, and coach IAPS personnel. The leader should recognise the achievements of good team in following a robust integrated plan and should apply consequence management on those that do not comply with the process. Moreover; the leader should include the IAPS performance on relevant company scorecards, staff performance contracts and resource assurance activities**.**

Asset objectives clear at all levels and cascaded across the organisation is another crucial success factor. It allows IAPS Plans to be built across different horizons from long term to short term and take decisions based on clear business targets, plan premises and prioritisation criteria.

The IAPS should be integrated to all other asset plans such as asset reference plan (the long-term plan), business plan, or production forecasting. IAPS is not an isolated plan and should take input and provide outputs to different plans.

The asset should aim to have one IAPS; having more than one integrated plan would confuse the organisation and duplicate the efforts. Everyone in the organisation should be able to refer to one integrated plan.

The functions should play their role; functions are accountable for maximising asset value and committing to delivering their business targets. To realise this, they must have adequate and recognised planning and delivery processes that make available both plans of activities suitable for integration and enable activities to be matured in a proper and timely fashion. The functional plans should be owned and signed off by function leadership. Transparent activity readiness is crucial to target high plan stability; including activities that are not ready for execution jeopardise the plan's delivery and book resources which will not be utilised and can cause waste. The changes in the plan should be controlled through a stipulated process. Once the plan is endorsed, then its frozen and changes should not be allowed without clear justification.

5.9.1.1 Demonstrate commitment to IAPS

These critical success factors are supplemented with clear ground rules, called "IAPS Golden Rules" which set clear expectations on how the organisation will implement the IAPS framework. These rules are used to establish an aligned and agreed vision on what a well-integrated plan should look like. This should drive healthy leadership behaviours, clear ownership and accountabilities for the players in the IAPS process at all organisation levels. It is a control point for business leaders to manage change to the plans and improve plan stability. The following IAPS Golden Rules should be introduced and implemented.

Visible and Committed Leaders	(Assets and Functions) are committed to making IAPS meetings into success through preparation and attendance. Delegate with full authority and recognise achievements in execution as per plan and apply consequence management.
Clear Asset Objectives	Accountable to maximize asset value and committed to realising assigned business targets. It is vital to make clear decisions and cascade clear business targets, plan premises and prioritisation criteria timely to our troops.
IAPS Integrated to Asset Plans	To ensure the IAPS plan is integrated with Long Term Plan- 5 Years Business Plan- 2 Years Medium Term Plan- 90 days Short Term Plan- 14 days Integrated Schedule. Each team is accountable for their expectations and commitments. Best practice, such as a Player's Mindset and not a Victim Mindset, shall be in place.

One IAPS for the Asset	Commitment to stick to one Integrated Plan which will only execute and provide resources to the activities in the frozen IAPS Plan with a Work Order and a Purchase Order number.
Functions play their role	Deliver Function's target to maximize Asset value. Create and own high-quality Function Reference Plan and Function Activity Plan with credible Activity Readiness. It is essential to stick and fully adhere to cut-off dates specified in Planning Calendar.
Transparent Activity Readiness	Accept activities that comply with Activity Readiness and remove ones that do not comply. IAPS activity Owners are accountable for the Activity Readiness of activities. The proactive approach shall be in place from the "green" mentality and move to what does it takes to be "green".
Changes under control	Leaders shall fully understand the change control process and criteria. Any activity can be "no" that do not have clear enterprise risk and value impact assessed.

5.9.1.2 Lead by example and show interest

Leadership commitment to IAPS is demonstrated by attending the IAPS meeting following the terms of reference. Embedding a common language in conducting IAPS meeting and decision-making, supported by a consistent set of behaviours, should be used to support IAPS execution and drive organisation performance. The IAPS framework recommends using the meeting as a decision-making forum rather than discussing the details of the plan. All details, clashes, opportunities, and risks should be discussed during the functional planning meeting before the IAPS meeting. The IAPS meeting should be used to highlight the readiness of activities for execution, unresolved clashes, risks that should be mitigated and further opportunities to grow the business. The leader should attend the IAPS meetings as the owner of a respective time horizon plan and a decision-maker. Having the right composition of personnel in the IAPS meeting and regularly reviewing the plans as the opportunity matures is critical to driving effective decision making. The IAPS Process Owner and the Chair of the meeting (Plan Owner) should be responsible for developing the meeting terms of reference. The terms of reference should identify the people who should be in the meeting. The critical business and functional (technical and non-technical) expertise should be represented and

reflect the opportunity's specific characteristics, exposure and significant risks (upside and downside).

The plan owner should practice the following behaviour to promote a good meeting outcome:

- Create productive meetings dynamics; encourage everyone to participate and highlights their point of view;
- Make sustainable decisions; based on data and facts;
- Champion the IAPS; use the plan during regular visits and refer to plan during team meetings;
- Maintain asset profit mindset; challenge the scope of the activity and resources and push for optimisation;
- Exhibit commitment and accountability; once the plan is approved then the whole organisation should follow and implement as per plan;
- Advocate and explore the reasoning behind not delivering the activities in the plan for better improvement in the next plan delivery; and,
- Own the IAPS success; celebrate with the team and highlight their achievements.

By attending the IAPS meeting; leaders demonstrate engagement in IAPS and drive the organisation to be more proactive rather than reactive. The leader should harness others' creativity to generate new approaches and listen to understand staff needs and their perspectives. The ability to effectively communicate difficult messages should be one of the skills the leader acquires in such challenging business environments. The leader should focus the team effort on activities that deliver commercial results and support with all resources required.

5.9.2 Leaders creating the system to have access to the right information

The company leaders should define with the IAPS process owner, a set of criteria to structure the discussion and govern the IAPS performance. Such criteria will ensure systematic information flow and provide access to the right information at the right time. The IAPS related specific criteria required are IAPS inclusion criteria and Activity Readiness.

5.9.2.1 Inclusion criteria

The inclusion criteria, including the activity details, should be communicated with the functions, particularly the function planners. These criteria should be used to help identify all

related activities to IAPS. Functional Planners should be aware of the inclusion criteria and understand:

- Which IAPS activities are relevant for inclusion in the MT IAP and ST IAP;
- What activities will be included in the Integrated Schedule; and,
- The level of detail of activities in the MT IAP, ST IAP and IS.

5.9.2.2 Activity readiness criteria

Activity readiness is a control mechanism that can be used to manage risk in delivering the plan through a continuous assessment of work preparation status (maturity) relative to the execution timing. If activity owners fail to mature work within the agreed timeframes in the plan, it can lead to problems such as last-minute changes, delays and incomplete or inadequate work preparations. The asset leader and IAPS process owner should define the minimum requirement for the activity readiness criteria to be used by the function and IAPS teams. The IAPS Team should support functions to develop the activity readiness criteria if required. It is proposed that activity readiness should use a traffic light system:

- Green colour: indicates the high maturity of work preparation and that the preparation is on track. The activity will proceed as planned;
- Amber colour: indicates that not all preparations are on track, but there is only a small risk that this will affect the execution window; and,
- Red colour: indicates that the preparations are not on track and is unlikely the execution window will be made. Such activity might introduce high risk in IAPS plan execution and IS delivery.

Activity readiness is crucial information for the leaders to make a decision based on plan readiness for execution. The red/amber activity readiness status may be used to drive the agenda at IAPS meetings. However, it is not intended to create any new work preparation steps; it reflects a way of capturing the work preparation status based on each function's work process and indicating whether it is on track in a standard format across all functions. It is a proactive measure to track that work is on target for execution and is suitably prepared. The initial rating is performed by the functions based on the preparatory work's critical path in their Functional Plans; if the execution window is at risk, the activity cannot be green. The ratings can be altered by the IAP planner's assessment based on discussions with activity owners or because of clashes with other Functional Plans. The activity readiness status should be kept up to date, and it should not be a bureaucratic data management exercise.

Each horizon plan owner should hand over activities to the next plan horizon with a clear indication of the activities that have satisfied the minimum requirements, particularly with respect to the gate criteria, i.e. activity readiness. This should be accompanied by highlighting AR 'Amber' activities with agreed actions to mitigate the risk. Activities with AR 'Red' should not be handed over to the next plan horizon unless agreed with the plan owner, and a clear mitigation plan is in place to assure delivery.

5.9.3 Being a decision-maker and taking an informed decision

Effective decision making is critical in delivering the company strategy, improving business performance and ultimately creating value. When there are conflicting activities for the same resources, and a decision is needed to prioritise, a leader should make a decision based on transparent information. Managing uncertainty in planning is a significant discussion area. Verderame et al. identified some sectors using a conditional value-at-risk approach (Verderame et al., 2010). The IAPS framework and supporting leaders to make the right decision have created the following ranking criteria in case of conflicting activities illustrated in Figure 5-14 IAPS ranking matrix. The framework uses the value-at-risk approach, customising it to be IAPS specific by adding the activity readiness and measuring the probability of execution. The ranking criteria are used to evaluate the severity of the consequences of not doing the activity concerning people, asset, environment, or reputation with the do-ability likelihood for execution. The highest in terms of consequence and the rate of execution will take priority. These ranking criteria help deal with conflict, mainly when the competing activities are from different functions. The objective of ranking activities was to determine which activity would provide the most significant benefit. The ranked values enable the IAPS Team to sequence work where resource constraints exist, to resolve conflicts/clashes and overloads. Where there is a significant conflict between functions, the ultimate decision-maker is the Plan Owner, and the IAPS Team should assist in developing scenarios to decide on the best options to carry forward.

SEVERITY	CONSEQUENCES				LIKELIHOOD OF ACTIVITY EXECUTION DOABILITY				
	People (Safety/Health)	Assets (Integrity/ Production/ Reliability/ Financial)	Environment	Reputation	A	B	C	D	E
	P	A	E	R	Activity Execution Doability (AR) 51-60-%	Activity Execution Doability (AR) 61-70-%	Activity Execution Doability (AR) 71-80-%	Activity Execution Doability (AR) 81-90-%	Activity Execution Doability (AR) 91-100-%
0	No gain/ impact towards safety or health	No gain/ impact	No impact/ gain	No impact/ gain	O8	O8	O8	O8	O8
1	Slight gain/ impact towards safety or health	Slight gain/ impact results in value < $10K	Slight impact/ gain	Slight impact/ gain (public awareness)	O7	O6	O5	O4	O3
2	Minor gain/ impact towards safety or health	Minor gain/ impact results in value < $100K	Minor impact/ gain	Slight impact/ gain (local public/ media)	O6	O5	O4	O3	O2
3	Major gain/ impact towards safety or health	Moderate gain/ impact results in value < $1M	Moderate impact/ gain	Moderate impact/ gain (region/ state/ public/ media)	O5	O4	O3	O2	O1
4	Increase / decrease risk of Permanent Total Disability or up to 3 fatalities	Major gain/ impact results in value < $10M	Major impact/ gain	Major impact/ gain (national/ extensive positive media)	O4	O3	O2	O1	O1
5	Increase / decrease risk of more than 3 fatalities	Extensive gain/ impact results in value > $10M	Massive impact/ gain	Massive impact/ gain (international/ positive media coverage)	O3	O2	O1	O1	O1

IAPS Ranking	
Order	Order Setting
O8	Any Time
O7	Low
O6	Low
O5	Medium
O4	Medium
O3	High
O2	Urgent
O1	Must Do

Figure 5-14 IAPS ranking matrix

The following step by step methodology to rank activities using the IAPS Ranking Matrix can be used to ensure a consistent approach in all assets:

- Step 1 – Define activities and scope of work;
- Step 2 – Review and identify activities competing for the same resources or time slots and their potential consequences (PAER categories);
- Step 3 – Estimate the severity of each potential consequence (severity increase from 0 to 5);
- Step 4 – Determine the activities execution do-ability (an increase from Level A to E), whichever lower will be selected;

- Step 5 – Rank the activities (criticality increases from light blue, blue, yellow, amber to red); and,
- Step 6 – During the ranking process, trade-off impact (consequence towards impacted activities) should be included.

Should activities fall under the same priority after the above ranking, the exact value or quantified impact will be compared to determine the winning activity. For any unsolved matter of activity prioritisation, or where the result of the prioritisation exercise is too close to call, the planner will seek support from management.

5.10 End to End IAPS Framework- Next Step

The IAPS framework consists of 8 elements ***direction setting, organisation structure, people, process, data, system, culture, and leadership.*** Each element is addressing a gap identified in the GC IAPS effectiveness. Setting a clear direction is guiding senior leaders to send a clear message about the company vision and aspired business outcome using the IAPS plans as a vehicle for delivery. The One Plan Concept ensure all different plans horizon is linked and translate strategic intent to operational from strategic plan to integrated schedule. The organisation structures ensure IAPS planners have single-point accountability for the IAPS plan and control changes to it. The proposed organisation structure clarifies the reporting lines with clear responsibility and interfaces with other processes that help trace accountability to the right level. The people element helps the organisation develop the IAPS and functional planners' right capability and provides guidance to focus on training, coaching, and succession planning. The Process element stipulates a detailed step by step IAPS process, explaining how the activities gathered, integrated, optimised and produced as one plan for approval and execution. Such standard approach helps to drive standardisation across companies belong to the GC and enable continues improvements. The IAPS process consists of 4 main blocks (build functions plans, integrate plans & schedule, approve and communicate plans, and monitor scheduled executions). The Data element in the IAPS Framework defines the information required for each activity to be entered into the planning system and enable the IAPS planner to sort out, classify and validate resources profile for activities. The standard data fields allow the IAPS planners to merge Functional Plans with IAPS plans and check misalignment quickly and efficiently. The System element emphasises in using one standard system for planning Primavera P6 across all companies.

Every Primavera P6 roll-out in any company of the group will have a similar structure to store planning information. Primavera P6 should be integrated with SAP through impress to ensure

more efficient work in integrating all functional plans. The Culture element supports moving away from “silo functioning” organisation to more collaborated organisation valuing different perspectives, discussing opportunities, sharing enthusiasm, and achieving more significant results. The culture element demand for transparent performance KPIs and quality meeting by creating ownership and rewarding organisation. The leadership element is the heart of the IAPS framework and essential in driving the IAPS framework. Leaders create culture and systems and should challenge the IAPS performance and support the team to deliver improvements. The IAPS framework proposes tactics in supporting leaders to make an informed decision and gain commitment to the organisation by applying IAPS critical success factors and IAPS golden rules.

IAPS includes all activities that impact field operations and use shared resources such as personnel, equipment, contracts, or material. With such a comprehensive end-to-end IAPS framework explained in this chapter; the GC is ready for implementation. The framework was designed by the researcher and best in-house subject matter experts in IAPS. Once the group have made the best use of the shared experience to develop a solution, it is time to collaborate and implement the agreed solution and be in a stronger position to meet future challenges (Saxby and Burridge, 2013).

Chapter 6 RESULTS

This chapter will discuss the results and explain the outcome of this research. The framework proposed in Chapter 5 was tested and implemented in three different case-study companies belonging to the GC. The aim was to test the proposed framework developed in this research, to determine the extent to which it addresses the gaps identified earlier in the GC and examine whether it could be implemented across different companies and countries.

The IAPS framework was presented and communicated to all Asset Managers in the GC and the three case-study companies elected to be the pathfinder and test the IAPS framework. It recognised as an excellent opportunity to test the IAPS framework's impact in these three case-study companies before and after implementation as the previous data collected during the deep dive workshops would help for a better comparison. Useful to highlight that after the results obtained from testing the IAPS framework in these three case-study companies; the GC' senior management approved the IAPS framework to be the GC's official guideline; as today the IAPS framework is being deployed to all companies belong to the GC.

6.1 Evaluation criteria for the framework effectiveness

Before elaborating on the results obtained from implementation, it is essential to discuss the complexity of investigating the influence of changes to planning to measure tangible results. Such a relationship is not straightforward to measure on a day by day or month by month basis. The oil and gas business encounters different setbacks during operations, and hence extra care is required during analyses. In this research, the relationship is explained by using factors that drive results as illustrated in Figure 6-1. An effective IAPS framework starts from ensuring alignment across plan time horizons, so there is no conflict or mismatch between the MT, ST, and IS. It should also ensure collaboration between functions and improve stakeholder's alignment on priorities. These three elements create the environment to develop integrated activity plans and subsequently support better decision making. The integrated activity plan should stipulate better data visibility and assumptions, clearer accountability, correct planning of activities, and resources available when scheduled. The factor of better data visibility and assumptions will lead to improved forecast quality which will result in improved capital efficiency. The two factors of more transparent accountability and correctly planned activities will lead to safe work practice, resulting in improved asset integrity and consequently improved HSSE. The factor of correctly planned activities will lead to more opportunities to complete activities, resulting in increased resource efficiency & effectiveness and consequently decreased operating cost. The factor of resources available when scheduled will

lead to reduced overruns of scheduled work, resulting in reduced downtime and consequently increased production.

Such complexity in the system with other external factors such as ageing of facilities, the legacy of reliability issues, poor quality of maintenance, low competency of executors will affect the business outcomes and should be considered during evaluation. The case-study companies were advised to select one of the business outcomes to test the IAPS framework subject for the company's priority to accelerate the testing period; refer to Figure 6-1. Such approach would reduce the complexity in recording many factors for all business outcomes. There are 15 factors, and five outcomes need to be recorded if all outcomes are selected to be achieved. Each factor requires a database to be collected and performance to be analysed. It was the company's responsibility to use the IAPS framework to deliver all business outcomes or select one or some for a focused implementation. This decision was left to the company senior management to avoid potential bias. The definition of expectations in the outcome results due to IAPS framework implementation can be explained as follow:

Improved HSSE:

- Produces integrated plans enabling clear accountability for work that is taking place and safer working practices
- Prioritises activities across functions, ensuring that preventive and integrity maintenance activities are weighted equally with other activities
- Enables proactive identification of Simultaneous Operations (SIMOPS)

Increased production:

- Minimises the number and total length of production outages through cross-function integration of production impacting activities
- Exploits unscheduled outages as opportunities through contingent planning, preparation and readiness of work
- Provides focus on the prioritisation of production gaining activities to ensure execution per plan

Decreased operating costs:

- Increases work efficiency and optimise resource usage, e.g. workforce, tools, equipment, storage area and materials

- Increases productive time by reducing interfaces, eliminating delays, and re-work, e.g. waiting for materials, resources, permits to work
- Reduces the requirement for ad-hoc logistics or rushed orders for materials/equipment

Improved capital efficiency:

- Improves data quality leading to better use of financial resources
- Increases certainty in the delivery of business objectives and optimal use of resources
- Improves contractor and contracts management through visible demand management

The oil and gas business is complex and interlinked with many different factors affecting the overall performance—the relationship between the different factors of IAPS and business outcomes summarised in Figure 6-1.

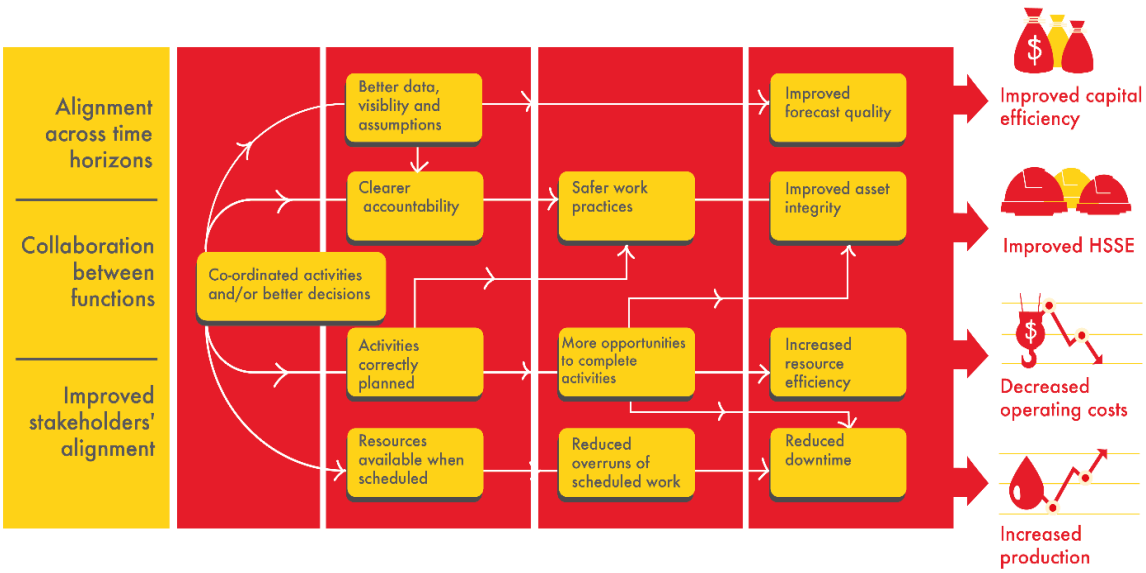


Figure 6-1 Anticipated benefit of IAPS Framework implementation

A better outcome is achieved through better alignment in asset priorities, cooperation between functions, and agreement between stakeholders. However, this is not a straightforward relationship, and attention should be given to different factors during the implementation. Example; the activities planning is getting better in a company which as a result, the downtime of equipment's was reduced, and availability was improved. This should be the preferred

scenario as per IAPS factors relationship; however; other reliability challenges in the facilities caused downtime to equipment, and hence the availability decreased, and oil/gas's losses were incurred.

The overall effectiveness of the IAPS framework will be measured in three case-study companies over 12 months of implementation to measure the medium-term plan, which is updated quarterly. The IAPS framework effectiveness will be examined through:

1.0 IAPS Process leading and lagging indicators performance trend in each company following the proposed KPIs in the framework:

a. Integrated Schedule delivery (%): activities executed as per plan in the current month. A higher value corresponds to better execution of the activities

b. Activity Readiness (%): activities that meet the readiness criteria and are included in the execution plan. A higher value means that most of the activities in the plan satisfy the requirements and are more likely for execution

c. ST Plan Stability (%); activities in the plan that remain unchanged over a period of three months (90 days). A higher value relates to fewer changes in the plan, which indicates a successful transfer of MT plan activities to ST plan

d. MT Plan Robustness (10%): the aim is to measure the changes in the MT plan activities, which negatively impact the business plan target and should not exceed 10% of the total number of activities. A lower value represents a better indication for robustness as it indicates a successful transfer of business plan activities to MT plan

2.0 Company business result in performance trend. Each company was requested to select one business outcome to focus on and use the IAPS Framework to support in achieving it.

a. Company-A selected to focus on cost reduction by reducing the non-productive time of the logistics marine fleet, which would improve the utilisation and reduce standby charges paid to the suppliers

b. Company-B selected to focus on production through improving the availability of facilities. The reducing facilities downtime increases the availability and consequently increases production

c. Company-C selected to focus on improved capital efficiency by improving the material on-time delivery, reducing material stocking and reducing the CAPEX to

purchase more stock material. Material on time is one of the efficiency metrics to measure the chain process capability to meet customer demand and deliver the required material on time

3.0 IAPS Process health check matrix: the aim is to check the overall improvements in the IAPS framework elements after implementing the three case-study companies' framework to understand the strength and weakness of each element based on ranking and support of evidence. The score is a collective group assessment with 20 to 30 subject matter experts participates in each company using the IAPS matrix explained in APPENDIX-B. The assessment should be supported with clear evidence of obtaining such a score.

As the three case-study companies were the first pathfinders in implementing the IAPS framework; a grace period of three months was given to the companies to deploy, train, and settle the IAPS process before recording the IAPS KPIs.

6.2 Implementing the IAPS framework in pathfinders

The upstream oil and gas business consists of different functions and disciplines focused on maintaining operations: exploration; development; well engineering; well services; project services; operation; maintenance; turnaround; optimised recovery; and, logistics. Such a complex organisation needs to be handled by care to ensure improvements in the IAPS framework are obtained without impacting business functions, resulting in a negative business outcome. Change management is vital for successful implementation. The researcher designed the following standardised IAPS implementation approach, which was used in the three case-study companies:

1. Assign a Project Governance: The company leadership should select a sponsor for IAPS framework implementation supported with in-house expertise to run the framework and monitor the progress. It is recommended to assign the Asset Manager for driving the IAPS framework implementation being the key decision authority. *All the three case-study companies selected their asset managers to be the sponsor for the IAPS framework implementation, who is also chairing the IAPS Process Council.*

2. IAPS Framework Implementation kick-off Workshop: This workshop is crucial to secure leadership commitment. The workshop should be opened by a senior leader and the project sponsor to send a clear message to the organisation about the IAPS

framework's importance. The workshop uses a PowerPoint presentation to explain the IAPS framework elements and generate an open discussion to create a paradigm shift to get the best out of the IAPS framework implementation. In all *three case-study companies, the Managing Director with the asset manager (sponsor) opened the workshop and attended the discussion.*

3. Conduct IAPS Health Check Assessment (refer to APPENDIX-B): This would help identify gaps in the company regarding the IAPS framework elements. *As the three case-study companies conducted this Health Check Assessment during the deep-dive workshops; there was no requirement to repeat the same.*

4. Create Implementation Plan: Based on identified gaps in the company using the IAPS Health Check Assessment; an implementation plan is developed to start addressing these gaps to achieve a quick win. Ultimately all the IAPS elements will be implemented, but the health check assessment would help to prioritise the efforts. *The three case-study companies took advantage of the deep-dive material and built on the focused improvement plan.*

5. Train IAPS Practitioners in the IAPS framework foundation: Conduct classroom training to explain in detail all IAPS elements. The IAPS team in the company will implement the IAPS framework and help in future to train others. *The researcher conducted three classroom training in the three case-study in which trained the local IAPS SMEs on the new IAPS framework. The participants assessed through a written exam, and syndicate exercise working various planning scenarios and propose solutions.*

6. Set up IAPS systems and integrate with the company's software: Such synchronisation and integration help improve efficiency to automate data transfer and centralise the activities database. *The three companies deployed Primavera P6 with SAP and Impress.*

7. Set up business and IAPS Process KPIs: This would help to monitor the progress of IAPS Framework implementation and validate the impact in IAPS process and business performance. *The dashboard was created for each of the case-study company, which is discussed in the next section.*

8. Conduct Monthly Performance Management: This session will be conducted with the company/asset sponsor to review progress and support any challenges during the IAPS framework implementation. *The researcher with the project team had*

conducted a monthly meeting with the sponsor to discuss progress and re-focus on implementing elements that need more improvements.

9. Establish a communication centre: Assign the right resources to establish routine communications about IAPS framework implementation progress to the organisation. Such communications would build momentum around the change and would enable a more robust leader-led dialogue. *The three case-study companies assigned a communication manager and were included as a member of the Process Council.*
10. Conduct IAPS Health Check Assessment: After completing the IAPS framework implementation; another IAPS health check assessment should be conducted post the implementation to validate the improvements in IAPS framework elements which would help to identify areas for improvement and to refocus the training and coaching in the specific IAPS framework element. *All three case-study companies conducted the IAPS Health check assessment; refer to section 6.3.3.*
11. Apply continues improvement cycle: evaluate the company performance and IAPS framework effectiveness based on the business outcome, process KPIs, and Health Check assessment. Conduct local assurance review and repeat above steps from 4 to 8.

The researcher spent three years travelling from one country to another to conduct deep-dive workshops and later to implement the IAPS framework and record the results. During the implementation phase; the researcher conducted around six visits to each case-study company with various online discussion sessions to follow up progress. Each visit varies from 1 to 2 weeks to strengthen the relationship, prepare for fieldwork, record findings, train & coach, support the sponsor and discuss results. When the researcher is away from the site; the responsibility to follow up progress was given to the company Process Council (refer to section 5.5.4) which is considered as a critical requirement for successful IAPS framework implementation. The IAPS framework provides guidance by recommending setting transparent governance to manage the IAPS framework and improvement journey in assets. Implementing improvements requires a higher authority to ensure learning is captured, and hence the Process Council in each company played a crucial role in implementing the IAPS framework. This Process Council coordinated an integrated approach to process improvements in the business and endorsed solutions.

It is quite extensive fieldwork to establish the IAPS foundation and train the local team. The challenge was more in training the functional planners to create a quality functional plan as

per the IAPS process requirements. Each function followed quite different planning process requirements and shifting to a standardised IAPS requirement took some excellent efforts to implement the change. Another challenge was creating a performance dashboard in each company to record performance. In Company-A as an example; it took five months to get the dashboard setup working due to complexity in integrating Primavera P6 with SAP through impress. Significant efforts spent to clean out SAP and Primavera P6 database to enable efficient integration. Such learning was implemented in Company-B & C in which accelerated the systems integration. The critical success factors and IAPS Golden Rules highlighted in section 5.9.1 were useful tactics to support change management and drive implementation. However; they required extensive follow-up and constant reminders with clear messages daily, weekly, and monthly. The intervention of senior leaders was crucial to ensure the organisation followed the agreed rules.

The IAPS framework is comprehensive, and the organisation should be fully prepared for such change. The standard implementation approach with described key levers helped the companies pass through and install the framework to be part of their routine operations. Communicating the intent, making performance visible, disciplined delivery, showing respect & motivating, asking why, and sharing are some of the leadership attributes required to drive a change.

6.3 Results of implementing IAPS Framework

In this section; the performance of the three case-study companies is reviewed after implementing the IAPS framework. The assessment starts with reviewing the changes in IAPS process KPIs performance, reflecting the plan quality and execution performance using the IAPS KPIs as described in Section 5.8.1 (MT Plan robustness, ST Plan stability, ST Plan AR, & IS Delivery). The 2nd part of performance assessment is the business outcomes achieved by each company as per the selected outcome by the company (Company-A: NPT Cost, Company-B: Availability, Company-C: Material on Time). The 3rd part of the assessment reviews the improvements in IAPS framework elements in all three case-study companies using the IAPS Health Check assessment before and after the framework implementation. The effectiveness of the IAPS framework can only be proved through results which are explained next.

6.3.1 IAPS process KPIs performance

Improved IAPS Process KPIs is a sign of plan quality and execution in the asset/company; it is the heart of the performance management in the IAPS framework. All three case-study

companies implemented Primavera P6 for managing IAPS plans which were used as a reporting tool. These KPIs calculations are obtained automatically from Primavera P6, and a monthly performance report is generated, shared, discussed and issued to the Asset Leadership Team. The open discussion between the different team members and leadership helped support the IAPS framework and identify critical areas of improvement. It also helped the team to take corrective actions to improve performance in the next plan proactively.

The IAPS process KPIs performance was started recording after three months from implementing the IAPS framework for 12 months and the results illustrated within Figure 6-2. There was initially a slow start in Company-A as it took some time till full training to the local IAPS team was obtained, but overall the four KPIs improved over the 12 months. The IS delivery improved from 48% to 82%, with few challenges during the year and particularly during four months in which the delivery declined to below 79% as a result of adverse weather and limitation with resources; but in general, the performance trend was positive. There is still significant room for improvement to reach 90% best in class and Company-A should incorporate weather forecast, especially in monsoon (rainy) season. The ST Plan Activity Readiness was relatively flat and above 85% throughout the 12 months. Such flat performance questions the discipline of following the activity readiness criteria strictly. Activity Readiness is a leading indicator for the IS delivery KPI. The better the activity is prepared for execution, the higher the chance to be executed.

The significant impact came from maintenance as their activity's readiness was not scrutinised by the maintenance planner; an open discussion to challenge the green AR was missed which with the help of IAPS framework was corrected, and hence better improvements were witnessed. The ST Plan Stability KPI increased by 14%, from 64% to 78%. Which indicates fewer changes in the 90 days plan activities, and the change control process has been active. It also indicates a good improvement in the activities transferred from MT plan to ST plan (90 days). The MT Plan robustness KPI is measured four times per annum (every three months). It started very low at 59% and improved over time to reach 15%. The 59% indicates that more than half of the business plan's activities changed whether in duration, schedule, or impact.

A good example of this was the change in the Over Head Line (OHL) project scope and duration. This project was discussed in the business plan without the clear implication of penalties for the variation to contract if agreed timing or methodology changed. The Company-A facilities were suffering from increased power supply interruption due to ageing and reliability issues with existing electricity Over Head Line (OHL) which resulted in tripping production facilities and wells, caused oil deferment. In order to resolve the problems, an OHL

replacement project was instigated led by the Engineering Function. The project in charge set up a contract with a local company to execute the work and developed a programme to replace the OHL. The contract with the executing contractor contained clauses for penalties if a contract variation is requested to deviate from agreed timing or methodology. During MT plan discussion; this project was picked up, and discussion around changing the scope and delivery was requested. As the IAPS framework specifically demanded an up-to-date Activity-Based Cost Model to be in place and included current activity and cost data with planning assumptions and deviations (refer to section 5.2.2); the MT IAPS planner reviewed the assumptions with the project planner and highlighted the penalties clause for any delays. The operations manager refused to take any additional facilities shut down, and the project engineer did not appreciate the impact of the project in the broader business. The operational decision and penalties could undermine the value of a project to the business could be paid out to the contractor. The senior management decided to accelerate the facilities planned shutdown to accommodate the OHL project. However, such decision impacted the MT Plan robustness; however, the IAPS framework improves communication between project engineer and Asset planners. The IAPS framework (section) clearly explains the one plan concept in which linking strategic plan to business plan to medium and short term IAPS plans is required. This check brings another insight that the business plan quality was low in Company-A, and more improvement is required while building the business plan for next year. Thanks for the IAPS framework for bringing such insights which were missed in the past. As improving IAPS framework is a journey; understandably, starting measuring something takes some good time to be stable. What is essential in this analysis is that the trend for all four KPIs is in a positive direction. In general, Company-A improvement in all four KPIs; however, there is still room for improvement, significantly to enhance AR and reduce changes in the plan.

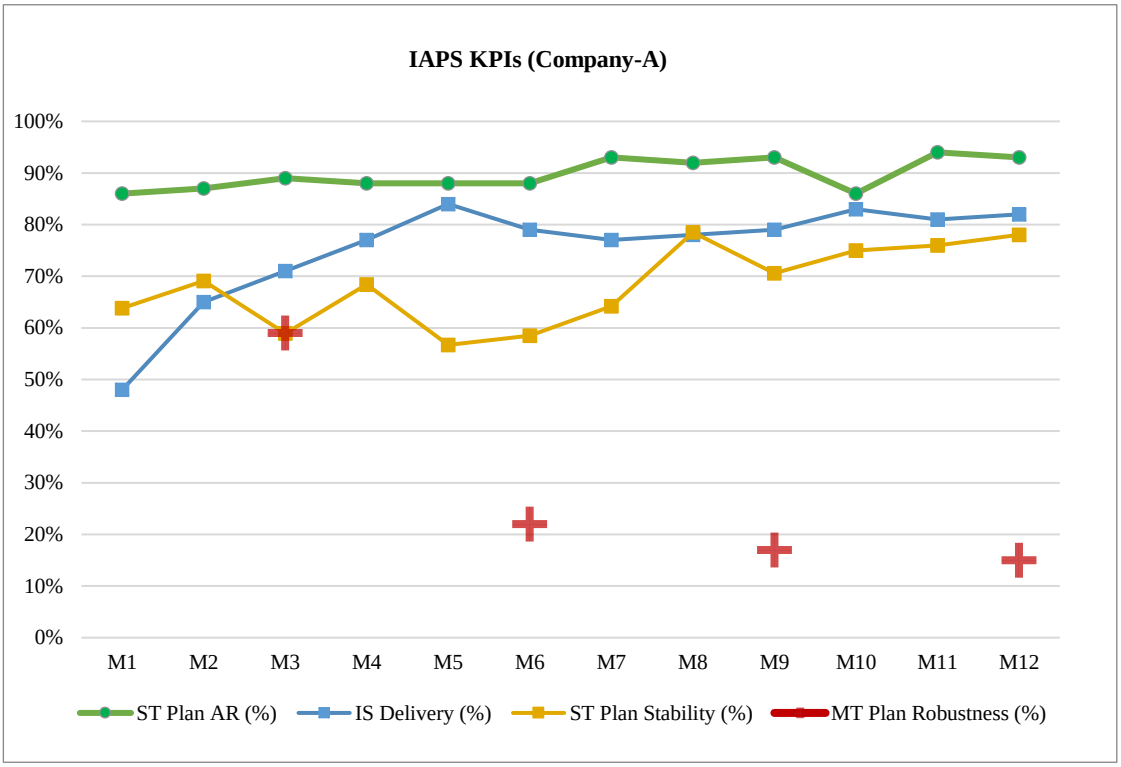


Figure 6-2 IAPS Process KPIs Results (Company-A)

The Company-B overall performance in the 4 KPIs improved by 31% over 12 months, as illustrated in Figure 6-3. The Company-B implementation journey was quite challenging; it took a great effort to embed the IAPS framework as the organisation is matured and have been following the old ways of working for years. The functions teams always dominated the discussion during the IAPS meeting until the IAPS planner demonstrated his capability. It took a while to train & coach the IAPS planner and build his capability to challenge activities before integration. The IAPS planner still needs to continue learning and strengthen his skills which is part of the IAPS framework implementation.

The IS delivery started very low with 27% and improved to reach 65% due to the slow start-up in following stringent AR criteria. Although the IS delivery improved but 65% is still considered low as it indicates that 35% of the activities planned for execution were not completed. The ST Plan Activity Readiness has improved from 46% to 79%, which indicates that the organisation started to understand the value of the Activity Readiness criteria. No wonder the improvement in IS delivery results from functional improvement in Activity Readiness being the activity is fully prepared for execution. The maintenance function was the most significant contributor to the low IS delivery and AR in Company-B; the maintenance team felt that the IAPS planner took away their flexibility to change their activities without

applying robust change management. The IAPS Process Council spent reasonable efforts to coach and support but also to apply consequences management when required to improve compliance.

The ST Plan Stability KPI improved by 15%; it started with 55% and reached 70%. Still, around 30% of the plan activities in the 90 days windows have been changed, which is explained by low-quality planning. The Company-B suffered from the impact of postponing a significant shut down due to gas pipeline project tie in delays. Because of the delay in project construction; the shutdown window was changed, and hence many activities were postponed. Such a significant change in the MT plan impacted the 90d plan and hence reduced the ST Plan stability. The project involved a significant volume of work related to the gas pipeline, which required operational facilities shutdown to execute several critical tie-ins. These facilities shutdown means less production and less gas export which also means less LNG cargo. The gas pipeline project team were not explicit about the shutdown duration and readiness for tie-in execution. During the 2nd MT Plan meeting discussion, the delay in project execution and proposed shutdown postponement was discussed; this proved the IAPS framework's importance in general and & MT plan in specific to deliver significant business plan milestones. The IAPS process (refer to section 5.5.1.2) specifically demands a credible function plan, and hence the project execution delay and shutdown requirement were captured. Looking at the MT robustness KPI, which still indicates significant changes in activities (due to delay in project construction), explains the ST plan's low stability. The MT Plan robustness KPI started at 75% and improved in the next three quarters to 41%. Although the performance trend is positive, such high changes in MT plan activities (60%) send an alert to the senior management about threats to deliver business plan targets.

The downstream LNG team had not been involved in the past in the Company-B IAPS process and meetings. Since implementing the IAPS framework; the LNG plant team were invited in IAPS meeting. During MT Plan meeting, it was highlighted the planned LNG shutdown which could be combined with upstream gas facilities shutdown for gas pipeline tie-in. The IAPS framework ensures that all 3rd party's activities are covered in the Integrated Activity Planning process (refer to section 5.5.2.2). The boundary should be set such that the complete value stream is covered. LNG Facilities, tank farms and potential relevant third parties should be included. Representatives from all assets should participate in the IAPS meetings to ensure that all activity plans are integrated so that the overall optimal business result can be achieved. If the IAPS framework was not implemented in the Company-B; it could end having two outages, which could have been combined into one, and resulted in the missed opportunity to export 2 LNG cargos (~ $200M).

These two significant activities (gas pipeline tie-in & LNG planned shutdown) could impact the Company-B business delivery and consequently, the GC (full value chain). Although the impact was more in MT plan robustness and ST plan stability KPIs, the IAPS framework brought the visibility about the project execution performance and third-party activities integration, which generate a good discussion at senior leadership to mitigate the impact and accelerate the execution.

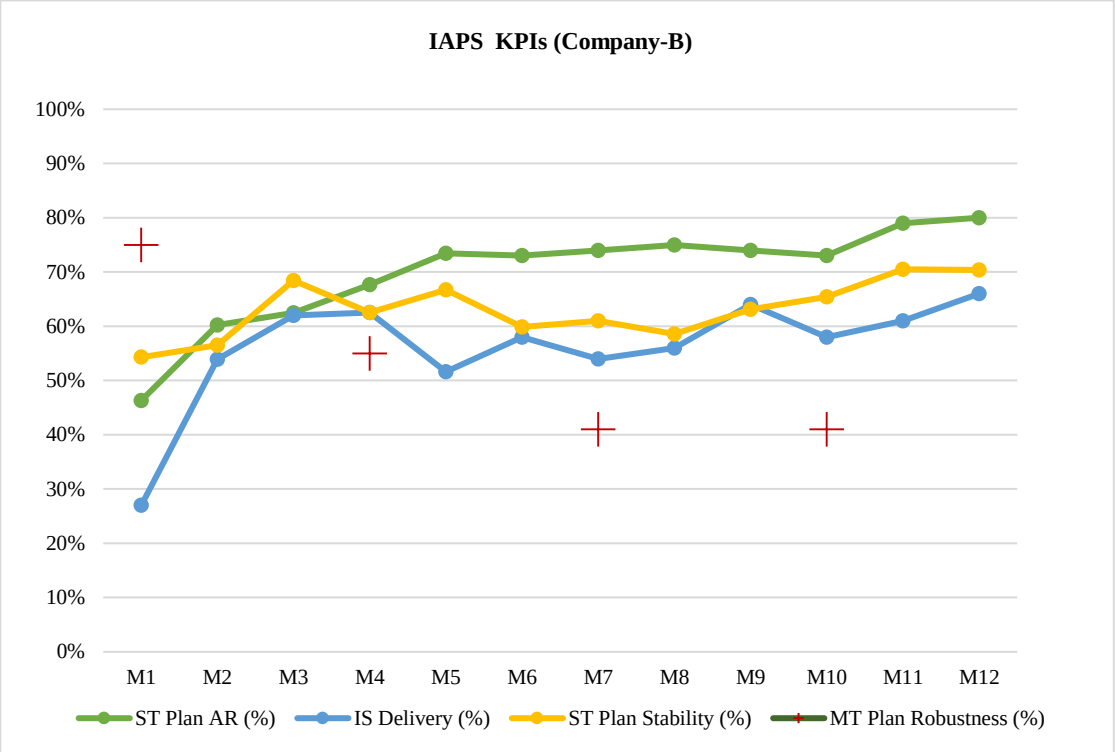


Figure 6-3 IAPS Process KPIs Results (Company-B)

The Company-C overall performance in the 4 KPIs improved by 14% over 12 months period and is illustrated in Figure 6-4. It noticed that all 4 KPIs started at suitable positions, which can be explained from taking the early learnings from the other two companies. The IS delivery started at 60% and improved to reach 72%. In the last three months, the IS delivery performance declined to less than 70%, consistent with ST Plan Activity Readiness. Such correlation is vital in this research, although it is not always a linear relationship but demonstrates AR's importance in plan stability and IS delivery (refer to section 5.9.2.2). The ST Plan Activity Readiness has remained constant, with minor improvement from 78% to 81%. Two months the Activity Readiness dropped to 66%, indicating the low performance of IS delivery 63%. Such performance indicates some complacency in following the Activity Readiness strictly. The ST Plan Stability KPI improved by 22%; it started at 65% and reached

83%, which is the highest in the three companies. The MT Plan robustness KPI achieved excellent performance with a good start at 21% to 10%. It is the only company reach to 10% robustness, indicating a high probability of meeting the business targets.

The significant impact came from wells as the wells planner did not scrutinise their activity's readiness; an open discussion to challenge the green AR was missed. Company-C historically excluded wells activities from the IAPS plan (refer to the deep-dive workshop in section 4.2.3). After implementing the IAPS framework in Company-C; wells activities started to be included. The IAPS planner also supported the Well's planner to understand the AR activity value and better improvements were witnessed. Such improvement to integrate wells activities with other functions helped identify a clash between the project team developing a large offshore installation and infill drilling programme. Both teams project and wells are competing for limited space in the platform to execute their programs. It is well known that People On Board (PoB) is with limited capacity authorised in offshore platforms due to requirements to meet safety standards and evacuation procedure. The offshore installation project was in the spotlight of the shareholders and delivery of first oil in the calendar year was mandatory, but drilling rig is also expansive equipment and underusing its capacity to drill the infill wells would cost the Company-C. Such constraints were not visible before implementing the IAPS framework. The IAPS framework specifically demands to resolve clashes and propose different scenarios for management to make the right decision (refer to section 5.5.2.3). The IAPS planner with support from project planner and wells planner developed the following two scenarios:

- Scenario#1: Execute the drilling programme as planned, demobilise project workers and revise the project plan to complete topsides work scopes after that. It would result in significant reputation damage with investors and reserves not being bookable as the new field tie in cannot be completed.
- Scenario#2: Man-up the topsides project personnel and suspend the platform drilling programme. It would result in first oil for the tieback field being produced before 31 December; proved reserves as promised; hence reputation with project protected but Rig crew idle for three months adding no value to the business (cost implication).

The second scenario was selected due to the impact on reputation with investors and the necessity to book targeted reserves. Of course, the ideal rig crew for three months had some cost implications, but many were used in other drilling rigs to mitigate the impact. The IAPS

framework supported the leadership to take the right decision at the right time, which secured the business outcome. The trends of the 4 KPIs summarised in the following figure.

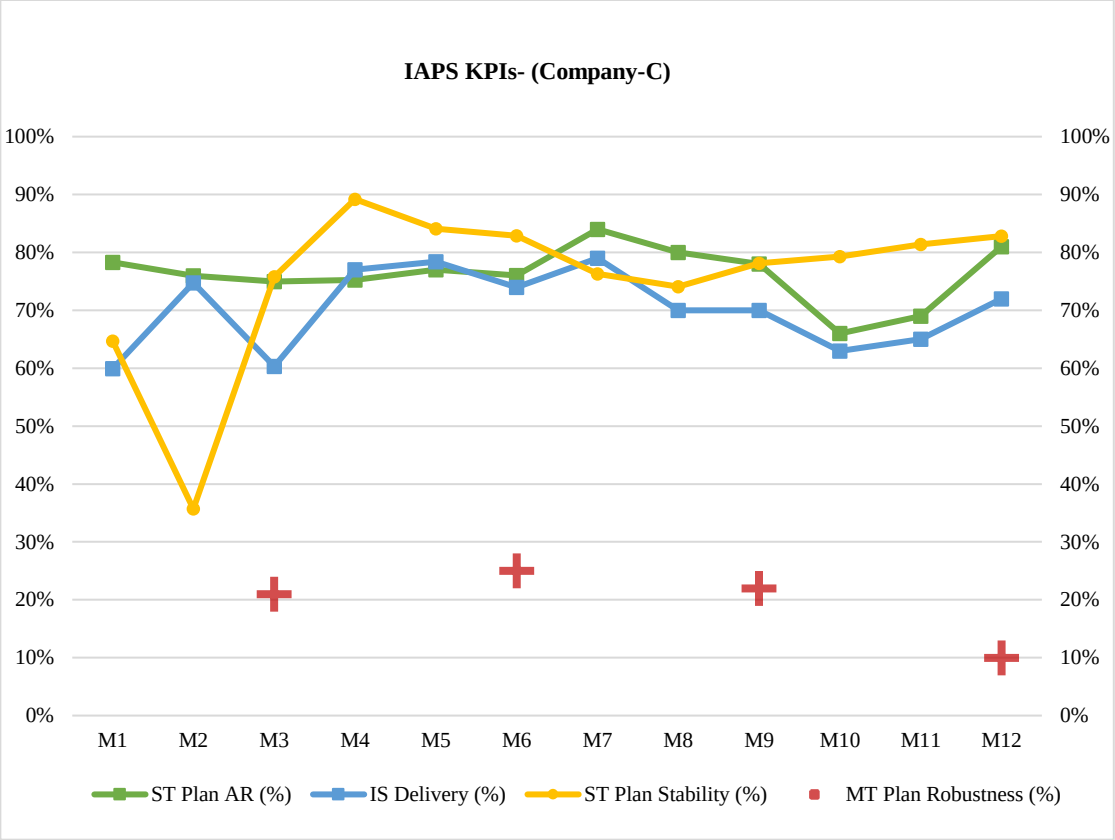


Figure 6-4 IAPS Process KPIs Results (Company-C)

6.3.2 Companies business outcomes performance

Company-A opted to test the IAPS contribution to optimising cost by reducing the Non-Productive Time (NPT) of the marine fleet, which in turn reduces the standby charges and enables improvement of fleet utilisation. It was the top business driver for Company-A with respect to the IAPS Framework implementation. It took around five months to train the staff in applying the IAPS Framework and setting up the performance KPIs.

The IAPS planner integrated all functions activities in one plan with exact resources requirements. Primavera P6 is equipped with functionality to develop a resources profile if the data entered correctly beside each activity. The IAPS framework stipulates the data requirements in section 5.6, and hence a demand profile using Primavera P6 could be developed, analysed, and optimised. With improved IAPS planning and IS delivery, the NPT reduced from 38% to 20%, which equated to approximately 4.5 days improvement per month as seen in Figure 6-5. With reduced NPT, the cost paid to the supplier reduced from $9500 to

$4800 per day. This cost was considered as waste, due to the marine logistics not being used. The overall cost reduction Company-A achieved was $480,000 over the 12 months. Extrapolating these savings within other logistic fleets would enable Company-A to make considerable savings and achieve the cost optimisation target. The IAPS framework enabled such business outcome achievement; in the past, without precise data requirements in IAPS, such optimisation could not be achieved.

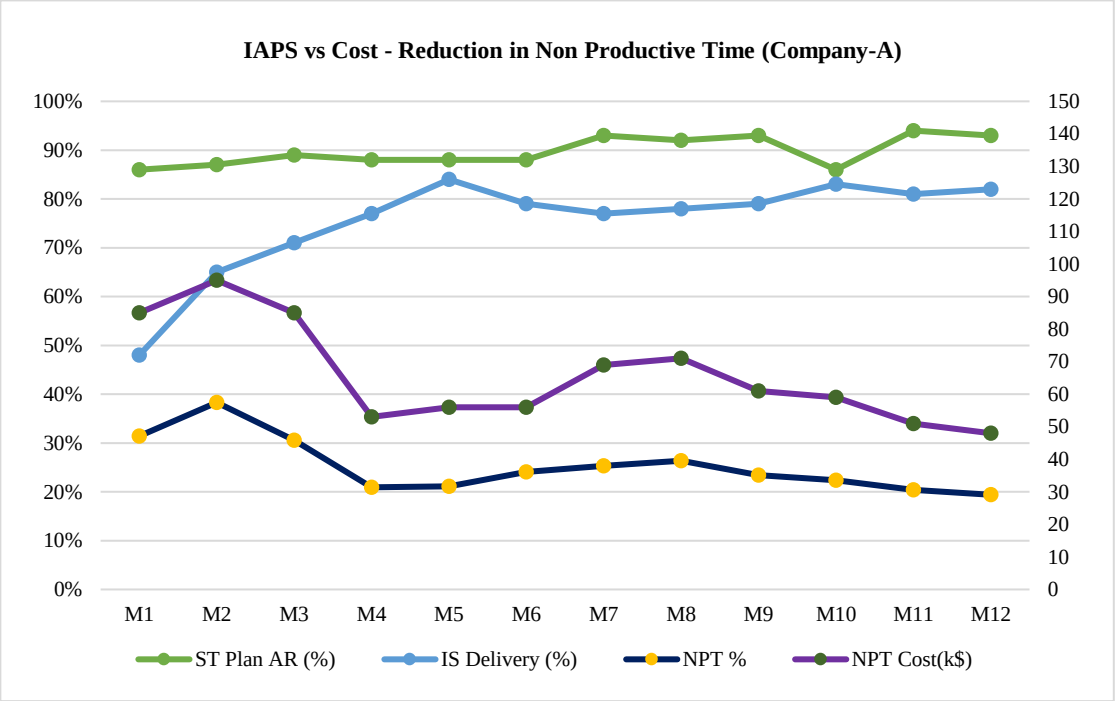


Figure 6-5 Business KPI Results (Company-A)

Company-B selected to focus on increasing production by improving the facility availability through implementing the IAPS framework. The better the IAPS plan is the better integration for activities to be executed in one window so reduce the downtime and increase uptime and availability. The IAPS planner integrated all functions activities in one plan with a clear indication of equipment shutdown requirement. Primavera P6 is equipped with functionality to generate a downtime profile for all facilities if the shutdown requirement flag was selected with a specific state and finish date. Such data quality was crucial for effective integration. Impress played a big part in synchronising SAP maintenance activities to Primavera P6 with the correct shutdown codes (refer to section 5.7.1). It enabled the IAPS planner to generate a good overview for all downtime and start combining activities to reduce the number of outages and hence reduce the overall scheduled deferment. Company-B improved availability from

67% to 85% as seen in Figure 6-6, which indicates that the downtime of facilities has reduced by 18%.

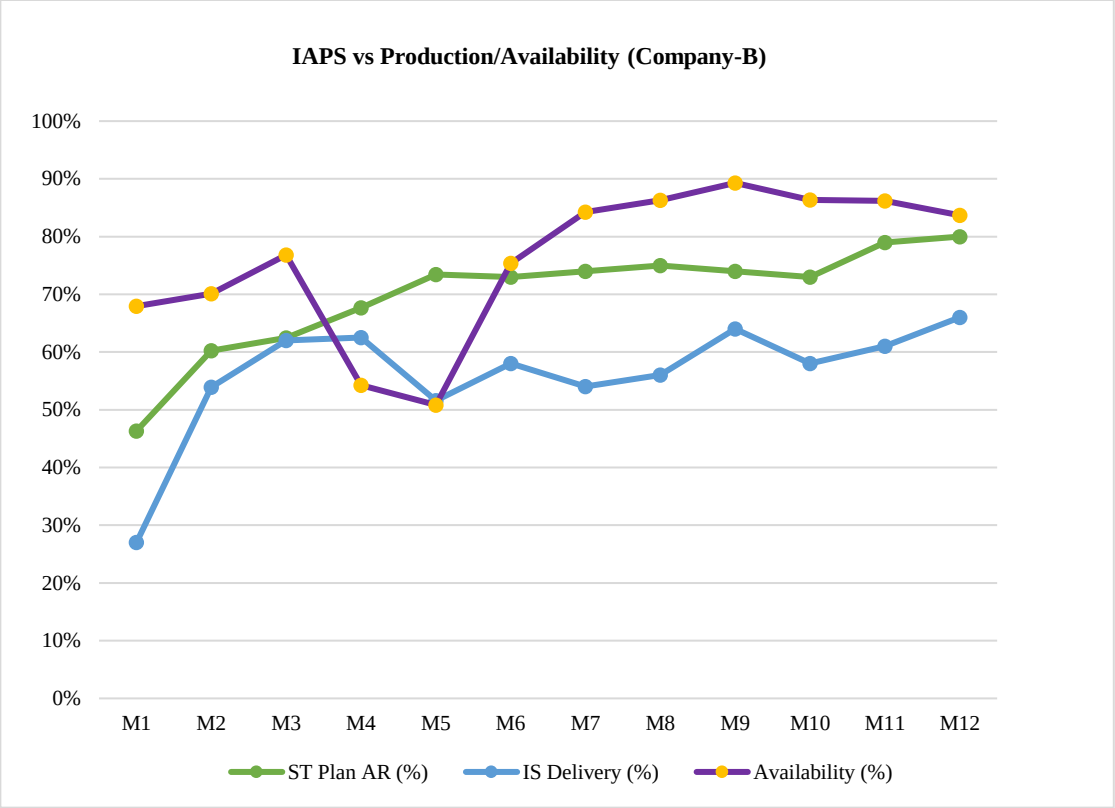


Figure 6-6 Business KPI Results (Company-B)

The two months of low availability were due to turnaround activities in one of the leading facilities executed as per the business plan. The production target was considered the most challenging business target to measure as it interfaces with the wells' potential to produce, reliability of equipment, and quality of maintenance. Overall, Company-C achieved improved production with the low scheduled deferment of 7% through the 12 months, including a significant planned turnaround in the same year.

Company-C selected to improve capital efficiency by improving the visibility of material movement and improving delivery through better IAPS planning. Having material delivered on time reduced the exposure for execution, and reduced the CAPEX spent on stocking material. The more efficient is the delivery, the better the supply agreement can be established with different vendors. Material stock is considered as inefficient CAPEX (money in stores),

and reducing the stock material, the CAPEX can be used for other more important activities to deliver business operations.

The IAPS planner after approving the IAPS Plan handover the execution to different parties including logistics, contracting and procurement. Early visibility for the material required to execute activities in the plan supported supply chain management to resources and plan for on-time delivery. IAPS should not be treated in an isolated manner; there is a strong relationship between the IAPS process and key work processes in the company, such as supply chain management (refer to section 5.3.2). The IAPS framework stipulated the importance of linking the work process and hence supported the Company-C to improve the material on time (from 44% to 61%, which in turn reduced the stock level by 17% and illustrated within Figure 6-7. It also provided an increased insight of fast-moving material which is the material run out of stock and requires to be replenished. Following this encouraging result, Company-C management decided to carry out an exercise to review the stock level (min/max) and good/bad stock based on equipment criticality. The IAPS plan provided improved demand planning for material, which allowed Company-C to utilise the available CAPEX more efficiently. The Company-C stock material value was $450M; the 17% reduction in stock equated to $76.5Mwhich was obtained from implementing the IAPS framework. Extrapolating such achievement to other parts of the business and other GC companies will bring massive value in overall business outcomes.

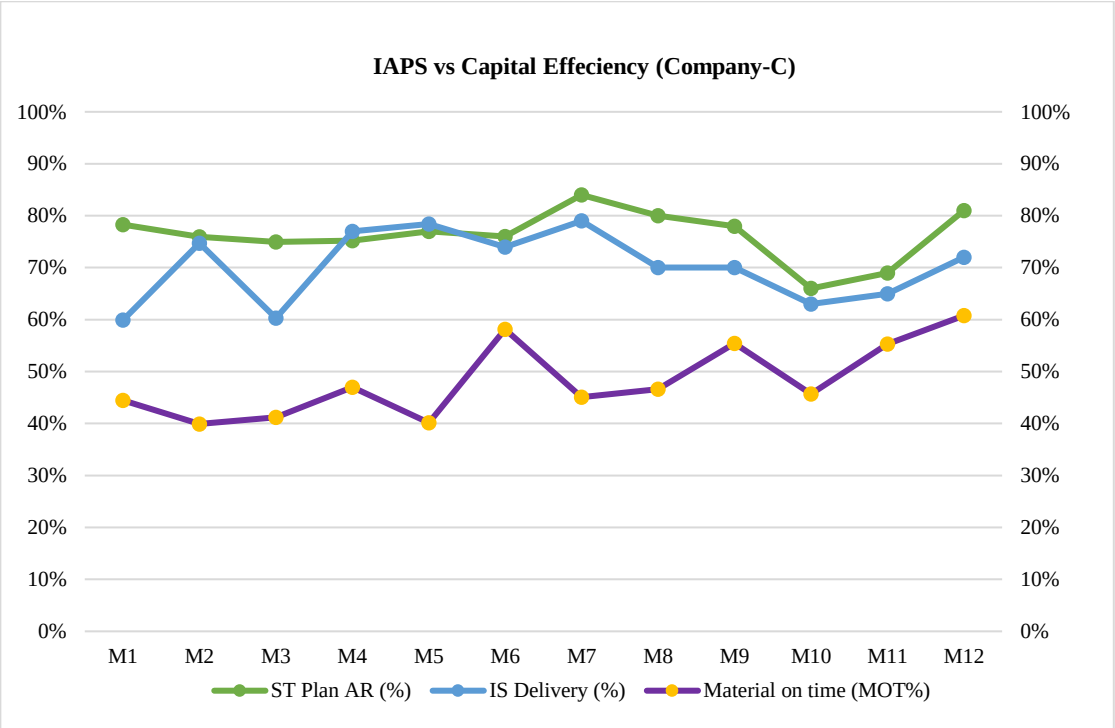


Figure 6-7 Business KPI Results (Company-C)

Through the IAPS Framework implementation in the three case-study companies, difficulties were experienced in establishing business outcomes linked to IAPS process performance. There are 15 factors, and five outcomes need to be recorded if all outcomes are selected to be achieved. Even only with one business outcome was selected by each case-study company; each factor required a database to be collected and performance to be analysed. It requires a full-time job and loaded the IAPS team to generate such KPIs.

To overcome such a challenge in future; it is considered best practice to name an owner for each business KPIs to link it to IAPS process KPIs. Once the link created than will be more transparent to show the IAPS Plan Compliance KPIs and the company business outcomes on the same slide in order to monitor the performance closely and take the right intervention to improve, as an example; the production programmer can own the production target and link it to availability and IAPS plan. The C&P planner can be the focal point to material on-time delivery, and the logistics planner can be the focal point for the boats NPT and utilisation.

6.3.3 Companies IAPS health check matrix results

All three case-study companies demonstrated significant improvement after implementing the IAPS framework as all companies met the minimum requirements and scored 3.0 and above. It is considered an excellent achievement in 12 months. The IAPS framework supported the three companies to move into a structural organisation change to develop a quality IAPS plan and deliver inspired business outcome. A structural change is necessary to enable continues improvements and sustainable achievements (Sletbakk Ramstad et al., 2010).

Company-A had the most significant overall improvements in IAPS framework elements with an average score from 2.1 to 3.2, as illustrated within the IAPS health check results of Figure 6-8. The direction setting and business context achieved a score of 3. Company-A leadership and IAPS sponsor continually sent a clear and consistent message about aspired business outcome and importance of IAPS. In town halls, formal and informal meeting, field visits, managing director monthly message to staff, and magazines; the IAPS was present, and leadership talk about it. The organisation started to see IAPS as a vital tool for delivering a business outcome, especially after achieving a reduction in NPT in marine logistics ($480,000). The company-A developed KPIs dashboard to measure IAPS impact on business performance and IAPS process with a feedback mechanism to ensure that activities in the IAPS reflect changes made through the business planning. It was not the case before implementing the IAPS framework (refer to section 4.2.1)

The leadership achieved a range of 2.5 compared to 1 before implementing the IAPS framework. Leadership supported disciplined driving execution of the IAPS process using

IAPS golden rules. Ownership and accountability were clear after implementing the definitions in Table 5-3 IAPS plan definitions with roles and responsibilities (refer to section 5.3.1). Leaders responded timely with a decision when a clear proposal was presented to them about the OHL project. What could be done more better to score higher in leadership; is to improve behaviour in meeting and drive disciplined discussion about risks and opportunities.

The culture element is always considered the most challenging element which requires continues improvement to achieve a sustainable result. Company-A achieved a score of 2.5 compared to a score of 1 before the IAPS framework. Such improvement resulted from assigning a plan owner for each plan time horizon which created a positive discussion about the IAPS plan's quality and delivery. The plan owners chaired their various IAPS Plan meetings as per the meeting TORs and staff were held accountable to deliver the requirements of IAPS framework. Continues efforts required to follow IAPS process critical Success Factors and IAPS Golden Rules.

Company-A achieved remarkable improvement in the process by achieving a score of 3.3. The Company-A had a strong start in IAPS inclusion criteria s during the deep dive session, it was considered a best practice and was used in building the IAPS inclusion criteria in the IAPS framework. The planning calendar was also recognised as a best practice and hence maintained a score of 4. The 3rd party activities scored high as they were invited to the IAPS meeting, and their activities were integrated with other functions activities.

The data and systems scored arrange of 3. All Functional plans exist and reside in the IAPS planning database Primavera P6 to support effective integration. The Functions planners described their activities data as per planning level prescribed at each planning level (AP: Activity Unique ID, Activity Name, Plan: MT or ST or both, Planned Start Date, Planned Finish Date, Asset, Facility, Function, Activity Readiness Status, Shared Resource). Company-A performed data cleaning exercise in SAP and Primavera, which improved the activity details in general and allowed better integration.

After implementing the IAPS framework, the organisation structure and people elements improved from a score of 1.75 to a score of 3.5. The Company-A central asset planners were almost non-existent, having a minimal role in integrating plans. The island map demonstrated in Figure 4-4 indicated the isolation of different planning teams; each was located within a different island, dominated by the asset planners compared to the central planning team. It was changed entirely after implementing the IAPS framework proposed organisation (Figure 5-2). The organisation structure was established clearly with the central IAPS team integrating all functional plans and was adequately resourced with experienced IAPS planners. The Central

Planning team was resourced with a Planning Manager who has oversight of the company integrated plan. There was transparent reporting from functional planners to the central IAPS team. Such reporting lines have given the IAPS central team more authority on functional planners and could influence the functional plans' quality. The IAPS roles and responsibilities were clearly defined and included in staff performance reports. The IAPS framework demanded to update the job descriptions, job competence profiles and succession plan, which were all completed. The below Figure 6-8. summarise the Company-A IAPS health check results.

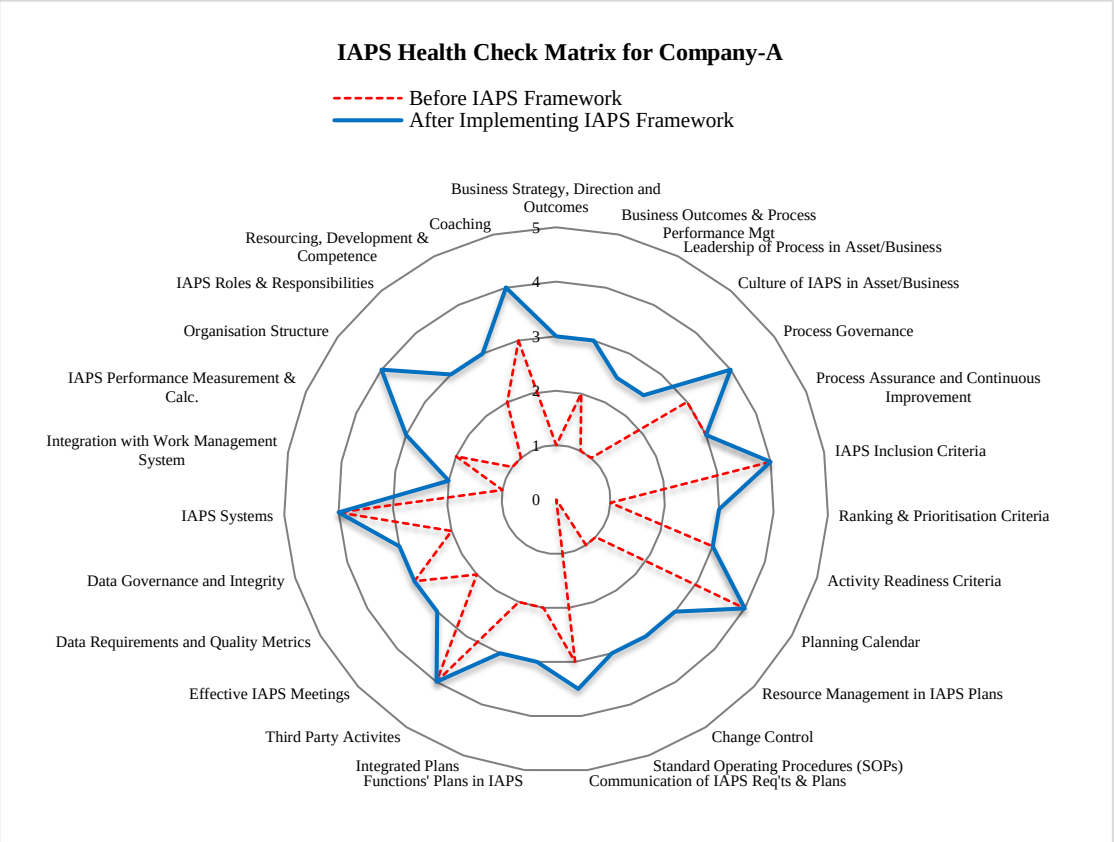


Figure 6-8 IAPS Health Check Matrix (Company-A)

The Company-B improved in overall score from 2.1 to 3.0, as illustrated in Figure 6-9. The company-B scored 2.5 in direction setting compared to 1.0 before implementing the IAPS framework. It is considered a good improvement despite the challenges faced in transforming the organisation, as explained in section. Part of the organisation and specifically the maintenance team was not entirely on board to follow the IAPS rules fearing to lose their authority over the IAPS plan. It took significant efforts to train & coach the maintenance team to move away from an old way of working and start using the IAPS process; thanks for the

IAPS framework training program (refer to section 5.4). The Company-B could build a strong case for change after achieving a profitable business outcome in availability (from 67% to 85%). The IAPS sponsor and leadership team were consistent in sending a clear message about the value of IAPS and linking it to the company aspired business outcome in different meetings; however, more mass communication techniques such as town halls and managing director monthly message could be considered.

The leadership achieved 2.5 compared to 1 before implementation. Leaders were visible and accessible; when IAPS team faced challenges to onboard the maintenance team; the IAPS sponsor intervenes and put clear expectations for the organisation. The leader expressed positive reinforcement of the disciplined execution of the IAPS process but need to continuously set a clear expectation in IAPS meetings and one to one business interactions.

The culture element slightly improved to a score of 2 compared to a score of 1 before implementing the IAPS framework. Culture element improvement is recognised in Company-B, but consequence management is an area that requires more attention from leadership. The non-compliance from the maintenance team was addressed but could be managed early before seeing the IAPS delivery performance's impact. Staff should understand the requirements of their rules and deliver as per management expectation.

Company-B delivered an improvement in process by achieving a score of 3. The governance scored 3.0 compared to a score of 1 before implementing the IAPS framework as IAPS planner, and IAPS process owner demonstrated robust control in applying the IAPS rules. Ranking and prioritisation achieved 3.5 as the plan's activities used objective value ranking with delivery following the IAPS prioritisation matrix (refer to section 5.9.3) Extra efforts required in applying strict change control that scored 2.5 as some changes were sanctioned without following the process. The integrated plan has scored 2.5 as maintenance activities were delayed in including them in the IAPS plan.

In data and system, the company-B scored 3.4. All specific activity fields were populated (location, duration, POB, activity owner, system condition and impact in production). The data quality standards were communicated to all relevant IAPS, and Functional Planners and data quality assurance steps were documented. Planning system Primavera P6 is integrated with SAP through impress, which allowed to manage IAPS plan in a single tool.

Company-B scored 2.8 in organisation structure and people elements. The organisation structured through central IAPS team was established, but the functional planners reporting to the IAPS central team was not established clearly for all functions. Such shortfalls created less influence of the IAPS planners on controlling the quality of submitted functional plans. Staff

performance did not include IAPS improvement targets. The advanced training by the IAPS framework was conducted, but more coaches should be expanded in other functions as it scored only 2.5. The below Figure 6-9 summarise the Company-B IAPS health check results.

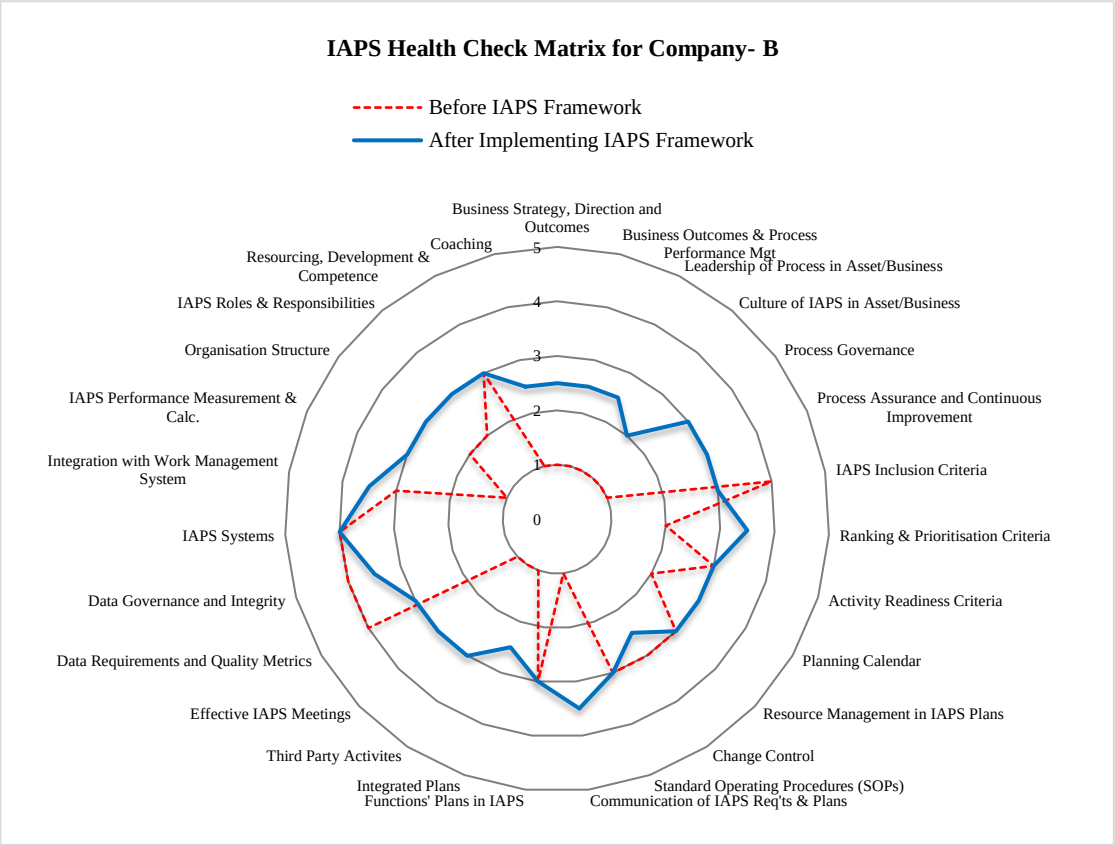


Figure 6-9 IAPS Health Check Matrix (Company-B)

The Company-C improved in overall score from 2.4 to 3.1, as illustrated in Figure 6-10 and considered the 2nd highest improved company in IAPS framework elements after the company-A. The direction-setting element scored 3.0 compared to 2 before implementing the IAPS framework. The organisation sees IAPS as a vital tool for delivering the company objectives aspired business outcome. The significant change was bringing wells to function part of the IAPS to be integrated with other functional activities and optimise resources. The leadership and IAPS sponsor were clear and consistent in delivering the company vision via IAPS framework and using one plan concept (refer to section 5.2.6) as a vehicle for integration. Company-C continued the improvement to align business plan major activities (such as top sea new facilities) with the IAPS plan and revalidate assumptions and commitments.

The leadership and culture scored 3.0, which is considered high compared to the other two companies. The IAPS framework positioned the IAPS Planner to be part of the asset leadership team. The broader organisation sees such improvement as an increased authority to the IAPS planner. Leaders monitored the IAPS KPIs and provided necessary intervention and required decision timely; the clash between infill drilling and topside facilities platform was resolved. What made the leadership in Company-C improve more than the other two companies was the effective use of field visits and following through on issues surfaced.

The company-C culture element scored higher than the other two companies and moved from a score of 2 before the IAPS framework to a score of 3. Staff in Company-C were held accountable to strictly deliver their roles with evidence of applying the IAPS golden rules strictly. The difficult conversation occurred in various meeting to set the right expectations in the organisation. The business outcome was the trigger point for better IAPS performance.

In the process element, the overall performance was of a score of 3.1. Company-C started from a strong base in managing resources within the IAPS plan, which helped drive better performance. The inclusion criteria were improved and scored 3.0 after using the IAPS definition highlighted in section 5.9.2.1. The ranking and prioritisation criteria scored 3.5 due to the diligence in following the proposed criteria in the IAPS framework (refer to section 5.9.3) which enabled the IAPS planner to resolve most of the clashes. Extra efforts were required to establish a planning calendar in which scored a range of 2.5 and improved in functions plan quality which scored a range of 2.5.

The Company-C scored an average of 3 in data and system. The integration of IAPS with SCM and logistics considered best practice. The automated KPIs calculation and data transferred to the SCM team to identify and optimise the required material played a big part in data excellence. The Company-C however, still needs to improve in adhering to data assurance and implement minimum data requirements across all functions.

The Organisation structure & people element scored 3.3. The company-C implemented the recommended organisation structure proposed by the IAPS framework and functional planners reporting to central IAPS team clearly demonstrated. Although the Wells Planner reporting to the IAPS team was delayed but eventually was established. The most robust function connected to the IAPS team in Company-C was the SCM. This key integration enabled to deliver the required material on time and at the right place. IAPS triggered the SCM process to deliver activity as per plan. The collaboration between functions and IAPS teams was open, honest, structured & informed by good quality demand and supply profiles. Activity executions performance reported through the IAPS process. The Company-C scored 4 in

dedicated staff to manage the IAPS process and perform coaching to the organisation. The below Figure 6-10 summarise the Company-C IAPS health check results.

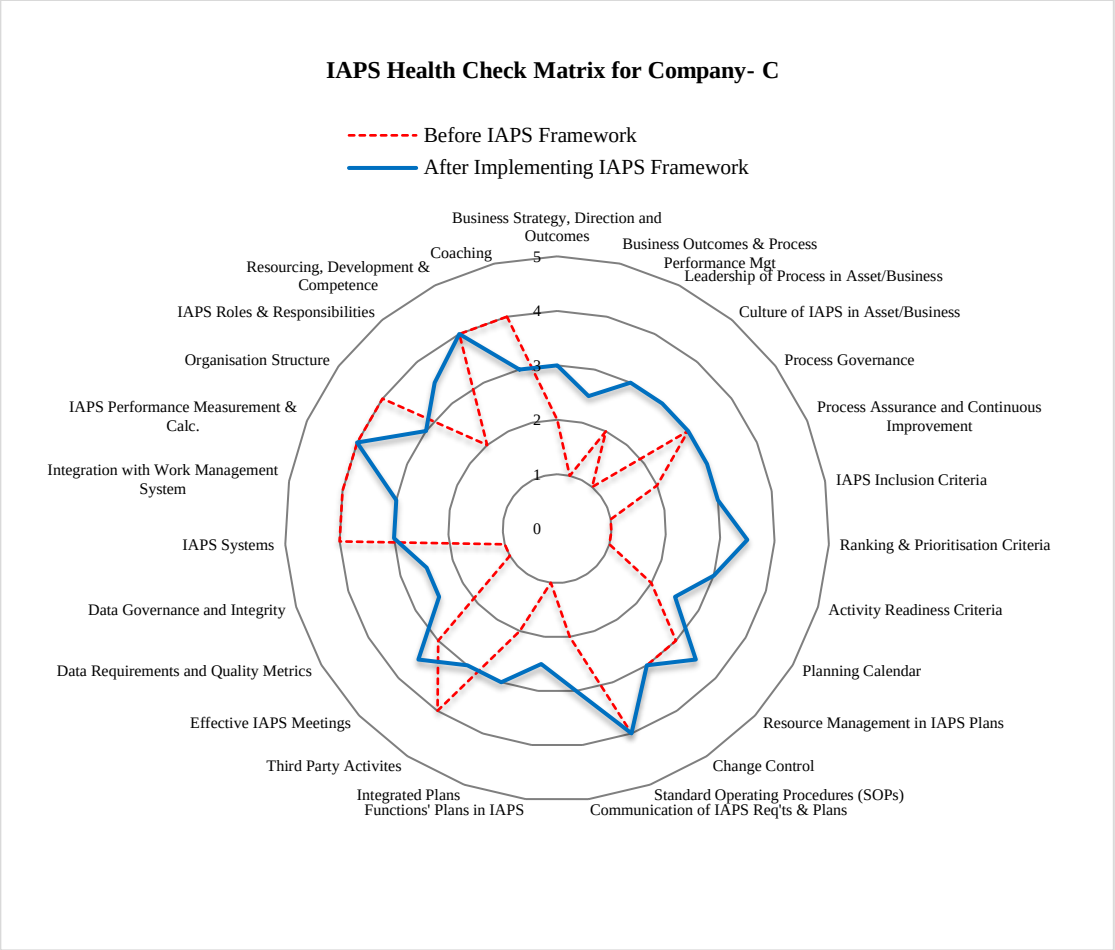


Figure 6-10 IAPS Health Check Matrix (Company-C)

6.4 Summary of the results

The IAPS Framework implementation in three different companies demonstrated the improvements in delivered business outcome, IAPS process KPIs, and various elements in the IAPS Framework. The IAPS framework achieved a better alignment in the company's priorities, cooperation between functions, and agreement between stakeholders. The IAPS sponsor and senior leadership team in the three companies saw the IAPS framework a vehicle to deliver the company aspired business outcome. The IAPS plans (MT, ST, IS) exist and are recognised as a useful communication tool for the company priorities across all organisation levels. The IAPS team and functions had translated these priorities to approved IAPS plans and continuously challenged the performance. A governance structure exists by creating the

IAPS Process Council at senior management level, which set clear expectations for the organisation to follow the IAPS framework, deliver business outcome and track progress.

The IAPS framework supported the three case-study companies to deliver improved business outcomes. The Company-A achieved a cost reduction of $480,000 as a result of reducing NPT of logistics fleet NPT from 38% to 20%. The Company-B improved the availability from 67% to 85% as a result of reducing facilities downtime by 18%. The Company-C improved the material on time (from 44% to 61%, which in turn reduced the stock level by 17%, which equated to $76.5Mreduction in stocking material. Extrapolating such achievement to other parts of the business in the GC will bring massive value in overall business outcomes.

The IAPS process KPIs improved in the three case-study companies; the Company-A improved the MT Plan robustness KPI from 59% to 15%, ST Plan Activity Readiness above 85%, ST Plan stability from 64% to 78%, and IS delivery from 48% to 82%. The Company-B improved the MT Plan robustness KPI from 75% to 41%, ST Plan Activity Readiness from 46% to 79%, ST Plan stability from 55% to 70%, and IS delivery from 27% to 65%. The Company-C improved the MT Plan robustness KPI from 21% to 10%, ST Plan Activity Readiness from 78% to 81%, ST Plan stability from 65% to 83%, and IS delivery from 60% to 72%.

All three case-study companies improved in IAPS health check assessment after implementing the IAPS framework. The Company-A improved in overall average score from 2.1 to 3.2. Furthermore, the Company-B improved in overall average score from 2.1 to 3.0. Whereases, the Company-C improved in overall average score from 2.4 to 3.1.

The IAPS framework implementation journey requires more time to stabilise and harness the change. The culture element is the most difficult to sustain and requires a continues efforts in applying IAPS critical success factors and IAPS golden rules with clear communication. The overall trend is moving in the right direction; discipline & determination are required to sustain what already achieved to continue improving. Leadership commitment is critical and in the heart of the IAPS framework.

Chapter 7 DISCUSSION

This research aims to develop an end-to-end IAPS framework for the GC delivering improvements in business performance in HSE, production, and cost. The feedback and results obtained from implementing the IAPS framework in three case-study companies were auspicious. All three companies delivered better business outcome and improved the IAPS framework elements in the organisations. In this chapter, the appropriateness of the methodology & research method (deep dives) is assessed and the research outcome across the GC & within other oil and gas industry and if any changes are required as future work is discussed.

7.1 Research methodology

The research philosophy chosen was pragmatism with Action Research strategy. The research approach was structured around four cycles: discover cycle; deep dive cycle; development cycle; and, test and learn cycle. The research utilised the depth of knowledge and wealth of experience in the GC organisation to identify challenges, produce solutions, create IAPS framework, implement, and facilitate change management. During the discover cycle, the GC's challenges in implementing integrated activity planning were identified by conducting a workshop with IAPS global SMEs. The main inefficient elements and the GC requirements for an effective IAPS framework were discussed and agreed. Different concepts, models, approaches, and frameworks have been identified concerning Integrated Planning and Scheduling in the literature review. Most of the literature reviewed had emphasised the importance of planning and scheduling, but there was no complete IAPS framework addressing all the GC requirements. Hence the deep dive cycle became more critical to elicit an understanding of the gaps and challenges at the operating company/asset level. The deep-dive workshops were conducted in three case-studies companies which considered representative to the GC business. Deeper insights and knowledge regarding the organizational challenges to implementing the integrated activity planning procedure were identified, which helped develop a fit for purpose solution. The development cycle was the knowledge generation of the research. Best practices gained from the three case-study companies, experience within the group, and external learning through literature review were utilised to develop the IAPS framework. The developed IAPS framework focused on addressing the GC requirements in 8 elements: the direction setting, organisation structure, people, process, systems, data, culture, and leadership. The IAPS framework aimed to improve business outcome in the GC; it was a must to be tested and validated. This was the next cycle test and

learned in which the IAPS framework was implemented in three case-study companies which considered as pathfinders. A standard implementation approach was used to support implementation and review results. The IAPS framework evaluation was conducted on business outcomes, IAPS process KPIs, and IAPS framework elements improvements. This cycle's learning was to focus on continuous improvement and continue deploying the framework in the GC. The IAPS framework was approved by the GC management and considered the new guideline to implement the IAPS in the companies belong to the GC (implementation in all companies/assets was estimated to take a minimum of eight years which is considered outside the scope of this research).

The GC challenges in implementing integrated activity planning and losing value due to inefficiency is a specific organisation problem. It requires a good understanding of the GC business context, organisation structure, stakeholders, and internal dynamics. The research methodology considered appropriate for such industrial research to create a solution to a real problem in a specific organisation through participation and collaboration. The research methodology developed the IAPS framework, which had a very positive implication on three companies. As a result; the IAPS framework was generalised and approved by the GC management to be implemented across the GC, which will have a more significant impact beyond the research project. Action research is about ‘research in action rather than research about action’; it focuses on exploring and evaluating different solutions and promoting change within an organisation. The deep-dive workshops enabled us to develop the IAPS framework and pilot it in three different companies. Participation is crucial in action research, and the quality of discussion and sharing of knowledge was the most significant success factors. The structured deep-dive program proved its appropriateness as it was implemented in three different companies and still delivered the targeted outcome. The deep dive workshop results were consistent, which helped develop different nine elements for the IAPS framework.

To solve a complex industry problem, the organisation needs to believe in the solution and implement it. Since the solution was generated using in-house expertise and through local resources in the GC; it helped to be adopted quickly by the organisation, which is considered another advantage of the research methodology. The organisation showed more ownership for implementation and improvement. Thus, the deep-dive workshops were an excellent technique for organisation change management.

Every research methodology has its challenges; the Action research and deep dive approach's main challenge is the requirement for intensive fieldwork, frequent visits, strong stakeholder’s

management, excellent knowledge in the subject, and outstanding skills in deep-dive facilitation solution's generation. The organisation participants shared issues, experiences, reflected on data, and the researcher facilitated the discussion and conducted data mining and solution's generation. The researcher was always under spot, and understanding the subject was crucial to earn respect for successful research. The organisation recognised the researcher as a subject matter expert and was demanding to learn some useful best practices. Leaders in the organisation were also looking at the researcher as a good change manager and were demanding to learn some proper techniques in change management. Such expectations would need to be considered by any future researcher if he/she decided to use the same approach.

The appropriateness of the Deep Dive approach can be checked if a standard approach was generated and could be used in different companies to elicit the company's requirements, develop the IAPS Framework, implement the IAPS Framework then support the company to deliver improved IAPS performance. In this perspective; the starting point is examining the outcomes of the deep-dive workshop in three case-study companies in different countries with a different context of the business and having different cultures. The researcher chosen such set up is to confirm that the developed deep-dive workshop approach is applicable to deliver similar results. Chapter-4 demonstrated that the outcome of the various deep-dive workshops was consistent. The overall challenges were quite similar, but the specific requirements and focus areas were different. The deep dive approach managed to reveal these similarities and differences, as described in Section 4.3. These workshops' outcome was also utilised to develop the IAPS Framework and later deploy it in the same three case-study companies to improve IAPS delivery.

Asking the local team from the company to lead the discussion in the deep dive workshop and presenting the findings to the senior management team provided the ownership aspects and helped obtain a commitment to implement the IAPS framework. Requesting the local SMEs to participate at a global level in supporting the IAPS Framework's development using their extensive experience instilled a sense of pride in their contribution. Such a positive outlook helped transform the SMEs into the IAPS Framework ambassadors in their own companies. The commitment shown from the SMEs in these three companies was clear during implementation and the confidence in the IAPS Framework that will address the various challenges. They aimed to deliver credible IAPS plans, and the results demonstrated such improvements.

Assigning a senior leader in the company to host the fieldwork and implementation was received very well by all three companies, with the organisation recognising its importance.

The senior leader had also influenced the organisation to participate in all deep-dive workshops and supported critical participants' release to spend quality time.

The deep-dive workshops' structure was clear to follow, and the overall aim and expected outcome were understood by all participants who supported having a fruitful discussion. Interviewing three levels in the organisation provided diverse and useful insight into each level requirements and explained how they view the challenges in IAPS. The introduction and overview of the company operations, challenges, business context, and performance helped the researcher to understand key stakeholders and consider the local content during the IAPS deployment. The IAPS health check was one of the tools used to evaluate the overall IAPS Framework elements. The same health check was used again after implementing the IAPS Framework to measure each element's change and to support continuous improvements in the elements required more attention.

The “voice of the customer” helped deepen the researcher’s understanding of the sensitive gaps that generally do not come to surface quickly without probing such as the relationship between different functions, behaviours, and leadership attributes. At the end of the workshop, the alignment session helped align functions and IAPS team on one list of requirements. This aligned view between all functions in the company helped deploy the IAPS framework smoothly, which was considered a success.

Leadership understanding of the company aspirations, opportunities, main challenges, and expectation about what good looks like in the last workshop ‘integration’ was a premium channel to send a strong message to the organisation on the importance of the IAPS. Leaders should drive cultural change, as good as all company’s leaders aligned on the importance of the IAPS; this contributed to the leaders being consistent on their IAPS related messages to their departmental staff. In the same workshop, the leaders agreed to the value driver of IAPS in their company which was used later as a business KPI to evaluate the IAPS framework effectiveness. IAPS was intended to deliver a credible plan and support the organisation for timely execution, resulting in improved business performance.

While implementing the IAPS framework, caution was required to start fixing the highest priority element based on the specific company requirement. The priority should go to the most significant gap to score some “quick wins” to increase the confidence in the IAPS framework's organisation.

The implementation of the IAPS framework was done also using a standard approach; refer to section 6.2. Such an approach proved its effectiveness in driving a successful implementation; however, it required the researcher to support the company in change management, and

support a smooth transition in applying the IAPS framework elements. During the IAPS framework testing in the three case-study companies; the researcher kept a weekly cadence to ensuring visibility of implementation progress at the leadership level, which enabled the right level of focus and sustained momentum on the change. The IAPS team found this energising and believed it would ensure the importance of leadership, behaviours, culture and process are consistently embedded. The continues communication was necessary as enabled a more robust leader-led dialogue and excellent asset communication. Clarity on a single point of contact on IAPS framework in the company/asset was another important as it ensured that things were moving in the right direction, enabled cross-learning between the teams, and obtained global support when required effectively. There is a risk of reverting to the old ways of doing things. To keep the mindset reset live at the company, the leaders need to refresh the ultimate business outcomes of the IAPS framework and re-emphasises in the golden roles.

The research method's strengths, weakness, and improvements are:

Strengths

- Standard deep dive and implementation approach proved the consistent analyses to identify gaps of IAPS framework elements in different companies and countries. The structured deep-dive workshops are well integrated and complement each other. The outcome was consistent, and hence the research could identify a common theme for each element. The workshops were easy to follow and delivered a structured review program with clear input and output for each workshop.

Weakness

- Quite a hectic review program and requires good experience in conducting various workshop. Special skills required in change management and facilitation; encouraging people to speak up. Good understanding of IAPS, cultural sensitivity and business context is crucial for successful deep dive. The deep-dive workshops depend heavily on the researcher skills, and hence a proper consideration is required before considering such an approach.

Improvements

- Train more facilitators in the standardised deep-dive workshops to cover more companies; supervision is critical to ensuring quality discussion. The quick after-action review at the end of each workshop day was essential but recommended to extend the participation to include other functions leads, which would

comprehensively validate if the intended outcome from the specific deep-dive workshop was met. It would help to re-focus the discussion in missing elements and catch up in the next deep-dive workshop.

In conclusion, using a standardised deep dive approach worked in all three case-study companies and revealed the required information to elicit challenges and requirements. The approach was developed to be used again in any company and should reveal similar outcomes in general with a few specific local content requirements. The research method considered as appropriate for broader implementation within and outside the industry; the structured deep-dive workshops (whether tailoring is necessary) are easy to follow and implement. The critical success factors for IAPS framework implementation and IAPS golden rules can also be generalised and used by other industries; as long the essence is preserved.

The research succeeded in developing a framework for IAPS, implementing it in three different companies, delivering consistent performance, and can be spread over a large number of companies in different countries belonging to a GC. The research developed a standardised approach for deep dive and implementation which can be applied in and outside the industry.

7.2 IAPS Framework strengths and weaknesses

After evaluating the research method's strength, weakness, and proposed improvement; it is beneficial to review the IAPS framework's effectiveness in delivering better business outcome and evaluate its appropriateness to be implemented in other companies. A more in-depth look into each element of the framework, and a summary of the discussion describing the strengths, weaknesses and improvements presented in this section. The evaluation is supported by the results obtained after implementing the IAPS framework in three different companies (refer to section 6.3) to provide more objective discussion.

7.2.1 Direction setting

The direction-setting element of the IAPS Framework was constructed to send a clear message to the organisation about the company strategy, and translate it to executable work through IAPS with clear definitions. The organisation needs to understand the value of the IAPS and how it is supporting the company strategic objectives. This element in the framework was created to address the gap identified in the GC; the organisation did not take the IAPS seriously, and most staff did not recognise its importance or the impact in the business if not executed correctly. Senior leaders did not explain the importance of the IAPS (refer to section

4.3). The direction-setting element supported the three companies' leaders to set up clear expectations which resulted in improving Company-A from a score of 1 to 3, Company-B from 1 to 2.5, and Company-C to 3. Such scores demonstrate that the IAPS framework improved the perspective to the IAPS in GC and the organisation sees IAPS as a critical tool for delivering business objectives, and there is a clear and consistent message about the vision and direction of the business. The full details of scoring requirements of this element using IAPS health check assessment illustrated in APPENDIX-B.

Because of the IAPS framework; leaders communicated the company's priorities and ensured the team has a consistent basis for assessing opportunities through the IAPS process. Through chairing IAPS meetings; they ensured all IAPS activities are checked to meet business objectives included in the ranking criteria for IAPS activities. The three companies integrated plans had a clear objective and a hierarchy reflecting business priorities. The Functions plans were also aligned with the business objectives and signed off. During the discussion of the result with the team; it was observed that IAPS plans definition was understood, and that the IAPS plans were reviewed by relevant stakeholders and approved by the Plan owner. It was also presented during the IAPS meeting. The examples highlighted in section 6.3.1 of challenging significant activities in the plans demonstrated that the IAPS Lead was empowered to change activities in the IAPS, and challenge any work that was not meeting the business objectives. The IAPS lead continued to challenge activities that were not ready for execution when entering the Short-Term IAP (90-days out).

IAPS Framework guidance suggested working with one plan in the company to ensure integration between different functions, which would, in turn, provide a single source of truth. The one plan concept was better implemented within Company-A and Company-C (improved from a score of 2 to a score of 3), which enabled the IAPS team to carry out their mandate as per the IAPS framework. It was apparent that Company-B had more significant improvement (from a score of 1 to a score of 2.5) and continued focus is required in the one plan concept, and integrate the business plan with the MT plan and the ST plan. The three companies' strategic plans indicated major events that provided input to the Medium Term; with a recognition that all three companies should continue the efforts to improve strategic and business planning.

The IAPS Team should conduct a quarterly review during the MT plan discussion, to assess if the activities obtained from the strategic asset management plan, project portfolio and field development plan are matured to the correct level. It is good practice to report how many

strategic asset plans have been enrolled in the MT plan to ensure the strategic plan is in action and will be delivered.

Strengths of Direction Setting element

- Set a requirement that the company should integrate all plans from long term to medium term to short term to integrated schedule to enable timely execution (one plan concept). It helped in driving the integration across different functions.
- Enable the leaders to set clear expectations and accountability for the organisation. As an example; the Facility Manager was held accountable to ensure all activities from different time horizons should be included in the Integrated plan and be ready for execution.

Weaknesses of Direction Setting element

- In case the strategic plan is not available, then the medium-term plan will lack detail and miss the translation of strategic plan to action through IAPS. Such a challenge jeopardises the essence of one plan for the asset, which in turn would affect the business outcomes. It was well known that the medium to long-term plan is primarily responsible for profit-making, and if this is missing, then the efforts will be limited to short term execution. There is a dependent factor of having high-quality strategic plan & business plan to ensure better plans integration. The direction-setting needs to emphasise in such a critical requirement.

Improvements to Direction Setting element

- The leaders should address any gaps observed in strategic plans to ensure IAPS translate strategic activities to delivery. The IAPS framework should explicitly include a quality gate check before transferring strategic activities to the MT plan. It would help to mature the right activity to IS in which execution happen to ensure activities delivery. The better is the quality the MT plan; the better is the business outcome. Embrace the Business plan, and MT plan robustness KPIs making it visible will drive the organisation for better IAPS plans integration.

7.2.2 Organisation structure

The organisation structure element's focus was to establish clear rules and responsibilities for the IAPS organisation to deliver IAPS plans. The organisation structure element aimed to link the IAPS leader to report to the Asset manager to secure the required influence to implement

IAPS criteria. This element in the framework was created to address the GC's gap; there was no standard approach in designing the planning organisation structure. In many cases, the organisational structure did not support integration, creating silo thinking within functions, rather than integrated thinking. The roles and responsibilities were not defined (refer to section 4.3). Implementing the IAPS framework supported Company-A to improve organisational structure from a score 1 to a score of 4. Company-B from a score of 2 to a score of 3 and Company-C achieved a score of 3. Such scores demonstrate that the IAPS framework improved the perspective to the IAPS in GC and the IAPS roles and responsibilities were clearly defined and documented. The responsible parties' roles and responsibilities were communicated with up to date job descriptions, and the roles were adequately resourced to deliver the right IAPS plans.

The proposed structure in the IAPS framework (refer to Figure 5-2) helped the companies to deliver quality plans; however, missed an important link between the IAPS organisation structure and other processes structures. Several critical roles significantly influence how the IAPS process is implemented in an asset such as Functions Planners, Work Preparers, Work Executors, Production Support Engineer, Budget Holders, and Resource Owner. These roles and their interfaces were identified in the IAPS framework. However, during the IAPS framework implementation, there was an apparent strong relationship between IAPS and several other processes (such as the IAPS and SCM; refer to section 6.3.2); the interfaces exceeded the roles and required more data and processes integration. As an example, the IAPS process has a strong relationship with the supply chain process, which manages critical resources (e.g. trucks, helicopters, vessels) that should be shared by multiple activity owners.

In most cases, these resources are constrained to maximise the utilisation. The IAPS team should meet regularly with the supply chain team to discuss changes to the critical resources, and provide detail of the resource demand over the coming two years, including risks and opportunities to enable the supply chain team to come up with accurate supply profile. Failing to develop the demand profile before the business planning cycle can jeopardise the value of integration and reserve valuable resources that can be optimised. The forecast and plan production process also interface with IAPS. The production forecast is built yearly during the Business Plan process and updated monthly. The IAPS process has a strong relationship with the Forecast and Plan Production process, as managing production impacting activities is a critical component of the IAPS process. The scheduled deferment is one of the components of the Production Forecast latest estimate and is supplied by the IAPS Planner. If new deferring activities emerge in the Short Term IAP window, the IAPS Planner should contact the Production Support Engineer to investigate the best opportunity to execute this scope, as

Production Engineering is responsible for meeting sales commitments. The Integrated Schedule has a strong relationship with the Maintenance Execution Process, as most Integrate Schedule activities are related to maintenance execution. It is critical for an effective IAPS process that the Integrated Scheduler and Maintenance Scheduler work closely together. In a small organisation, these two roles could easily be carried out by a single person; however, it may be necessary to split the roles in a large organisation. In this case, the collaboration between the maintenance execution and integrated schedule should be carefully managed. It is recommended to keep both staffs operating jointly together, ideally in the same office, and attending daily and regular weekly updates.

Strengths of organisation structure element

- The proposed IAPS organisation structure in the IAPS framework focused on delivering the IAPS process and ensured a quality handover between different time horizon planners. It also brought standardisation across all companies belonging to the GC.
- The proposed organisation delivered one single accountability under one Planning Manager, who is directly reporting to the Operation Manager or Asset Manager and use their power to influence the organisation. It helped in re-positioning the IAPS within the asset leadership to drive change and influence functions planners.

Weaknesses of organisation structure element

- For better integration between the IAPS planners and other rules in the organisation; it requires expanding the proposed IAPS organisation to stipulate other functions that influence the IAPS process. The challenges observed in linking the business metrics to the IAPS process resulted from missing an adequate alignment between the IAPS process and other processes in the same asset. Not having these functions mapped clearly to the IAPS organisation structure makes the integration and flow of data challenges.

Improvements to the organisation structure element

- Develop a clear link between the IAPS organisation and other functions organisations. The link and data flow should be explained to help the different part of the company organisation work flawless and improve overall company business delivery. IAPS is considered the company's integration tool; such clarity to include

other influential functions and link their processes to IAPS would holistically improve the efficiency across all functions in the company.

7.2.3 People

Training, coaching and succession planning are the main deliverables of the People element of the IAPS framework. This element in the framework was created to address the GC's gap; there was an apparent demand for a training matrix to ensure competent planners carry out critical planning activities (refer to section 4.3). The people elements proposed training and coaching program, as described in Figure 5-3 IAPS Training Programme. The training and coaching were implemented in the three case-study companies. Evaluating this element's effectiveness by looking at the three case-study companies after implementation revealed that Company-A improved in people element from a score of 2 to a score of 3. In contrast, Company-B and company-C maintained a score of 3 and 4, respectively. The coaching was improved Company-A and scored 4, Company-B scored 2.5, whereas Company-C achieved a score of 3. Such scores demonstrate that the IAPS framework improved the IAPS resource competence and development in the three companies. There was an adequately staffed IAPS organisation championed by asset leadership and staffed by competent individuals with clearly defined roles. The Job Competency Profiles (JCP) and individual training plans designed to close Job Competency Profiles gaps were in place and linked to the global IAPS training staircase. Through a different training session, the feedback received from different participants was positive. The training helped improve the staff competence to do a better job by understanding the IAPS process details and being master in Primavera P6. The planners acquired skills in managing interfaces, facilitate IAPS meeting, challenge data and optimise plans. The job description was considered a significant improvement to specify IAPS requirements to deliver the IAPS planner role, which was created after implementing the IAPS framework. Most of the planners had completed their competence assessment with an agreed gap closure plan in place. There were clear objectives for personnel performance, and training was being provided to all new IAPS planners. During implementation, an adequate transition time between outgoing/incoming IAPS leads in Company-A enabled a quality handover, and staff have been trained to use the IAPS tools.

Succession planning was done in the three case-study companies for key IAPS roles, and potential candidates were identified in advance. Staff development, training and succession were regularly reviewed to identify improvements in cooperation with HR. The company’s senior management provided a clear pathway to further career development opportunities for successful IAPS staff. There was a clear employee value proposition in place for all IAPS

positions, and this subsequently was successful in attracting top talent and perpetuating the importance of IAPS. The role was seen as a crucial foundation for future business leaders.

Further improvement was required in relation to the formal coaching programme: it was identified that IAPS practitioners required more on the job coaching to gain the necessary skills. Some planners did not get the time required to dedicate for quality coaching due to the work pressure. The was a gap in having quality coaches in the three companies; some IAPS leaders and senior managers have less coaching experience and consequently needed more training. It had been identified as explicitly impacting Company-B. Some of the coaches did not spend the required amount of time coaching their staff, and such requirements were not reflected in the staff performance report.

Strengths of the People element

- The IAPS framework developed and provided a simplified training matrix with more focus on practical knowledge and problem-solving, which enhanced IAPS planners' competence.
- The concept of "rain the trainer" supported the global SMEs to extend the training to different assets simultaneously. The standard training pack was more comfortable to be taught, and hence more resources could be deployed.

Weaknesses of the People element

- Coaching requires skills in the ability to guide and support. In addition to the technical knowledge of the IAPS; personal & leadership's attributes are required to be demonstrated by coaches. Such requirements were not stipulated in the IAPS framework People element.

Improvements to the people element

- It is suggested for the GC to specify the coach's selection criteria and support to develop more coaches. Such requirements can be included in the company HR system.

7.2.4 Process

The IAPS process is the core element of the IAPS Framework. It describes the step-by-step process to build functional plans, integrate activities, optimise the plans, and approve and communicate. The IAPS process also stipulates the foundation required to deliver an effective plan. This element in the framework was created to address the GC's gap as the IAPS process

was not standardised all assets detailed IAPS process was quite different. The heat map demonstrated how each asset followed a different number of steps (refer to section 4.3). After implementing the IAPS framework; Company-A improved in process element from a score 2.2 to a score of 3.2, Company-B from a score of 2 to a score of 3 and Company-C from a score of 2.2 to a score of 3.1. Such scores demonstrate that the IAPS framework improved the perspective to the IAPS in GC and that the process steps were precise and had been easy to be followed.

The first delivery of this element was to support the planners understanding the different blocks of the process and follow a step-by-step procedure to produce an integrated activity plan and schedule. The three companies met the minimum requirements of this element. Company-A and Company-B's functions' plans were submitted from all the relevant functions that impact the asset's operations and production. These plans were checked to ensure alignment with the business targets set for each company. The functions submitted plans following the IAPS inclusion criteria, with Activity Readiness status and mitigation plans to address the associated risks. The functions' plans were established to have the level of detail required for the given plan horizon and were subsequently signed off by the Functional Plan owner before submission. The activity details underpinning the Functional plans were consistently available and recorded, including the preparatory activities, associated resources, timescales, constraints and production impacts. These details were essential for activities integration and resources optimisation. During the IAPS implementation; functions observed to continuously improve their planning process after discussing the plans in a functional planning meeting. More efforts are required in Company-C; the Functional plans were not always updated and submitted as per the IAPS planning calendar deadline; this in-turn affected the quality and timely delivery of IAPS plans.

Three different time horizons were produced for the three companies' plans; however, the integration between the three plans faced challenges due to a lack of MT plan availability or poor quality of detail within the plan. As per the IAPS framework; the MT IAPS supposed to form the basis of the first two years (at a minimum) of the Business Plan submission. It was not the case in all companies; for example, the Company-B did not include all significant MT plan activities from business plan apart from the turnarounds. The IAPS Planner and activity owners, with the support of the functional planners, continued to mature, prepare, prioritise, and packaged activities into the plan to ensure execution. The Medium-Term plan's focus was more on the readiness of, and confirmation of, month four activities to meet the Short-Term Activity Readiness Criteria to move into the Short Term Plan. Once month four activities have been reviewed, ranked and prioritised, readiness criteria met and confirmed, month 4 of the

Medium-Term plan was handed over to the Short-Term IAPS for integration into the next Short-Term planning cycle. In all three companies, it was observed that this process did not operate smoothly; it required significant effort from the ST planner to fully understand the MT plan activities and link to the business plan. It indicated the importance of explaining the business plans to target all IAPS planner beginning of the year and invite them for a good discussion.

The ST plan's focus was to prepare, mature, and package activities in the ST IAPS plan to meet the Integrated Schedule readiness criteria. The ST IAPS Planner highlighted and addressed specific support requirements and areas of concern that may impact execution. As the company used SAP and Primavera P6, it was quite easy to monitor activity maturation. The planner checked that work orders were ready for execution, i.e. work orders detailed all activity elements to be carried out on the facility, and included labour, materials and service requirements. The ST IAPS planner then handed over activities in the Short-Term plan that have met the Integrated Schedule readiness criteria to be scheduled, resource levelled, work confirmed with executors and the schedule confirmed and approved. The ST IAPS Planner held a monthly pre-meeting with activity owners, functions planners and function leads to review the readiness of activities to meet the acceptance criteria (AR criteria) and confirm activity prioritisation to be accepted into the IS. The outcome of that review was a proposal for each activity and indicated either: *"Regret", "Recommend for Execution",* or *"Not Ready"* to be reviewed at the IS meeting.

Before the work could advance into the Integrated Schedule, the Scheduler, Plant Manager, and ST IAPS Planner reviewed the incoming activities every week during the Integrated Schedule meeting for acceptance. The Plant Manager would approve work that passed the readiness criteria, and assign actions to address any exceptions. The main challenge faced during process implementation was to confirm the Integrated Schedule with executors and receive approval from the field team. The process dictated that the scheduler should provide the next week of the Integrated Schedule to the field technicians and job executors required to do the job to verify appropriateness and resource loading. Their feedback was incorporated into preparing and updating the final schedule, which was then locked down. Getting the field operations team to confirm their readiness to accept IAPS activities to be executed on their facilities was crucial. The field operations team commonly rejected oil or gas deferring activities at the last minute to ensure that they met the daily production target. The dynamics of daily operations was well understood, and hence having such discussion during the 90-day plan provided more assurance for plan stability. The IAPS planner, in conjunction with Field Operations, should highlight the operation's readiness, e.g. Permit to Work, isolations,

worksite inspections, operations resource availability to support execution. Mitigation plans were put in place to ensure that the activity could be executed in line with the plan if any operations readiness gaps were identified. During the integrated schedule delivery, the Facility Manager could manage a minor change to ensure a balance between the daily production target delivery and activities executions as per approved plan. There were many changes in all three companies, and hence the advanced alignment and engagement during the 90 day Short Term plan discussion was regarded as good practice for better IS delivery.

The site team reviewed the Schedule to ensure that all work scheduled for the following week was achievable and permit preparation was progressing, all work scheduled for week two was understood, and all materials required for week three work were on-board and correct. Following the Integrated Schedule meeting, the Integrated Work Scheduler should update the current schedule to reflect the outputs and actions arising and the Work Order status updated to:

- "RELEASE" where a gate action is outstanding, and the action is communicated to the action owner
- "EXEC" where no further actions are required

Resource loading is one of the success criteria for IS delivery—the Company-C has chosen to improve material delivery to improve capital efficiency (refer to section 6.1). Estimated resource requirements and forecasts were incorporated in Company-C, which enabled them to bring more visibility to material movement. As a result; the activity details underpinning the functions plans were recorded with associated resources, timescales, constraints and production impacts. It enabled better alignment between the ST IAPS and MT IAPS over time. Such improvements were demonstrated in Figure 6-7.

From a Change Control perspective, during IAPS implementation, all three companies implemented the process. The change control is explained in details in Figure 5-6 and Figure 5-8. All changes were registered and controlled following the change control process which enabled a good discussion around it, get approved by the right level in the organisation, align all stakeholders on the requested change, and take the right measures to improve further. It was the first step for improvement; the IAPS Change Control process was in place and adhered to authorise changes to the approved IAPS plans. Relevant changes to IAPS activities in the Functions' Plans have followed the Change Control process and were communicated to all impacted parties. All changes to IAPS plans take account of the impact of the change, have proper offsets of resources established and are authorised by the agreed authority (plan owner). From a control perspective, the process worked; however, more focus is required to improve

the quality of activities details to reduce the number of changes in the three companies. Such a significant number of changes impacted the ST plan stability.

Strengths of the Process element

- The IAPS framework (process element) provided a consistent approach to building an integrated activity plan and schedule in any asset. Such process enabled standardisation across all GC and allowed to conduct a performance review continuously. A standard process will also allow a better knowledge transfer between various companies in the GC.
- The IAPS framework (process element) established a reference point for future improvement; the process was presented in sequential blocks which were easy to follow. The process also established clear responsibility which should what and when.
- The IAPS framework (process element) improved the alignment between the activity planner and executor. Such alignment is crucial to ensure timely and quality execution. The process dedicated a specific block to check the site readiness for execution and demanded field team acceptance before approving the plan.
- The proposed KPIs made the issue of plans handover very visible as each plan owner want to defend his plan performance. For example; if the ST plan stability is low, then handover the plan to IS should raise a question of accepting it. This transparency is healthy in such a dynamic environment where business outcomes take priority.

Weaknesses of the Process element

- Although the process demand for explicit assumptions to the IAPS plan from functional planner; this was not sufficient, and most of the times were not provided which made the discussion and challenging the plan quality quite tricky.
- In different occasions and during execution it was observed some last-minute changes which question the robustness check. It is not aligned with the process which demands adequate alignment between the activity planner and executor after providing clear scope, robustness check, and fully resources plan. All risks and mitigations to execution should be discussed and agreed.

Improvements to the Process element

- To ensure a better quality of the functional plan; the functions' leadership requires to sign-off the plan to demonstrate the ownership of the functions' plan before submitting it for integration. Signoff means that the Function's Manager confirms that their plans meet the Business and Function's Targets and that the plan complies with IAP requirements. During the IAPS implementation; most of the functional plans complied with the IAPS requirements; however, mitigations should be explicitly discussed for the activities that do not meet the activity readiness criteria. Such discussion will improve the robustness check and enable timely execution.
- Function's plan norms and assumptions need to be validated as these norms and assumptions are used to build Functional Plan. The function planner should challenge the activity owner and ensure the latest and most accurate data is used. The rationale behind this is to ensure that the Functional Plan is robust, competitive, benchmarked and incorporated with agreed functional planning process improvements. The use of historical data to perform a trend analysis when developing base planning assumptions is recommended, as well as the use of industry norms and standards, and best practices.
- In testing the robustness of mitigations; their related actions should be challenged to validate that the robustness will improve and ultimately, the activity will be executed on time. Sound mitigation should result in declining or improving the risk of execution and plan delivery. The discussion should focus on mitigation outcome and its related action rather than the mitigations themselves.

7.2.5 Data for the planning system

The IAPS Framework Data element describes the level of detail required for each IAPS plan that should be entered into the planning system. This element in the framework was created to address the GC's gap; the data owner was missing, and data quality did not follow a precise protocol. There was no standard set of data to ensure consistency across all functions and enable software integration (refer to section 4.3). Evaluating this element's effectiveness by looking at the three case-study companies after implementation revealed that Company-A improved in Data element from a score of 2.5 to a score of 3, Company-C from a score of 1 to a score of 2.5 whereas Company-B became more stringent and maintained a score of 3.5. The Company-C scored 2.5 because not all spare parts and material were updated in SAP, and a project was initiated to update the asset register. In general; all three companies improved in the data element. Such scores demonstrate that the IAPS framework improved the perspective

to the IAPS in GC and the Functions and their planners hold their activity planning data at the level of detail prescribed at each planning level. The activities associated with all projects were defined within Primavera P6 using the mandatory fields: Activity Unique ID, Activity Name, Plan: MT or ST or both, Planned Start Date, Planned Finish Date, Asset, Facility, Function, Activity Readiness Status, and Shared Resource. It allowed the IAPS planners to retrieve the related activities as per the inclusion criteria and integrate their plans. The data quality standards were communicated to all relevant IAPS and function planners, and activities submitted in IAPS were checked monthly against the data quality standards. The assurance review for the data quality was documented for future references which would help in understanding main gaps and improve further. IAPS planners were in control of the planning data; any change to the activities in the approved IAPS is done through the Change Control process and approval of the IAPS planner. The Data element not only specified the mandatory fields but also provided the full authority to the IAPS planner to accept or reject.

The example of the level of detail within each plan's horizon as prescribed within the IAPS Framework (refer to Table 5-2) was received well by the case-study companies IAPS planners, as it supported the creation of a shared understanding of each planning level required for different time horizons.

Strengths of the Data element

- The IAPS framework (Data element) provided standard data required for the planning system, which enabled integration at a low level. Such data availability was a must to have for the IAPS planner to aggregate and integrate resources for execution. Some companies in the GC were using Primavera P6 as the planning system but not efficiently used because there was no clear mandate for which data and at which planning level should be entered. The Data element covered that gap, and the IAPS framework dedicated a specific section to explain the data requirement (refer to section 5.6).

Weaknesses of the Data element

- The IAPS framework demanded that the data owner be assigned to each company. However, this role was not yet formally assigned within the IAPS team and functions planning team in all three companies. Such delay to resource the role with a competent staff will impact the data quality sustainability as data check consumes long hours of work to assure compliance.

Improvements to the Data element

- The company IAPS council should officially assign a data owner and ensure proper training and coaching to address the above-observed weakness in Data element. The data owner importance is not less than the process owner whom all works as assurance bodies for quality of IAPS execution.

7.2.6 IAPS planning systems

The IAPS framework provides guidance with respect to using Primavera P6 as the planning system that should be integrated with the company ERP system. In the GC, the ERP system used was SAP in which the IAPS Framework developed an interface to connect to Primavera P6 through a system called Impress. This element in the framework was created to address the GC's gap as the planning systems were different in each asset, and the integration between tools was missing (refer to section 4.3). Implementing this element supported Company-A to improve in Planning Systems from a score 2.3 to a score of 3, Company-B from a score of 2.6 to a score of 3.5 and Company-C maintained a score of 3.3. Such scores demonstrate that the IAPS framework improved the perspective to the IAPS in GC; all three companies' Functional Plan resided in the IAPS planning database (Primavera P6) to support effective integration.

The advantage of providing integration between Primavera P6 and SAP was to reduce the planners' manual data entry, which adds overhead and imposes data quality risks due to human error. The interface between the planning and ERP systems should automatically retrieve the Asset Register's information within SAP into Primavera P6, to group all activities under the right Functional Plan. From the IAPS health check results, Company-A scored 2 for system integration sub-element and 3 for IAPS KPIs calculation. The reason for scoring 2 in system integration was that it did not provide this level of integration between SAP and Primavera P6. The maintenance function of Company-A perceived risk of transferring all maintenance activities to Primavera P6 at this stage and wanted to do a data quality in the asset register before moving on this direction. Company-B scored 3.5 and Company-C scored 3.0 as both companies had utilised the interface between Primavera P6 and SAP. As a result of implementing this integration, Company-C discovered large volumes of low-quality data in the asset register, particularly in the material stock level, which resulted in initiating a project to improve the SAP data quality. In both Companies-B and C, the integration between Primavera P6 and SAP fostered efficiency and eliminated discrepancies as the Functions' planners provided plan information into a standard solution allowing the management of IAPS to be performed in a single tool. Knowledgeable users are in place and known within the

organisation with a clear IT training guide. The system custodians are known at the company and group level.

Strengths of the IAPS Planning System element

- A fit for purpose planning system was a prescribed part of the IAPS framework to enable standardisation across the different assets. It was imperative to the GC avoid changing the ERP system, bringing additional complexity and cost.
- The appropriate integration between the proposed planning tools (SAP, Primavera P6, & Impress interface) supported the data transfer and improved efficiency. The proposed Impress interface in the IAPS framework proved its effectiveness in enabling transparent performance metrics which resulted in improved IAPS quality.

Weaknesses of the IAPS Planning System element

- Not all assets might accept the adoption of the proposed planning systems (SAP, Primavera P6, & Impress interface) due to cost implication, making the integration for the planning system challenging. It will also affect KPI measurement as the IAPS framework required assets to use the global dashboard, which is linked to Primavera P6. The asset's decision in which planning tools should be used is always commercial, and the global SMEs should help make the package more attractive. There was also some perception that integrating SAP with Primavera P6 would transfer inaccurate data into the planning system and make it difficult to manage.

Improvements to the IAPS Planning System element

- Produce a more attractive package for all asset to use the global planning tools set or provide free cost. Such cost can be absorbed by the GC, especially for the dashboard. The benefit of deploying the global planning tool is much higher than the cost of development. Such internal arrangement within the GC can help to overcome the cost challenge.
- A standard work process description based on global layouts will better understand how the connection between SAP and Primavera P6 works. It will enable different functions to get an assurance of transferring the required data only. It also brings the opportunity for data cleaning and SAP asset register update.

7.2.7 Culture

The IAPS Framework emphasised the importance of building the right culture, knowing that integrated planning results from full organisation collaboration, proactiveness, and discipline. The framework's culture element proposed tactics and a list of critical success factors to highlight the importance of having the right culture. This element in the framework was created to address the GC's gap; a firefighting and reactive culture rather than proactive measures. Such acts encouraged the wrong behaviour, with the planning team feeling that they had been left behind. The GC's focus was more in production rather than quality planning (refer to section 4.3). After implementing the IAPS framework; Company-A improved in culture element from a score 1 to a score of 2.5, Company-B from a score of 1 to a score of 2 and Company-C from a score of 1 to a score of 3. Such scores demonstrate the improvement in the culture in the GC with a recognition that cultural change can take significant time to see a difference; it needs persistence and patience. The seven critical success factors proposed by IAPS framework helped the leaders drive culture transformation; leaders within the company create the culture, and similarity of Company-A scores for leadership and culture reflected this relationship (leadership was 2.5 and culture was 2.5). It was also observed within Company-B results (leadership was 2.5, and culture was 2). There were evident efforts in the three companies to execute Critical Success Factors (CSF). The CSF was embedded and applied with various intensity; example the non-compliance with IAPS CSFs was dealt with more rigorously in Company-C by reviewing the compliance with each function manager and hence the culture element improved by 2 points within the 12 months.

In contrast, the Company-A needed to develop more in leadership visibility and commitment and work on IAPS integration with other processes. Company-B needed to develop more leadership commitment, change control, and ensure the one plan concept. These CSFs allowed the leaders to create clear expectations of how the organisation should work around the IAPS process and provided the change management technique to drive behaviours and clear ownership and accountabilities for the IAPS process.

Making the performance KPIs visible was an important step to change the culture and push for improvement. The IAPS Performance KPIs in the different plan horizons contributed to improving the IAPS process compliance by enabling the asset to understand their plan value and probability to move to the next plan horizon before transferring it for execution. People were held accountable to deliver their roles' requirements, and IAPS performance excellence was subsequently recognised.

Plan owners were identified for each time horizon and demonstrated accountability for the plan contents and delivery as per the IAPS process (refer to section 5.5.2). Risks associated with the plan's delivery was discussed during IAPS meeting and managed during execution by closely following up progress at the site. Evident commitment in the Company-C from the plan owners who chair various IAPS Plan meetings as per the meeting TORs. The meetings held were purposeful with clarity of intent and took decisions to deliver the plan. The IAPS lead was regularly engaged with the Asset Leader and was seen as a valuable aid to their work, bringing insight and exact value.

Strengths of the Culture element

- The IAPS framework proposed that CSF supported the three companies in transforming the culture and the intent and tactics they found very useful. The CSF has allowed for a standardised approach in which exchanging the knowledge and experience across the three companies became easier.
- Data visibility brings insight and insights to bring action and action drive behaviours; such tactic was proposed by the IAPS framework and supported the companies to drive ownership. The visibility of performance management enabled the leaders to drive a constructive discussion and focus on what can be done extra to improve business outcome.
- Clear meeting structure and effectiveness measurement supported the organisations to continue improving IAPS performance and activities delivery. It was also reflected in the companies improved business outcome.

Weaknesses of the Culture element

- No company should be entirely a KPI motivated. Hence, extra caution is required to manage wrong behaviour to avoid unintended consequences, e.g. opportunities which add significant value to the business with low associated risk and impact should not be rejected after applying for change control because they will impact the IAPS compliance KPI. Equally, an activity which is not wholly meeting the AR criteria can be included in the IAPS plan as long the risk is managed using the threats and opportunities register/action list

Improvements to the Culture element

- The IAPS Performance Analyst should analyse the KPIs, and learnings with improvements should be identified. The knowledge gained from this should be

discussed in the IAPS meetings and, if possible, action party should be assigned. The motive is not the KPI but the overall business outcome. It was identified that good practice was to organise regular visits to other assets and companies to share and learn from each other.

7.2.8 Leadership

Leadership in the IAPS Framework should create cultural change from leading by example and showing commitment through chairing IAPS meetings, ensuring full attendance, particularly by activity owners, observing the work, asking the right questions, and coaching IAPS personnel. Leaders should create an environment that provides access to information and supports decision making. This element in the framework was created to address the gap identified in the GC as Leadership lacked clarity in decision-making with regards to planning choices, and most of the time did not attend the IAPS meeting. Such behaviour sent the wrong message: that IAPS meetings were not necessary. There was no clear guidance on how to manage planning meetings and who the chair of the meeting (refer to section 4.3). This element's effectiveness can be checked by looking at the three case-study companies after implementation of the IAPS framework, which revealed that Company-A & Company-B improved in leadership element from a score 1 to a score of 2.5 whereas Company-C from a score of 2 to a score of 3. Such scores demonstrate that the IAPS framework improved the leadership element in GC and leaders recognise IAPS as a critical tool for delivering the business outcome.

Leadership is at the heart of the IAPS framework; every other element has some relationship with leadership. It is crucial to set clear rules and hold the team accountable to deliver. The IAPS framework successfully introduced control points such as Inclusion Criteria, Activity Readiness (AR), Ranking Criteria, Meeting Effectiveness requirements, and the Asset Calendar. There was a gap in the literature related to such explicit control points to ensure the IAPS process's effectiveness. The deep-dive sessions within different assets also revealed the urgent need for such controls to support assets in delivering quality plans.

The leadership element minimum requirements demand that leaders be purposeful, clear in intent, passionate about outcomes, and can clearly articulate what good looks like for their companies' IAPS performance. During the IAPS framework implementation, leaders in the three companies were more involved in IAPS discussion and connected to their teams. They articulated their vision, built connectivity across sites, and developed pride in the site, department and work to create a sense of family. The leaders also recognised the achievements

of good team in following a robust integrated plan, and when needed, they applied consequence management on those that did not comply with the IAPS process.

Leaders should inspire through personal integrity, transparency and humility and lead by example. They balance authentic expression with curiosity to learn and take personal risks, encouraging the team to open up and share challenges. The leadership within the three companies created the right system to have access to information. The Inclusion Criteria to decide which activity should be included in IAPS plans was implemented. The IAPS framework helped define such criteria to enable the assets to integrate those activities impacting the business delivery. The criteria were communicated to all functions to get their agreement. As a rule; there should be no function planner who is not aware of such inclusion criteria. The criteria were improved further to include activities from third parties and integrated service contractors such as LNG, gas plants, pipeline companies, and oil terminals that may impact production outages or shared resources. The following additional guidelines have enabled the assets to flag activities as being IAPS relevant:

- HSSE: safety-critical activities, e.g. those related to major accident hazards or addressing risk.
- Production Impact: activities which have a production impact, e.g. greater than 1% of Integrated Production System Capacity or 300 BOE/day.
- Critical Shared/Constrained Resources: activities that require access to critical or constrained resources, for example:
    - Additional transport requirements, e.g. helicopter/flight seats over and above those allocated for the core crew rotation schedule.
    - Critical equipment which requires the use of, or impacts equipment such as crane and crane barges, workboats, supply vessels, survey vessels, support vessels, fast crew boats, helidecks, and lifeboats.
    - Deck space and material movement requirements require material to be delivered to the site or access a significant deck space area. However, they do not include planned movement of production chemicals, regular maintenance inventory items, food boxes, long-lead material or any other regular material delivery arrangements.
    - The additional workforce from vendors.
    - PoB (bed space); any activity requires additional bed space at the site.

Concerning Activity Readiness (AR); the criteria were clearly defined and agreed by functions, working well in all three companies and improving the IS delivery. The AR criteria were used consistently by function leadership in team meetings. When receiving activities from functions for inclusion in the IAPS, the IAPS planner checked the AR status's quality. Functions might consider the activity ready in terms of preparation, but the IAPS planners were to discover clashes with other functions. In that case, the IAPS planners changed the AR status to partially ready to ensure the activity will be discussed in the next IAPS meeting. The IAPS Framework successfully supported the assets to define AR as per the following:

- The minimum requirements AR in MT IAP is related to Opex Activities and budget approval for the first year of the submitted Business Plan.
- The minimum requirements AR for entering the ST IAP are the following in which should be delivered four months before starting the activity execution:
    - Projects and Modifications: Ready for Construction (RFC) package is issued per construction window, including specific pre-Shutdown and post-shutdown activities.
    - Drilling: Final Investment Decision taken which is required to include the drilling activity in IAPS plans.
    - The Well Services non-routine activities: the proposal was signed with detailed scope and resources.
    - Turnaround activities: construction work packs signed and Work Order (WO) approved.
- The minimum requirements AR for entering the frozen month of the ST IAP:
    - Execution Coordinator (activity owner/job owner) assigned and confirms plan is appropriate.
    - The budget confirmed, e.g. Final Investment Decision was taken.
    - Shutdown scope approved by the Turnaround Coordinator.
    - Execution Team confirmed (resource coordinator contacted if required).
    - Vendors confirmed (vendors contacted if required).
    - No issues were experienced with Operations support (Operations were contacted if required).
    - Unusual activities, e.g. radiography, is discussed and approved by Operations.

- All materials and equipment are confirmed on time delivered at the store.
- Additional for Modifications and Projects: work packs are issued before the ST meeting that freezes the next month.
- Additional for Maintenance and Well Services: work orders are at least at status: “Awaiting Release” and approved before the ST meeting.
- Additional for Well Services: Wells programme is issued before ST meeting.

Activity Readiness is about actual readiness for each time horizon before activities can proceed to that horizon. If activities do not meet the set criteria for that time horizon, they were either rejected (not included), or included with clear mitigation and approved by the time horizon plan owner to get them ready in time. If this was not possible, they should be rescheduled to a different time in the plan where they meet the readiness criteria. More work will be needed from the three companies’ leadership to be disciplined to the use of AR criteria.

Leaders are also decision-makers; they should ensure fast and quality decision making in the organisation. The right governance systems were put in place to ensure that the right people were involved at the right time, with data and metrics leveraged through visual management. Ranking Criteria was one of the tactics proposed by the IAPS framework. It was is used by the three companies when activities of different functions clash. The objective of ranking activities was to determine which activity provided the most significant gain and the least challenge by considering the added value of executing the activity and its feasibility. The ranked values helped the leaders to take the right decision, but it is essential to emphasise that the ranking criteria should not be applied for all activities but should be used only when there are conflicting activities.

The assessment of Meeting Effectiveness was another approach within the IAPS Framework under the leadership element. IAPS is about decisions; therefore, the IAPS meeting should present clear data to enable the leader to make the right decision. Pre-meetings were held between IAPS planners and functions to share information and explore the impact on IAPS plans. These pre-meetings contributed to improving the main IAPS meeting efficiency. Effective IAP pre-meetings were vital to the integration step. Preparation for the IAPS meeting included a pre-reading pack, a summary of the key issues to be addressed, a table of proposed changes to the previous plan with reasons why and impact assessments, a copy of the plan with associated resource were done in the three companies. Such preparation and using the meeting effectiveness scorecard helped in improving the IAPS meeting across all three companies.

Non-compliance to IAPS CSFs and golden rules (refer to 5.9.1) was dealt with more rigorously in Company-C with the culture element improving by 2 points over the 12 months. These critical success factors helped the leaders set up clear expectations of how they should work around the IAPS process. They provided the change management technique to drive behaviours, clear ownership and accountabilities for the IAPS process players.

Strengths of the Leadership element

- The leadership element played a crucial role in supporting the effective IAPS framework implementation by driving asset business results. This element was a knowledge gap, and the IAPS framework filled the gap through practical implementation.
- The proposed tactics of creating data visibility (Inclusion Criteria, Activity Readiness, Ranking Criteria, Meeting effectiveness, and Golden Rules to drive behaviours) worked well and became a standard approach to strengthen leadership in the GC.
- Effective decision based on transparent information played a significant role in delivering the company strategy, improving business performance and ultimately creating value.

Weaknesses of the Leadership element

- Too many details need good focus and attention; it required continuous effort for alignment and followed up. This appeared exhausting for leaders, mainly when they took this role on top of their day to day delivery.

Improvements to the Leadership element

- It was recommended to carry out a customer survey every year to review if the leadership tactics remain fit-for-purpose. Alternatively, the Process Council part of the continuous improvement cycle can provide feedback for further improvements.

7.2.9 Summary of IAPS Framework structure

This research has developed the IAPS framework validated in three different case-study companies that belong to the GC. The key strength of the IAPS Framework is that it was developed to address all of the gaps identified in the GC as a result of the deep-dive workshops, and proved its effectiveness and impact on the company's business outcome and IAPS process KPIs. All eight elements of the IAPS framework (direction setting, organisation structure,

people, process, data, system, culture, and leadership) showed improvements after implementing the three case-study companies' framework.

The Strengths of Direction Setting element was setting a requirement by the GC to all companies belong to the group to integrate all plans from long term to medium term to short term to integrated schedule to enable timely execution (one plan concept). It helped drive the integration across different functions and enable the leaders to set clear expectations and accountability for the organisation. The improvement required in the direction setting element is to emphasise in developing high-quality strategic plan & business plan to ensure better plans integration. In case the strategic plan is not available, then the medium-term plan will lack detail and miss the translation of strategic plan to action through IAPS, which jeopardises the essence of one plan concept.

The strengths of the organisation structure element were that the proposed IAPS organisation structure in the IAPS framework focused on delivering the IAPS process, and ensured a quality handover between different time horizon planners. It brought standardisation across all companies belonging to the GC and delivered one accountability under one Planning Manager. It helped in re-positioning the IAPS within the asset leadership to drive change and influence functions planners. The organisation structure element needs to expand the proposed IAPS organisation to stipulate other functions that influence the IAPS process as this will support better integration between the IAPS planners and other rules in the organisation. Not having these functions mapped clearly to the IAPS organisation structure makes the integration and flow of data challenges.

The strengths of the People element that provided a simplified training matrix with more focus on practical knowledge and problem solving enhanced the competence of IAPS planners. The concept of “rain the trainer” supported the global SMEs to extend the training to different assets simultaneously. The standard training pack was more comfortable to be taught, and hence more resources could be deployed. The People element needs to improve in specifying the coach’s selection criteria and developing more coaches. Coaching requires specific skills in the ability to guide and support in addition to the technical knowledge of the IAPS which were not stipulated in the IAPS framework People element.

The Process element's strengths that it provided a consistent approach in building an integrated activity plan and schedule in any asset. Such process enabled standardisation across all GC and allowed to conduct a performance review continuously. The Process element was presented in sequential blocks which were easy to follow and established clear responsibility

which should what and when. The Process dedicated a specific block to check the site readiness for execution and demanded field team acceptance before approving the plan. It improved the alignment between the activity planner and executor, which was essential to ensure timely and quality execution. The Process element needs to improve in obtaining a better quality of the functional plan; the functions' leadership requires sign-off the plan to demonstrate the ownership of the functions' plan before submitting it for integration. Signoff means that the Function's Manager confirms that their plans meet the Business and Function's Targets and that the plan complies with IAP requirements. Function's plan norms, assumptions and robustness need to be validated to reduce risk on execution and plan delivery. The function planner should challenge the activity owner and ensure the latest and most accurate data is used.

The data element's strengths that it provided a standard data required for the planning system, which enabled integration at a low level. Such data availability was a must for the IAPS planner to aggregate and integrate resources for execution. The Data element needs to improve in assigning a data owner and ensuring proper training and coaching. Such delay to resource the role with a competent staff will impact the data quality sustainability as data check consumes long hours of work to assure compliance. The data owner importance is not less than the process owner whom all works as assurance bodies for quality of IAPS execution.

The IAPS Planning System element's strengths were the use of a fit for a purpose planning system that was prescribed part of the IAPS framework to enable standardisation across the different assets. The appropriate integration between the proposed planning tools (SAP, Primavera P6, & Impress interface) supported the data transfer and improved efficiency. It was imperative to the GC avoid changing the ERP system, bringing additional complexity and cost. The IAPS Planning System element needs to produce a more attractive package for all asset to use the global planning tools set or provided free cost. Such cost can be absorbed by the GC, especially for the dashboard. The benefit of deploying the global planning tool is much higher than the cost of development. Such internal arrangement within the GC can help to overcome the cost challenge.

The culture element's strengths were in supporting the three companies in transforming the culture and the intent through CSF tactics, which found very useful by leaders. The CSF has allowed for a standardised approach in which exchanging the knowledge and experience across the three companies became easier. The culture element focused on bringing more data visibility to drive behaviours; such a tactic supported the companies to drive ownership. The data visibility also enabled the leaders to drive a constructive discussion and focus on what

can be done extra to improve business outcome. The proposed meeting structure and effectiveness measurement supported the organisations to continue improving IAPS performance and activities delivery. The Culture element needs to manage unintended consequences for being a KPIs driven without looking at the business requirements in a holistic view. Proposing a positive change to the IAPS plan that improves the business outcome is welcomed, although it might affect KPIs' plan stability. There is a subtle difference between looking at a process in standalone view or looking at the big picture and total benefit to the company.

The Leadership element played a crucial role in supporting the effective IAPS framework implementation by driving asset business results. This element was a knowledge gap, and the IAPS framework filled the gap through practical implementation. The proposed tactics of creating data visibility (Inclusion Criteria, Activity Readiness, Ranking Criteria, Meeting effectiveness, and Golden Rules to drive behaviours) worked well and became a standard approach to strengthen leadership in the GC. Effective decisions based on transparent information supported the leaders in delivering the company strategy, improving business performance, and ultimately creating value. The Proposed tactics in Leadership element found to be exhausting for leaders mainly when they took the IAPS process owner role on top of their day to day delivery. Many details need good focus and attention; it required continuous alignment and followed up, which is a risk for sustainable performance.

Each element in the IAPS framework addressed a gap identified in the GC IAPS effectiveness. Building a proactive planning culture in the GC with a process management mindset is a complex task and requires significant training, coaching, and monitoring performance. However, the IAPS framework, through the outcome of the implementation in three case-study companies, proved its ability to address the GC challenge in developing quality IAPS plans and deliver a better business outcome.

7.3 Generalisability of the IAPS framework

The IAPS framework was built to be implemented in all companies belonging to the GC, and the three case-study was only a pathfinder to test the framework's effectiveness. The goal of the end-to-end IAPS framework for the GC was to deliver improvements in business performance in HSE, production, and cost. It was expected that this research would transform the organisation to a process thinking mindset, taking the enterprise as a priority, and develop competent planning organisation that drives integration, challenges various stakeholders for better optimisation, and highlights risks/opportunity for informed decision using strict change

management. Despite the identified improvements in the IAPS framework elements; the IAPS framework was tested and enabled three companies to deliver a better business outcome. The research focussed on organisation effectiveness, and the relation between different elements to deliver optimum results through the IAPS framework. The research dealt with flux concerning inadequate processes, different ways of working, practices, and different experiences and still delivered improved performance. Evaluation of the research demonstrates the IAPS framework's appropriateness to be used across all companies belonging to GC. The three case-study companies represented the GC business and helped in identifying gaps and validating proposed solutions. As a result, the GC senior management endorsed the IAPS framework and included it in the GC Asset Management System.

Because the GC is considered a major player in the Oil and Gas industry and represents upstream business; the IAPS framework can also be used outside the GC in other oil & gas companies. The IAPS framework eight elements (direction setting, organisation structure, people, process, data, system, culture, and leadership) are quite generic and applicable to any organisation. The methodology of the deep dive and implementation are relatively standard approaches that can be implemented by any organisation after considering the company business context. The IAPS framework emphasises in common values which can be used by any organisation. The 1st value that IAPS framework demand for making the company objectives clearer at all levels in the organisation and ensuring that all staff involved in developing IAPS plans use the same language and work towards the same business outcomes. When people considered their activities, the aim was that they would always keep IAPS in mind whether short, medium or long-term plans. The 2nd value is honouring and respecting the plan, which becomes one of the IAPS golden rules; changes to approved plans should be taken seriously and managed through a prescribed process. The 3rd value is translating the Asset's Long-Term Plans and Business Plan activities into executable work. IAPS brings together all Functions' activities to be carried out on a facility, integrates these activities at different time horizons from a two-year Medium-term plan, to a 90 day Short Term plan, and then into the four-week Integrated Schedule (Execute).

The IAPS framework can help any organisation manage the better handover of activities from one plan to another and how to mature the planning cycle to ensure timely execution. Planning decides what and how, and the time estimate for a job. Scheduling decides when and who will do the job. Planning of a job should, therefore, be complete before scheduling the job. The prioritisation matrix included within the IAPS framework had supported the case-study companies to resolve any conflicts between activities, using value and risk as to the main drivers for allocating the valuable company resources. The prioritisation matrix (refer to Figure

5-14) is a very generic tool used by any company. It did not include anything specific to the GC and was built to improve prioritisation and ranking if any two activities are competing for the same resources.

The proposed technique of using critical success factors and IAPS Golden rules (refer to Figure 5-13) can help any company improve the IAPS performance and, consequently, the business outcome. Both methods make leadership and compliance performance visible and drive improvements. Translating the IAPS process KPIs and Business KPIs in one dashboard strengthen the relationship between IAPS plans and company business drivers.

In general, the IAPS framework applies to any company belonging to the GC without making any changes. The IAPS framework is also appropriate to be used outside the GC by any organisation in the Oil & Gas industry with minor modifications to organisation structure to suit the specific company, planning tools to integrate with existing ERP system, and data minimum requirements for the planning system. The proposed solutions in the IAPS framework for these three elements are quite specific to the GC business; however, most of the other tactics illustrated in the IAPS framework can be replicated in any organisation. The IAPS framework in the existing structure and eight elements can be considered one solution for the challenges faced by different companies in the oil and gas industry.

Chapter 8 RECOMMENDATION AND CONTRIBUTION TO KNOWLEDGE, FUTURE WORK, & CONCLUSION

The proposed IAPS framework aims to address some of the persistent current gaps in the Oil and Gas industry performance and contribute to significant business improvements that enable different companies to move to best in class performance. The Oil & Gas companies' strive to be the world's most competitive and innovative energy sector; still, many did not reach their aspired business performance level after many years. The GC understand the oil business thoroughly and know what excellent performance looks like; tremendous value opportunities missed because different parts of the organization are not well integrated and business improvement activities are insufficiently focused and not deployed with the necessary rigour. This research developed and tested the end-to-end IAPS framework and supported three case-study companies to improve the business outcome. The results obtained after implementing the IAPS framework demonstrate the IAPS framework's effectiveness and hence strongly recommend implementing the IAPS framework across all companies belong to the GC with consideration to the following.

8.1 Recommendation

The case-study companies accepted the IAPS framework, and it was implemented using the proposed standard deployment approach. Consequently, the GC endorsed the new IAPS Framework to be part of the company Asset Management System. The framework can be split into two documents and recommended to be a) IAPS Standard and Manual; and, b) IAPS recommended practices guidelines. The "mandatory requirements" of IAPS framework should be included in the standard and manual, and all companies must achieve such requirements belong to the GC. Such split would further provide more focus to execute the mandatory requirements first and then move to recommended practices that would accelerate the implementation. As an example; establishing IAPS organisation in each company with clear roles and responsibilities and interfaces with other functions can be one of the minimum requirements in the IAPS Standard and Manual. However, determining the exact number of the resources required for each asset or company is left for the company leadership to decide. The recommended practice guidelines should define an organisational structure that is advised to be replicated to represent how best to manage this aspect and what good organisation looks

like. It is up to the company to use the proposed organisation in the recommended practices guideline or design a better organisation that fits its environment and business context.

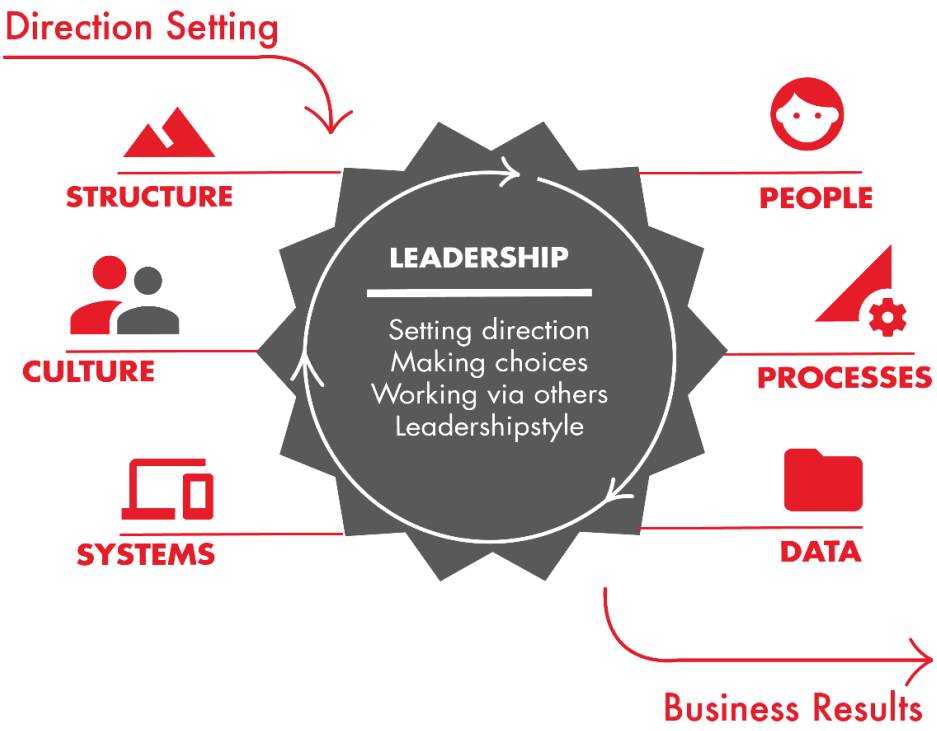
Any other company in the Oil & Gas industry can take a similar approach to customise the IAPS framework. The IAPS framework provides many standard elements, tactics, and solutions; however, specific organisation structure, planning system, or data specification still need to be considered carefully by the company to suit its specific business context and governess.

8.2 Contribution to knowledge

There is a strong business need to enhance planning in an increasingly more complex company with a focus on complex Enhanced Oil Recovery EOR projects, a high volume of new wells, declining brownfields, resource constraints, and ageing facilities, which implies integrity issues and constant replacement of assets. Shutdowns are becoming ever more substantial and more complicated due to EOR facilities. Therefore, it is necessary to document the IAPS process to enable its effective and efficient execution, as several threats and opportunities can have a positive or negative impact on the IAPS. The primary risk is that the plans' critical activities are not carried out or slip (e.g. drilling program, maintenance activity), and there is a knock-on effect on other activities in the plan. A secondary, but still significant risk is that activities are completed early, in which case opportunities open in the plan allowing other work to be brought forward. It is essential that any threats or opportunities are considered and that alternative methods are prepared, and suitable pre-work carried out should such risks materialise. Good IAPS practice should result in improving efficiency in Oil and Gas Industry through resources optimisation, activities readiness for execution, and functional plans integration. Poor planning for shutdowns is derived from a lack of accuracy with respect to the detailed scope and readiness for execution. This can result in high exposure to HSE – an extended closure may result in craft technicians working longer hours than expected with tiredness affecting judgement and safety, costs – the value (cost benefits), and reputational damage. Poor IAPS practice can lead to a reactive rather than proactive response being employed. A reactive response is much more visible than the first and difficult to recover from. Poor planning causes adverse knock-on effects on the business, causing unstable planning and inefficient utilisation of employees and contractor resources with higher risk on incidents.

The significant contribution to the knowledge of the research is the end-to-end integrated activity planning & scheduling framework improves business performance. A framework can be implemented in the Oil and Gas Industry in different companies, countries, and cultures

and can still produce a similar outcome. Academically; the research contributed to procedural knowledge by increasing the understanding in the field of IAPS. The research determined the lack of knowledge in this field in the literature review, particularly a gap in knowledge for an IAPS Framework that focusses on organisation effectiveness and supports effective implementation considering different cultures. The literature review did not reveal any comprehensive IAPS framework to address challenges in the Oil and Gas industry after many years; it looks that this research area was not a focus or overlooked. The research filled the gap with a comprehensive IAPS framework, as illustrated in Figure 4-14.



The IAPS framework identified gaps in the GC and provided solutions to meet the Oil and Gas industry requirements by achieving the following research objectives:

- To develop Integrated Activity Planning & Scheduling (IAPS) Framework which aims to fulfil the requirements of oil and gas assets to achieve optimised production deferments, improved new oil & gas production delivery, and reduced cost of waste through efficiency. The IAPS framework should integrate various multi-disciplinary functions and develop end-to-end IAPS process.
- To develop a standard deep dive and implementation approach. Evaluate asset performance based on specific business and IAPS process KPIs. Understand field

challenges in the implementation of end-to-end process to create sustainability and evaluate stakeholder's response globally.

- To develop tactics to support IAPS implementation and identify the measures for effective management of post-implementation process performance of IAPS process.
- To develop a framework utilising the company practical experience with academic research and industry best practices to produce an end to end process. Also, use a feedback loop through assurance review and knowledge sharing across the organisations.

A significant contribution accomplished in enhancing the understanding of the link between all the framework elements (Direction setting, Organisation Structure, People, Process, Systems, Data, Culture, and Leadership) and their impact in delivering a quality IAPS Plans. The importance of this aspect relates to the continuous improvement of each element based on results and feedback.

The research contributes to knowledge industrially is by addressing current challenges in the oil and gas industry to implement effective IAPS and improve business outcome. The IAPS framework supports oil and gas assets to integrate activities and schedules with all functions in a standardised way of working throughout the assets across the globe within an organisation. The theoretical knowledge was transferred to a practical solution by designing a standard deep-dive methodology and implementation approach which can be conducted in a systematic and controlled manner in different assets and different countries and still produce an improved business outcome. Testing the IAPS framework practically in three different companies brought insight in relation to how best to deploy the framework. The research proposed the appropriate governance, tactics and organisation model to ensure sustained implementation for IAPS end-to-end process. A feedback loop for continuous improvement was implemented to keep proved processes continuously updated with best practices worth replicating taking the best in-house technical knowledge.

From business delivery perspective and value; the IAPS framework supported the three case-study companies to deliver improved business outcomes. The Company-A achieved a cost reduction of $480,000 as a result of reducing NPT of logistics fleet NPT from 38% to 20%. The Company-B improved the availability from 67% to 85% as a result of reducing facilities downtime by 18%. The Company-C improved the material on time (from 44% to 61%, which in turn reduced the stock level by 17%, which equated to $76.5M reduction in stocking material. Extrapolating such achievement to other parts of the GC's business will bring more

value in overall business outcomes and adopt the same IAPS framework by all Oil and Gas companies worldwide would bring considerable value and significantly contribute to the world economy.

8.3 Future work

The IAPS framework is planned by the GC to be deployed across all companies belonging to the group in order to address the identified business delivery gaps (HSSE- Production-Cost). The main limitations for the IAPS Framework relate to the extensive resources, experience and knowledge required for the deep-dive workshops and implementing the framework. Limited skilled facilitators might jeopardise the results obtained from the workshops, which in turn could result in a weak implementation. The GC global SMEs should be vigilant in supporting different companies during deep-dive workshops and IAPS framework implementation cycle.

From an academic perspective and advance the knowledge; the IAPS process should not be treated in an isolated manner; there was a strong relationship between the IAPS process and other key processes in the company and ignoring such relationship might reduce the optimum benefit of implementing the IAPS framework. The IAPS Framework defines these interfaces, but further researches required to advance the knowledge in this area and establish clear alignment between these processes; As an example, the IAPS process has a strong relationship with the supply chain process, which manages critical resources (e.g. trucks, helicopters, vessels) that should be shared by multiple activity owners. The IAPS team should meet regularly with the supply chain team to discuss changes to the critical resources, and provide detail of the resource demand to enable the supply chain team to come up with most accurate supply profile. Failing to develop the demand profile before the business planning cycle can jeopardise the value of integration and reserve valuable resources that can be optimised. Any future work and academic research in this area to establish a clear connection between IAPS and supply chain process would benefit the oil and gas industry.

Another process has a strong interface with IAPS is the forecast and plan production process; the production forecast is built yearly during the Business Plan process and updated monthly. The IAPS process has a strong relationship with the Forecast and Plan Production process, as managing production impacting activities is a critical component of the IAPS process. The IAPS Planner should contact the Production Support Engineer to investigate the best opportunity to execute this scope, as Production Engineering is responsible for meeting sales

commitments. It remains an opportunity for academic research to combine production planning and IAPS in one process, or to define such integration clearly.

The Functional Plan was the primary source for the IAPS plans; low-quality input in this respect would result with low-quality IAPS plans. It also means that the IAPS team cannot only aggregate all Functional Plans and call them Integrated Plans; it requires scheduling the timing of work packages following their logical sequence, interdependencies, budget, specialist and shared resource requirements. It will all depend on the quality of data that are submitted in the functional plans.

Based on the above observations, after implementing the IAPS framework in the case-study companies, there are apparent opportunities for future research to continue development and improving implementation. These identified areas of future research with their anticipated benefits and rationale are as follows:

- An opportunity for future academic research to strengthen the integration between the IAPS process and other processes. There is a strong relationship with some common processes used in oil and gas companies such as supply chain management and production planning.
- There is an opportunity to move the IAPS process to demand process triggering the Logistics resources requirements. It is vital to have a new view of what needs to be transported and the delivery timeframe from 2 years to seven days. Such philosophy opens a new window for future academic research and would be a critical success factor in applying and improving transportation unit cost in all companies. This further work will provide the ability to move to the next planning stage in optimising capacity and increasing utilisation
- Additional research work required in areas of process culture and process thinking mindset. The process is designed to deliver an outcome and should be followed. Ignoring the process is not an option but challenging it, improving it is possible and should be encouraged. Stringent Process Management would be one of the solutions; it is considered an essential foundation in the drive for improved organisational effectiveness efficiency, and ultimately output. Future resources can consider the IAPS framework as a base and built process thinking mindset element for more sustained results.

From the GC perspective; the global excellence team could work further on the following:

- Implementing the “learn and replicate” cycle will be crucial to address new gaps observed during the full deployment of the IAPS framework in all companies that belong to the GC. This cycle will focus more on the feedback loop and continues improvement. The obtained learning would improve the IAPS framework tactics and solutions and make it more robust for sustained performance.
- The GC should conduct assurance of the IAPS framework implementation and audit various companies belongs to the group. Such an assurance level will keep the companies' focus belong to the GC and establish a good connection between the global SMEs and companies/asset teams.
- Develop a global dashboard to measure different assets performance process and business. The goal is the GC improving the business outcome (No safety incidents -Less operating cost – Less production deferment) using IAPS Process. The Business and Process KPIs were developed for three case-study companies, and the future research could expand the dashboard globally to connect all companies belong to the GC. It would help the GC to have a comprehensive overview of all companies performance in IAPS and make the right intervention to enhance business outcomes. Another product development opportunity for researchers which can help many companies in the oil and gas industry.

8.4 Conclusion

Traditional approaches to planning and scheduling are insufficient to meet current and future challenges in the oil and gas industry's dynamic and complex environment. With an average “tight” oil field economic life’s span of 15 to 25 years, it is a MUST to have a high-performance organization in place to ensure that all economic of oil and gas is extracted and revenue gained. The production phase is one of the essential phases because it directly impacts the field performance and business outcome through generating cash. Facilities are operated and maintained, and reservoirs are managed to the best economical level till the end of field life. Facilities age over time and consequently maintenance and modifications activities increase, which adds to Oil and Gas operations' existing activity complexity. The Upstream Oil & Gas business is a multi-disciplinary business. Almost every significant activity in the Upstream industry requires multiple Disciplines to work closely together, and only very few activities can be pursued in a single Discipline mode. Hence, integrating all functions and processes is one of the most critical success factors to meet business targets.

Within the Industry, different opportunities and theories have been developed and applied to improve the process for Integrated Activity Planning & Scheduling (IAPS). Nevertheless, in many assets across the world, almost 40% of planned activities are on average not executed in the planned period, resulting in massive inefficiencies regarding capital, production and resources. How is it possible that this massive value is still lost today, many years after the first academics penned the term “Integrated Planning” as a critical business enabler? The Integrated Activity Planning Process & use of associated Technologies (IT) are essential enablers to the solution, but there are many other elements to drive this high performance in activity executing organisation.

The literature review highlighted the current knowledge and practices with details of the different integrated planning and scheduling activities involved in oil and gas industry, where gaps were identified of not having a comprehensive IAPS framework to address the oil and gas industry requirements. From previous literature review; it is evident that most research to date has focussed on one, or a small number of elements. Much of the research has focussed on planning tools and systems, and the research concerning the soft side of organisation culture and leadership is sparse. As a result, it opens an opportunity for this research to bridge this gap and contribute to knowledge by developing a comprehensive end-to-end integrated activity planning and scheduling framework, which covers all elements of the GC requirements and test the implementation of the framework in different companies belonging to GC to investigate its effectiveness.

To solve a complex industry problem, the organisation needs to believe in the solution and implement it. The research philosophy chosen was pragmatism with Action Research strategy. The research approach was structured around four cycles: discover cycle; deep dive cycle; development cycle; and, test and learn cycle. The research utilised the depth of knowledge and wealth of experience in the GC organisation in order to identify challenges, produce solutions, create IAPS framework, implement, and facilitate change management. Since the solution was generated using in-house expertise and through local resources in the GC; it helped to be adopted quickly by the organisation, which is considered another advantage of the research methodology. The organisation showed more ownership for implementation and improvement. Thus, the deep-dive workshops were an excellent technique for organisation change management.

This research has addressed these gaps, and developed End-to-End IAPS framework consists of 8 elements (Direction setting, Organization Structure, People, Process, Systems, Data, Culture, and Leadership) and demonstrates the power of integration between IAPS and other

processes such as logistics and material management. It is imperative to integrate the work value chain and ensure that IAPS is not looked upon as a "stand-alone" process. The IAPS framework was the most appropriate means of solving the GC challenges. The eight elements that were developed within the IAPS Framework to achieve an improved implementation in the GC are summarised as follows:

- **Direction Setting**: This element of the IAPS Framework was constructed to send a clear message to the organisation about the company strategy, and translate it to executable work through IAPS with clear definitions. The organisation needs to understand the value of the IAPS and how it supports the company strategic objectives. This element states the desired future state of what the business wants to achieve and what the business must do to achieve it using integrated activity planning and scheduling.

- **Organisation Structure**: This element establishes clear rules and responsibilities for the IAPS organisation to deliver IAPS plans and describes appropriate organisation model in which stakeholders should be organised to execute integrated activity planning and scheduling tasks. The organisation structure element aimed to link the IAPS leader to report to the Asset manager to secure the required influence to implement IAPS criteria. The model also provides guidance on how stakeholders should be grouped into teams, departments, and functions, and how coordination occurs across these organisational boundaries.

- **People**: defines the talent management aspect of organisation capability and explains the training and succession planning strategy to equip people with the right knowledge and skills in the right locations such that we can deliver business outcomes. Training, coaching and succession planning are the main deliverables of the People element of the IAPS framework.

- **Process**: The IAPS process is the core element of the IAPS Framework, and it describes step by step process to build functional plans, integrate activities, optimise the plans, approve and communicate. The IAPS process also stipulates the foundation required to deliver an effective plan and provides guidance to develop a culture of integrated process excellence, balanced with continuous improvement to deliver business expectations. The IAPS process is standardised with a clear structured and sequential procedure to maximise the team efficiency during implementation.

- **Data**: This element describes the level of detail required for each IAPS plan that should be entered into the planning system. The data element describes how the data should be submitted to integrate different functional plans in one integrated activity plan and schedule. The aim is to produce a quality IAPS plan using a reliable, accurate and consistent single source of truth.
- **Systems**: This element provides guidance for using Primavera P6 as the planning system that should be integrated with the company ERP system. In the GC, the ERP system used was SAP in which the IAPS Framework developed an interface to connect to Primavera P6 through a system called Impress. The focus is to ensure that the IT systems used are fit for purpose, aligned and interfaced and provide appropriate support for integrated process execution in all companies belonging to the GC.
- **Culture**: This element emphasised on the importance of building the right culture, knowing that integrated planning is a result of full organisation collaboration, proactiveness, and discipline. The framework's culture element proposed tactics and a list of critical success factors to highlight the importance of having the right culture. The aim is to establish the right environment to influence behaviours and address the human component in terms of how people perform, and the underlying attitudes, beliefs and organisational norms that shape and define acceptable practices at the GC. It is one of the most crucial elements that need to be managed with care – leaders have the responsibility for creating the correct culture in the companies to effectively achieve the desired business outcomes.
- **Leadership**: states how the leaders at all levels should behave to motivate and inspire others to pursue the organisation's vision, strategy and objectives. Leaders are responsible for setting direction and making choices that enable the organisation to be successful. This element prescribes the leadership attributes to show commitment by chairing IAPS meetings, ensuring full attendance particularly by activity owners, observing the work, asking the right questions, and coaching IAPS personnel. Leaders should create an environment that provides access to information and supports decision making. Leadership is at the core of the integrated framework to ensure consistent delivery.

The eight elements are interconnected, and the organisation cannot achieve the optimum delivery without having all elements fixed and working in harmony. The company vision is the desired future state of what the business wants to be in which objectives are set & communicated; measurable goals are expressed, governance & business model are agreed to drive focus and organisation alignment of what constitutes success in terms of business outcomes and how IAPS support the company vision (Direction Setting). How people organized to execute their work and how people grouped into teams, departments, functions, and how coordination occurs across these organizational boundaries is what is required for the IAPS planner to deliver their goals (Organisation Structure). However, staff needs a development in which the talent management aspect comes to the surface; do we have the right people, with the right knowledge and skills in the right locations to deliver on the strategy (People). Once the vision is understood with clear message and expectations, the organisation structure is set up, and people are trained to deliver the task; the next is to have a clear process describes the activities that make up the work we do, including the tasks and targets that will deliver the results (Process). These processes required clear data set and systems to enable those results (Data & Systems). The company is a community, and each community create its own culture; the way things are done, which influences behaviour. It is the human component of organizational behaviour in terms of how people perform, and the underlying attitudes, beliefs and organizational norms that shape and define acceptable behaviours (Culture). Without creating the right culture to support IAPS plan delivery; the company will miss targets and leader's role become crucial to motivate and inspire others to pursue the organisation's strategy and objectives. Leaders are responsible for setting direction and making choices that will enable the organisation to succeed (Leadership). IAPS needs all the eight elements to be implemented in order to deliver the GC aspiration. The IAPS framework clarified each element's requirements and proposed specific tactics to resolve identified gaps in implementing IAPS in the GC.

The oil and gas business is complex and interlinked with many different factors affecting the overall performance. The relationship between the different factors of IAPS and business outcomes summarised in Figure 6-1. A better outcome is achieved through better alignment in asset priorities, cooperation between functions, and agreement between stakeholders. The GC aspirational business outcomes related to its business are increased safety by optimising the working hours; reducing the scheduled deferment by 10% year on year; reducing the unit cost by 3% year on year by improving utilisation of shared resources through better-integrated plans; and, improving planning compliance of activities delivered to 95%. These business outcomes were set to be achieved by 2030, and IAPS is one of the processes to support GC in

this regard. The IAPS framework was evaluated based on company business outcome, IAPS process KPIs, and IAPF framework elements improvement through IAPS health check assessment. The IAPS Framework implementation in three different companies demonstrated the improvements in delivered business outcome, IAPS process KPIs, and various elements in the IAPS Framework. The IAPS framework achieved a better alignment in the company's priorities, cooperation between functions, and agreement between stakeholders. The IAPS sponsor and senior leadership team in the three companies seen the IAPS framework a way of managing the business and a vehicle to deliver the company aspired business outcome. The IAPS plans (MT, ST, IS) were exist and recognised as a useful communication tool for the company priorities across all levels of the organisation. The IAPS team and functions had translated these priorities to approved IAPS plans and continuously challenged the performance. A governance structure exists by creating the IAPS Process Council at senior management level, which set clear expectations for the organisation to follow the IAPS framework, deliver business outcome and track progress.

The IAPS framework supported the three case-study companies to deliver improved business outcomes. The Company-A achieved a cost reduction of $480,000 as a result of reducing NPT of logistics fleet NPT from 38% to 20%. The Company-B improved the availability from 67% to 85% as a result of reducing facilities downtime by 18%. The Company-C improved the material on time (from 44% to 61%, which in turn reduced the stock level by 17%, which equated to $76.5M reduction in stocking material). Extrapolating such achievement to other parts of the business in the GC will bring massive value in overall business outcomes. The IAPS process KPIs improved in the three case-study companies; the Company-A improved the MT Plan robustness KPI from 59% to 15%, ST Plan Activity Readiness above 85%, ST Plan stability from 64% to 78%, and IS delivery from 48% to 82%. The Company-B improved the MT Plan robustness KPI from 75% to 41%, ST Plan Activity Readiness from 46% to 79%, ST Plan stability from 55% to 70%, and IS delivery from 27% to 65%. The Company-C improved the MT Plan robustness KPI from 21% to 10%, ST Plan Activity Readiness from 78% to 81%, ST Plan stability from 65% to 83%, and IS delivery from 60% to 72%. All three case-study companies improved in IAPS health check assessment after implementing the IAPS framework. Company-A improved overall average score from 2.1 to 3.2, Company-B improved overall average score from 2.1 to 3.0, whereases, Company-C improved in overall average score from 2.4 to 3.1.

Each element in the IAPS framework addressed a gap identified in the GC IAPS effectiveness (refer to section4.3). Building a proactive planning culture in the GC with a process management mindset is a complex task and requires significant training, coaching, and

monitoring performance. However, the IAPS framework, through the outcome of the implementation in three case-study companies, proved its ability to address the GC challenge in developing quality IAPS plans and deliver a better business outcome.

The proposed tactics in the IAPS framework of using critical success factors and IAPS Golden rules (refer to Figure 5-13) has supported the GC in implementing IAPS framework elements and improve business outcome. Both tactics made leadership and compliance performance visible which delivered better results. Seven CSF made the difference in the GC:

- Visible and committed leadership support is critical in ensuring the practical application of the IAPS process and, hence, in meeting its objectives. Each time horizon of the plan has a different owner who is accountable for its delivery and strongly supported by the function leader. The leader should recognise the team's achievements and successes in following a robust integrated plan and should also consistently apply consequence management to those that do not comply with the process.
- Asset objectives clear at all levels and cascaded to all parts of the organisation are essential success factors. It allows IAPS Plans to be built across different horizons from long term to short term and take decisions based on clear business targets, plan premises and prioritisation criteria.
- The IAPS should be integrated to all other asset plans such as the asset reference plan (the long-term plan), business plan, or production forecasting. IAPS is not an isolated plan and should take input and provide outputs to different plans.
- The asset should aim to have one IAPS; having more than one integrated plan can confuse the organisation, duplicate efforts and establish inconsistencies. Everyone in the organisation should refer to one unified plan with a single source of truth.
- The functions should play their role; functions are accountable for maximising asset value and committing to delivering their business targets. To realise this, they must have adequate and recognised planning and delivery processes in place that makes available both plans of activities suitable for integration and enables activities to be matured in a proper and timely fashion. The functional plans should be owned and signed off by function leadership.
- Transparent activity readiness is crucial to target high plan stability; including activities that are not ready for execution that might jeopardise the plan’s delivery. Activities do not meet the set criteria; they were either rejected (not included), or

included with clear mitigation and approved by the time horizon plan owner to get them ready in time.

- The changes in the plan should be controlled through a stipulated process. Once the project has been endorsed, it should be frozen, and alterations should not be allowed without clear justification. Proposing a positive change to the IAPS plan that improves the business outcome is welcomed after reviewing the company's total benefit and eliminating any wastes in resources that might occur.

These critical success factors are supplemented with clear ground rules, called "IAPS Golden Rules" which set clear expectations on how the organisation will implement the IAPS framework. Leaders use these rules to drive better behaviours, respect the plan, and ensure activity execution. Translating the IAPS process KPIs and Business KPIs in one dashboard have also strengthened the relationship between IAPS plans and company business drivers.

The research succeeded in developing a framework for IAPS, implementing it in three different companies, delivering consistent performance, and can be spread over a large number of companies in different countries belonging to a GC. The research developed a standardised approach for deep dive and implementation which can be applied outside the industry. The use of a standardised deep dive approach worked in all three case-study companies and revealed the required information to elicit challenges and requirements. The approach was developed to be used again in any company and should reveal similar outcomes in general with a few specific local content requirements. The research method considered as appropriate for broader implementation within and outside the industry; the structured deep-dive workshops (whether tailoring is necessary) are easy to follow and implement. The IAPS framework can also be used outside the GC in other oil & gas companies. The IAPS framework eight elements (direction setting, organisation structure, people, process, data, system, culture, and leadership) are quite generic and applicable to any organisation. The critical success factors for IAPS framework implementation and IAPS golden rules can also be generalised and used by other industries; as long the essence is preserved. The IAPS framework emphasises in common values which can be used by any organisation.

The significant contribution to the knowledge of the research is the end-to-end integrated activity planning and scheduling framework. A framework can be implemented in the Oil and Gas Industry in different companies, countries, and cultures and can still produce a similar outcome and improve business performance. Academically; the research contributed to procedural knowledge by increasing the understanding in the field of IAPS. The research

determined the lack of knowledge in this field in the literature review, particularly a gap in knowledge for an IAPS Framework that focusses on organisation effectiveness and supports effective implementation considering different cultures. The research filled the gap with a comprehensive IAPS framework. The IAPS framework identified gaps in the GC and provided solutions to meet the Oil and Gas industry requirements

The research contributes to knowledge industrially is by addressing current challenges in the oil and gas industry to implement effective IAPS and improve business outcome. The IAPS framework supports oil and gas assets to integrate activities and schedules with all functions in a standardised way of working throughout the assets across the globe within an organisation. The theoretical knowledge was transferred to a practical solution by designing a standard deep-dive methodology and implementation approach which can be conducted in a systematic and controlled manner in different assets and different countries and still produce an improved business outcome. As a result, the GC adopted the IAPS framework and included it as part of the Group Asset Management System.

As valuable as the research is; the ultimate value obtained is after turning the research in a product which is the ultimate contribution of this research; the IAPS Framework is live and has been used in the GC and contributing to the economy.

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APPENDICES

APPENDIX-A

The following interview guide developed to ensure structured interviews in all case-study companies. The interview starts with an introduction and welcoming the interviewee for joining and freeing up his/her time in their busy agenda, then move to:

The purpose of this interview: is to gather your candid perceptions on:

- Currently stated aspiration in the planning organisation and the strategy required to deliver
- Current enablers and barriers to performance
- Any improvement opportunities

Framing the IAPS deep dive: At this stage, our conversation will focus on [name the organisation] aspiration with the planning organisation and barriers to performance. This interview, together with the other diagnostics (data analysis and initial interviews), will provide us with input to define the hypotheses which we will test in further interviews or deep dives.

Bases to cover before you start the interview:

- Your responses during these interviews are confidential (we share them among the diagnostic team only). We will not disclose to anyone beyond the working team where the comments originated. We will summarize this information as an aggregated overall view from all the people we engage.
- We would like to take many notes to be sure we capture your answers accurately. The notes we take during this interview will be secured by this team once we have collected, summarized and processed all the information.
- Is there anything you would want to ask or have clarified before you participate in this interview?

Interview Details:

Interviewee	Interviewer
• Name: • Title:	• Name: • Date:

Interview Questions (strategic) for senior leaders:

1. What is the value of integration and having IAPS framework in your views?
2. What is the organisational context that the IAPS framework should operate in linked to the current business aspiration for [name the organisation]?
3. What are the top 3 enablers that the IAPS framework needs to get right to deliver the aspiration? Are we doing any of them today? If yes, how? If no, what is the reason?
4. What are the top 3 barriers to performance in the IAPS framework today? Why?
5. What is the one thing you like to change to have an effective IAPS framework?
6. What have we not covered that you would like us to discuss?
7. What questions do you have for me?

Interview Questions (Tactical) for middle management:

1. What is the value of integration and having IAPS framework in your views?
2. What performance targets/goals or expectations are not being achieved, what is causing this?
3. What are specific knowledge, skills and/or capabilities missing in the businesses that are contributing to this?
4. Think of a recent specific situation where a team in this organisation achieved excellent performance.
    - Please describe the situation (context, processes impacted, people involved, time frame)
    - To what do you attribute the success?
    - What made this example noteworthy?
    - What was the outcome?
5. Think of a recent specific situation where a team in this organisation experienced a failure.
    - Please describe the situation (context, processes impacted, people involved, time frame)
    - To what do you attribute the failure?
    - What made this example noteworthy?
    - What was the outcome?
6. What is the one thing you like to change to have an effective IAPS framework?
7. What have we not covered that you would like us to discuss?
8. What questions do you have for me?

Interview Questions (Operational) for IAPS process practitioners:

1. What is the value of integration and having IAPS framework in your views?
2. What are your most critical interfaces with suppliers, partners, and customers, and how are they working today? Planning team vs functions?
3. To what extent do you feel that roles and accountabilities between the planning team and the functions are clear? What is working well, and what could be improved?
4. How well do you think information and knowledge are being shared between the IAPS team and partners?
5. Where do you see misalignment in objectives or measures between the IAPS team and the functions?
6. What do the functions need more of from the IAPS framework in order for [name the organisation] to be successful?
7. What does the planning team need more of from the functions in order for [name the organisation] to be successful?
8. What is the one thing you like to change to have an effective IAPS framework?
9. What have we not covered that you would like us to discuss?
10. What questions do you have for me?

Closing remarks:

- Thank you again for your collaboration and time. We would like to reinforce that your responses are confidential (we will share them among the diagnostic team only). We will not disclose to anyone beyond the working team where the comments originated. We will summarize this information as an aggregated overall view from all the people we engage.
- The notes I have taken during this interview will be secured once we have collected, summarized and processed all the information.

APPENDIX-B

The IAPS health assessment was created by the researcher to support the company/asset to identify gaps in implementing the IAPS framework. The assessment derived from the discussion in the SMEs workshops about various challenges in implementing integrated activity planning procedure, motivated by literature review learning, and formulated by the aspiration goals the GC would like to achieve in each element of the IAPS framework. In each case-study company, the IAPS health assessment was used, and it became one of the deployment tools in the GC. The IAPS health assessment is used as a group discussion and scored as a group. The scores compiled in xl-sheet and discussion is carried out by the group around each statement

Focus Area	Question	Range Statements				
		Range 1	**Range 2**	**Range 3**	**Range 4**	**Range 5**
Business Context, Direction Setting & Outcomes	**Business Strategy, Direction Setting and Outcomes:** How is the IAPS process and plans linked to the vision, business strategy/objectives and outcomes (e.g., HSSE, Production Improvement/ Scheduled Deferments and Costs)?	There is no structured or formal link between the Business Plan, business drivers and targets to the IAPS plans (Medium Term/Short Term IAPS). 2. There is no clear and consistent message about the vision, direction and objectives of the business and the link to the IAPS process	At least 3 of the Range 3 statements are met with evidence	**Minimum Requirements:** 1. The business sees IAPS as a key tool for delivering assets and business objectives of HSSE, Cost and Production, and for minimising scheduled deferments. 2. There is a clear and consistent message about the vision and direction of the business throughout the organization, using the business strategy document (ARP) as the basis for achieving the business objectives 3. KPIs are in place to measure IAPS impact on business performance/value drivers. {eg.: The Business or Asset Leaders ensures all IAPS activities are checked to meet business objectives of Cost (reduce the cost	All of Range 3 statements met with at least 4 of the Range 5 statements are met with evidence	1. The IAPS process sits at the heart how the Asset/LoB operates and is the means by which business vision, strategy and direction are transformed into executable work. 2. IAPS enables better-coordinated decision making across functions. The process helps to integrate and optimise business delivery activities to achieve business targets with the best use of resources. 3. IAPS is embedded in the Asset and integrated with other key Business and Planning

				of waste by tracking cost associated with plan changes), Scheduled Deferment (e.g., < 5%), HSSE (e.g., Zero incident)} 4. The Business drivers are incorporated as part of the ranking criteria for IAPS, and each integrated plan has a clear objective and a hierarchy reflecting business priorities 5. The IAPS and other non-IAPS relevant Functions' activities being assured to be aligned with the business objectives, signed off and form the basis or is aligned with the first two years (at a minimum) of the Business Plan. 6. There is a feedback mechanism in place to ensure that activities in the IAPS reflect changes made through the business planning and approval process.		processes (Turnaround, Logistics, Materials Management, Maintenance Execution, Well Intervention, SCM, etc.) to enable E2E value creation, optimise resource utilisation and reduce costs due to waste. 4. The priority of activity execution is given to activities that contribute to the business performance outcome. 5. IAPS enables the reduction in the number and duration of Facility outages (Turnarounds, Shutdowns, Pitstops) by better

						integration of functions' plans to deliver more production for the asset. 6. The IAPS and other non-IAPS relevant Functions' activities being assured to be aligned with the Asset Reference Plan (Long Term plans or equivalent) and with the business objectives, signed off, and form the basis of or is aligned with the first two years of the Business Plan.

	Business Outcomes & IAPS Process Performance Management: How is the business outcomes and IAPS process performance managed?	1. Leading and lagging indicators are not in place. 2. Performance measurement of IAPS plans (MT, ST, IS) delivery does not take place. 3. There is no clear link between Business performance and IAPS process performance	1. A rudimentary performance assessment programme is carried out with benefits captured in a qualitative sense, but not quantitative 2. IAPS process performance is linked to business performance but not clearly documented and tracked. 3. The percentage of activities executed from the approved frozen month plan (Plan Delivery) is less than 80%.	**<u>Minimum Requirements</u>** 1. Leading and lagging indicators are in place and used to measure both business and IAPS process performance 2. there is a clear link between the IAPS process performance and business performance KPIs. 3. MT and ST IAPS execution performance is measured, analysed and corrective actions are implemented to meet stated business performance targets on Scheduled Deferment (e.g., <5%), UOC (e.g., < $10/barrel of oil equivalent) and HSSE (e.g., Zero Tier 1/2 Events). 4. The percentage of activities executed from the approved frozen month plan (Plan Delivery) is 80% and 84%. 5. The percentage of	1. In addition to Range 3 statements, benefits of integrated planning, both improvements in KPIs and narratives, are captured and published 2. The percentage of activities executed from the approved frozen month plan (Plan Delivery) is at least 85% to 89%.	1. MT and ST IAPS execution performance is measured, analysed, root causes for non-compliance against the plan are captured, and corrective actions are implemented for at least the preceding 12 months and used to drive improvements in the planning process 2. KPIs are in place to measure IAPS impact on business performance/value drivers and is actively monitored and reviewed to drive Continuous Improvements. 3. KPIs are visible to leadership, and they take action on

				activities that meet the activity readiness criteria for entering the Short Term plan window is at least 80%. 6. The percentage of core attendees at ST/MT IAPS meetings is at least 90%. 7. Meeting effectiveness is measured with a score of at least 160 and used to drive integrated discussions and decision making at the IAPS meetings		them as appropriate. 4. The percentage of activities executed from the approved frozen month plan (Plan Delivery) is at least 90%. An improved trend is present. 5. The percentage of ST activities that meet the Activity Readiness Criteria (ARC) on entering the short-term plan window is at least 90%. 6. The percentage of core attendees at ST/MT IAPS meetings is 100%. 7. Meeting effectiveness is measured with a score of at least 185 and used to drive integrated discussions and decision making at the IAPS meetings

Leadership & Culture	**The leadership of the IAPS Process in the Asset/Business:** How effective are leaders at providing visible and committed support and ownership for the IAPS process?	1. There is little to no drive by the Leaders to champion the disciplined execution and ownership of the IAPS process as a critical tool for delivering the business	1. Ownership and accountability are unclear with little challenge to drive the disciplined execution of the IAPS process in the Asset/Business 2. Leaders respond to problems by seeking reports and solving from a distance with little or no involvement in the IAPS process 3. Asset leaders and supervisors are predominantly 'desk-bound' or 'stuck in meetings', and there is little access to them on driving the IAPS process in the business	**<u>Minimum requirement:</u>** 1. Sponsorship and accountability for IAPS process are being demonstrated; the Asset/Business Leader expresses positive reinforcement of the disciplined execution of the IAPS process in meetings and normal one to one business interactions. 2. The Asset IAPS Planner/Lead is part of the Asset Leadership Team (ALT) or has access to the ALT (the Plan Owner in particular) and is seen as the "extended arm" of the Plan Owner	1. Asset teams use visual displays, and tracking of IAPS plans to inform the leaders to take actions. 2. Leadership supports through coaching and unblocking barriers outside the team's control. 3. The teams are empowered to make decisions consistent with Asset objectives. 4. Leadership actively reviews and challenges readiness of activities and does not allow IAPS relevant work to proceed outside of the IAPS process 5. Roles and responsibilities are clear to all involved in the IAPS process and have been actively	1. Leaders are purposeful, clarity of intent - passionate about outcomes and can clearly articulate what good looks like. 2. Active ownership of activities and plans is evident and authentic at all levels and able to withstand the replacement of key individuals (plan/activity or resource owners) whether on a temporary or permanent basis; e.g. the ways of working are sufficiently well embedded that they become business as usual 3. Involvement and connection - Leaders ensure

					demonstrated over the last six months	their vision is shared and supported, building connectivity across sites, regions, and COBs. This sustained vision builds pride in site, department and work and creates a sense of family 4. Decision making - Leaders ensure fast and quality decision making in the organisation. This gives people a sense of empowerment to make decisions. Also, the right governance systems are put in place to ensure that the right people involved at the right time, with data and

						metrics leveraged through visual management. 5. Authenticity - Leaders inspire through personal integrity, transparency and humility. They have an overarching sense of personal purpose and bring meaning to work. They balance authentic expression with curiosity to learn and take personal risks 6. The IAPS Planner/Lead is regularly engaged with the Asset/Business Leader and is seen as a valuable aid to their work, bringing insight and clear value 7. Roles and

						responsibilities are clear to all involved in the IAPS process and have been actively demonstrated over the last year

	Culture of IAPS Process in the Asset/Business: How is the Culture of IAPS Process excellence, ownership and accountability embedded in the Asset/Business?	1. There are no clear drivers or the application and embedment IAPS Critical Success Factors (IAPS Golden Rules) in the Asset/Business 2. IAPS performance excellence is not recognised, or consequence management is not applied to non-compliance to IAPS CSFs 3. People are not held accountable to deliver the requirements of their roles and responsibilities in the IAPS process	1. There are clear drivers of IAPS Critical Success Factors (IAPS Golden Rules) in the Asset/Business, but the application and embedment is lacking 2. IAPS performance excellence is not recognised, or consequence management is not applied to non-compliance to IAPS CSFs in a consistent way. 3. People are not consistently held accountable to deliver the requirements of their roles and responsibilities in the IAPS process	**<u>Minimum requirement:</u>** 1. Plan owners identified for each time horizon, and are clearly demonstrating accountability for the plan contents and delivery, manage the risks associated with the IAPS Plan delivery 2. Plan Owners chair their various IAPS Plan meetings per the meeting TORs, are purposeful with clarity of intent and make decisions to deliver the plan 3. Roles and responsibilities are clear to all involved in the IAPS process and are actively demonstrating it. 4. People are held accountable to deliver the requirements of their roles 5. There are clear drivers of IAPS process / Critical Success Factors (IAPS Golden Rules) in the Asset/Business, and these CSFs are embedded	1. People are held accountable to deliver the requirements of their roles with evidence over the last six months. 2. There are clear drivers of IAPS process / Critical Success Factors (IAPS Golden Rules) in the Asset/Business, and these CSFs are embedded and applied in the Asset/Business with evidence over the last six months 3. IAPS performance excellence is recognised, and consequence management is applied to non-compliance to IAPS CSFs over the six months	1. The Asset/Business sets the bar high and play to win. The ambition is to be the best they can be - they are never comfortable with current performance. 2. People are held accountable to deliver the requirements of their roles with evidence over the last year. 3. There are clear drivers of IAPS process / Critical Success Factors (IAPS Golden Rules) in the Asset/Business, and these CSFs are embedded and applied in the Asset/Business with evidence over the last year

				and applied in the Asset/Business. 6. IAPS performance excellence is recognised, and consequence management is applied to non-compliance to IAPS CSFs consistently		4. IAPS performance excellence is recognised, and consequence management is applied to non-compliance to IAPS CSFs over the last year 5. There is evidence of disciplined execution of the IAPS process leading to disciplined work execution in the field.
Process Governance, Assurance and Continuous Improvement	**Process Governance, Assurance and Continuous Improvement:** How is the IAPS process governed and assured in the Asset/Line of Business? To what extent is there a commitment to	**Process Governance** IAPS process governance is not in place, and there is no formal ownership of the process.	**Process Governance** The Asset/LoB Process Ownership or Sponsor role is assigned, but ownership and accountability are unclear.	**<u>Minimum Requirements:</u>** **Process Governance** Formal Process Ownership is in place within the Asset and/or LoB with Asset/LoB Process Owner, and Process Focal Point identified.	**Process Governance** All of Range 3 statements met with at least 1 of the Range 5 statements are met with evidence	**Process Governance** 1. All of Range 3 statements met with the Process Owner in Asset Leadership position and the Process Focal Point on the seat. 2. Regular review meetings between process owner and

	improve, embed and sustain IAPS in the Asset?					IAPS stakeholders including process owners, plan owners, planners and contractors to drive IAPS Continuous Improvements with clear accountabilities and timescales.
		Process Assurance and Continuous Improvement 1. IAPS process assurance is not in place or if in place, is not followed. 2. There is no documented CI process for IAPS in the Asset/LoB	**Process Assurance and Continuous Improvement** IAPS Self Assessment is performed but not annually and seldomly used to identify local improvement areas within the Asset and LoB.	**<u>Minimum Requirements:</u>** **Process Assurance and Continuous Improvement** 1. There is a documented CI and Assurance Process and timelines for Self Assessments (LOD 1), Process Effectiveness Reviews (LOD 2) and External Audits (LOD3) 2. Self Assessment is performed at least every 1-2 years and used to identify local improvement areas within the Functional plans and Asset/LoB IAPS process. 3. There are regular	**Process Assurance and Continuous Improvemen**t 1. All of Range 3 statements met with at least 1 of the Range 5 statements	**Process Assurance and Continuous Improvement** All of Range 3 statements met in addition to 1. IAPS Process Effectiveness Review (LOD 2) and peer reviews take place at least every three years against these requirements resulting in Functional and IAPS improvement plans with actions

				review meetings between Process Owner and IAPS stakeholders to drive IAPS Continuous Improvements with clear accountabilities and timescales. 4. There is a mechanism in place and used for acquiring and sharing best practices/learnings.		being closed out within agreed timescales. 2. LOD 3 Assurance (Audit) is conducted where there is a significant business risk (or at least once every five years) and actions closed out within the agreed timescales. 3. The Asset/Business connects on a regular basis with the Global DEN community, share learnings and implement PWRs to improve the IAPS process and delivery

Process	**IAPS Requirements and SOPs:** To what extent is the IAPS Requirements defined, documented (SOPs) and applied?	**IAPS Inclusion Criteria** No IAPS inclusion requirements have been developed, communicated and are used to include activities in IAPS	**IAPS Inclusion Criteria** 1. IAPS Inclusion criteria are identified but cannot be supported by data (plans do not reflect stated criteria). 2. The IAPS Inclusion criteria are clear, pragmatic or understood by activity and plan owners for that horizon	**<u>Minimum Requirements:</u>** **IAPS Inclusion Criteria** 1. IAPS Inclusion Criteria filters are applied to activities in Functional Plans which go into the Integrated Plans 2. Criteria, time, cost and resources are clear, understood and supported by data 3. Criteria are rigorously applied and result in effective planning of activities with identified cross-functional constraints	**IAPS Inclusion Criteria** 1. Inclusion criteria are rigorously applied and result in effective planning of activities with identified cross-functional constraints at all time horizons (MT, ST, IS) 2. Inclusion criteria are rigorously applied and result in visibility of IAPS activities from the Work management system (SAP or Maximo) and effective planning to optimise the delivery of work against known constraining variables (POB, Shared Resources like Vessels & Cranes, SIMOPs, etc.) at applicable time horizons (ST, IS)	**IAPS Inclusion Criteria** 1. IAPS inclusion criteria are regularly updated to reflect new events and constraints 2. Different IAPS plan horizons have different identified inclusion criteria

		Ranking & Prioritisation Criteria No prioritisation process and procedures are used to drive addition and inclusion of activities in the plans or resolve conflicts between activities	**Ranking & Prioritisation Criteria** Activities are prioritised, but no clear criteria are used to drive sequencing	**Ranking & Prioritisation Criteria** 1. Identified prioritisation criteria are used to drive activity sequencing within the Integrated and Functional plans and are applied objectively to resolve conflicts between activities or constraint busts 2. Plans clearly show priority activities, reflecting business objectives 3. IAPS prioritisation criteria are clear and understood	**Ranking & Prioritisation Criteria** 1. All of Range 3 statements are met with at least 1 of the Range 5 statements met with evidence	**Ranking & Prioritisation Criteria** 1. Prioritisation criteria are routinely updated based on the asset/business strategic vision 2. In addition to IAPS Integration, the Functional plans apply prioritisation criteria in creating their plans

		Activity Readiness Criteria there is no activity readiness criteria or gated process and procedures in place to ensure activities are matured and ready to be executed as they move from one plan horizon to the next	**Activity Readiness Criteria** 1. MT, ST, and IS plans have Activity readiness criteria, but the purpose of the gates is not clearly identified. 2. Activities are not managed consistently, especially those from functional plans	**<u>Minimum Requirement:</u>** **Activity Readiness Criteria** 1. There are clear Activity Readiness requirements defined for all Functions, and plan horizons (MT, ST, and IS), kept up-to-date in the planning system and is made visible. 2. The Activity Readiness criteria have been defined by the Functions for all major activity types and have been agreed with the IAPS team. 3. The purpose of AR criteria is clearly communicated and understood 4. The AR Criteria support the flow of work into and out of the Integrated Plans in a controlled manner 5. AR criteria are rigorously applied. Activities not passing the gate are put 'on hold' and rescheduled to a later date	**Activity Readiness Criteria** 1. All of Range 3 statements are met with at least the AR Criteria are rigorously applied; activities which do not meet the gate criteria are put 'on hold, escalated to higher-order plan owners and re-incorporated into updated Functional plans with appropriate deference procedures applied	**Activity Readiness Criteria** AR Criteria definitions are regularly updated to reflect new events and understanding of business issues causing work to arrive within plans or schedules in an unready state

				or escalated to the plan owner		
		Planning Calendar There is no clearly defined calendar in place for managing Functions and IAPS plans.	**Planning Calendar**Asset/LoB IAPS Planning Calendar is in place	**Minimum Requirements:Planning Calendar**An Asset/LoB IAPS Planning Calendar, aligned with the Business Planning calendar, is in place for Functions and IAPS planned events, incorporating key planning milestones and Function/Asset planning meetings, and communicated to relevant stakeholders.	**Planning Calendar**1. All of Range 3 statements are met with at least 1 of range 5 statement	**Planning Calendar**1. IAPS Planning Calendar is clearly defined, aligned with the Business Planning Calendar and in place for managing Functions and IAPS plans.2. There is an Asset/LoB planning calendar that contains data freeze times so

						that IAPS data can be submitted on time to support other business planning processes such as Forecasting, Business Planning and ARP.3. The planning calendars are reviewed annually and communicated throughout the business.
		Resource Management in IAPS Plans Integrated plans are not resourced	**Resource Management in IAPS Plans** Some resource constraints applicable to the MT and ST plan horizons identified are managed in the Integrated plans or tied to Functional plans	**<u>Minimum Requirements:</u>** **Resource Management in IAPS Plans** 1. Integrated plans show future resources required (Demand Profile) where these correspond to identified constraints (IAPS inclusion criteria definition) 2. MT, ST and IS plan horizons shows applicable constraints, e.g. Personnel on Board (POB) limits, Shared	**Resource Management in IAPS Plans** LT (ARP) and MT plans are tied to strategic resourcing plans with specific requirements to link resourcing and procurement plans	**Resource Management in IAPS Plans** Strategic resourcing plans and resource constraints are actively used to drive prioritisation of activities within LT (ARP), and MT integrated plans in line with business objectives

				resources/Vessels, etc 3. Resource requirements from the plans (Demand Profile) are integrated with resource availability management. Updates to either demand or supply are made in respective tools 4. Identifiable plans for procuring additional resources are in place		
		Change Control No formal IAPS Change Control process is in place.	**Change Control** IAPS Change Control process is in place but not fully adhered to or utilised.	**<u>Minimum Requirements:</u>** **Change Control** 1. IAPS Change Control process is in place and adhered to for authorising changes to the frozen ST (IS) and MT IAPS plans. 2. What constitutes a change is defined and clearly communicated. 3. Relevant changes to IAPS activities in the Functions' Plans have followed the Change Control process and have been communicated to all impacted parties. 4. All changes to IAPS plans take account of the	**Change Control** All Range 3 statements are met with at least 4 of the Range 5 statements met with evidence	**Change Control** 1. IAPS Change Control process is consistently applied by all Functions, and there is evidence to support this for at least the preceding 12 months. 2. All changes to IAPS plans are approved by the right authority as specified in the Manual/Table of Authorities. 3. Reasons for changes are

				impact of the change, have proper offsets established and are authorised by the agreed authority (plan owner).		captured and communicated 4. The overall impact of these changes are tracked across the asset and reviewed to ensure that IAPS process is delivering desired business results. 5. Changes are analysed, root causes are captured, and corrective actions are implemented. 6. Business results impact from the changes is communicated to the Stakeholders concerned.

		Standard Operating Procedures (SOPs) No IAPS SOPs are in place, or SOPs are in place but not effectively used or followed	**Standard Operating Procedures (SOPs)** IAPS procedures are in place and occasionally used to deliver the IAPS Plans	**<u>Minimum Requirements:</u> Standard Operating Procedures (SOPs)** 1. IAPS procedures are aligned with Global Process, in place and being followed. 2. Procedures have timelines for generating, updating and issuing integrated plans 3. There is a governance process in place to manage changes to local IAPS procedures.	**Standard Operating Procedures (SOPs)** In addition to Range 3 statements, local IAPS and Functional planning procedures are aligned, current and adhered to.	**Standard Operating Procedures (SOPs)** In addition to Range 3 statements, 1. Local IAPS and Functional planning procedures are aligned, current and adhered to. 2. Swimlanes have been created for the SOPs
	Communication of IAPS Requirements and Plans: To what extent are the IAPS Requirements and Plans communicated throughout the Asset/LoB?	IAPS Requirements and approved plans are not communicated	IAPS Requirements and approved plans are communicated in an ad-hoc manner. No clear structure on communication.	**<u>Minimum Requirements</u>** 1. The approved IAPS Plans and Requirements are communicated in via a documented and clear communication structure. 2. Leaders cascade the plans throughout their organization or departments for effective alignment and execution	1. In addition to Range 3 statements, at least 1 Range 5 Statement is met	In addition to Range 3 statements, 1. Feedback is sought to ensure the IAPS plans are effectively communicated throughout the organization 2. there is a clear understanding throughout the organization of the IAPS requirements and

						how they are applied.
	Functions' Plans in IAPS: To what extent are the Functions' Plans integrated into the IAPS?	1. Key Functional plans needed for integration are not identified 2. Functions do not submit Functions' plans with clearly identified IAPS relevant activities. 3. Functions do not have improvement plans in place to address any gaps with Functional Planning process/data.	Functional plans exist for most of the key Functions needed for integration, but not all functions	**<u>Minimum Requirements:</u>** 1. Functions' Plans are submitted from all the relevant functions that impact on the asset's operations and production. 2. These plans are checked to ensure alignment with Business Outcomes/Targets set for the Asset or Business. 3. Functions submit plans per the IAPS Inclusion Criteria, with Activity Readiness status and mitigation plans to address associated risks. 4. All Functions submit their Functional plans with the level of detail required for the given plan horizon and is signed off by the Functional Plan owner before submission.	In addition to Range 3 statements, 1. Functional plans are reviewed regularly and approved in a timely manner 2. Right people attend plan review, with the right data, to allow timely decisions	In addition to Range 4 statements, 1. All the Functions proactively engage with the other Functions to identify constraints and optimise the activities before submission. 2. There is a clear hierarchy of plans and meetings within the Functions supported by plans that echo the delegation of activity from strategy and objective setting (ARP, MT) to work execution

				5. Activity details underpinning the Functional plans are consistently available and recorded, including the preparatory activities, associated resources, timescales, constraints and production impacts. 6. Functions continuously improve their planning process with outcomes reflected in their updated Functional plans. 7. Functional plans are updated and submitted per the IAPS planning calendar deadline in order to support quality and timely IAPS plan delivery.		(VST/Integrated Schedule). 3. Scenario building with a clear probability of success for execution and scope optimisation is done for MT plans to enable decision making at the asset level for integration. 4. Functions' plans are owned by the appropriate level of leadership within the functions and signed off before submission for Integration. 5. Functions proactively identify, quantify, and document risks associated with the delivery of their activities and actively work mitigation plans.

	Integrated Plans: To what extent are IAPS plans developed and implemented?	1. There is no Integrated Activity Plan and Schedule covering the required plan horizon windows and include activities from all functions.2. The Short Term plan is not aligned with the Medium Term plan for the asset.	1. Plans exist for all proscribed time horizons (MT, ST and IS) but are not integrated with Functions or across time horizons2. LT and MT plans exist but do not cover the whole Asset3. ST (and IS) plans exist but are not in place for each operational facility	Minimum Requirements: 1. LT (or ARP), MT, ST and IS plan horizons exist and cover the requierd time horizons in each case2. LT and MT plans cover the whole Asset/LoB3. ST plans are in place for each Operational Asset and cover all Functions delivering IAPS work on the facility3. Each integrated plan has a clear objective and a hierarchy reflecting business priorities4. LT plan is linked to established business objectives and/or Asset vision statement; these cascade through the MT, ST and IS showing clear connectivity between executable work and business objectivesFor the MT Plan:5. The MT IAPS forms the basis of the first 2 years (at a minimum) of the Business Plan submission and is aligned with the approved	In addition to Rage 3 Statements,1. ST integrated plans are integrated with the Work Management System (SAP) and a IS schedule is created for All Work2. MT plans clearly drive the Production Forecast for the business and contains all production impacting activities	1. There is a clear connected hierarchy of plans and meetings within the business, supported by integrated plans that echo the delegation of activity from strategy and objective setting to work execution2. The IAPS Plans are underpinned by detailed Functions' plans which are consistently available and updated3. Functions's Plans incorporate; activities for execution, preparatory activities, associated resources and constraints, HSSE and Third Parties

				Business Plan.6. The MT IAPS takes account of identified constraints and displays the latest Activity Readiness (AR) status, formerly known as Plan Execution Criteria (PEC) status 7. The MT IAPS is linked to and aligned with the annual Production Forecast. 8. All Turnarounds, or other activities requiring production outage(s), are included in the asset IAPS which sets the Turnaround date in the Asset/Business calendar. 9. A high level, Integrated Turnaround Plan for the next five years (minimum) are incorporated in the long-term asset plans (ARP, BP or equivalent). 10. Estimated resource requirements and forecast are incorporated into the asset MT IAPS, e.g. POB/POS/Barges.For the ST Plan.		impacts and outages.4. Plan content is agreed and adhered to. 5. Functions and asset, identify, quantify and mitigate risks which are reviewed regularly and updated.6. Risks to plan delivery (schedule risks) are identified and mitigation measures defined and in place.7. The Medium Term Integrated Activity Plan has been updated at least quarterly for at least the preceding 12 months. 8. The Short Term Integrated Activity Plan has been updated at least monthly for at least the

				11. Activity details underpinning the functions plans in the ST are consistently available and recorded, including the preparatory activities, associated resources, timescales, constraints and production impacts. 12. The ST IAPS is aligned within agreed MT IAPS windows, take account of identified constraints and display the latest ST Activity Readiness (AR) status. 13. The ST IAPS is aligned with the ST Production Forecast. 14. Detailed turnaround plans are in place and aligned with the IAPS and are supported by turnaround driver sheets. 15. Detailed resource requirements are incorporated into the asset ST IAPS including trades/constrained/third party resourcesFor the IS/Integrated Schedule.		preceding six months. 9. Plans affecting the Integrated Production System has fully adhered to the requirements of the IAPS planning process.

				16. The IS/Integrated Schedule contains all activities (IAPS + non-IAPS) to be executed on the facility. 17. The approved IS/Integrated Schedule is used to freeze the PoB, Flights and Vessel scheduling.		

	Third-Party Activities: To what extent are activities from relevant third parties currently integrated with the asset plans?	Relevant third parties activities that impact the Asset objectives are not involved or consulted, and their project plans are not included as part of the planning process.	Relevant third parties activities that impact the Asset objectives are not regularly consulted, and their project plans not always included as part of the planning process.	**Minimum Requirements** 1. Relevant third parties and project plan tie-ins affecting the Integrated Production System and business objectives are collated and integrated into the IAPS plans in accordance with agreed data structures and timelines. 2. All third parties are informed of Turnarounds/Shutdowns in good time for them to prepare.	1. In addition to Range 3 statements, at least 2 of the Range 5 Statement is met	1. Plans affecting the Integrated Production System has fully adhered to the requirements of the IAPS planning process. 2. Third-party demand plans are aligned with company activity plans. 3. A formal decision making and change process are in place with the third parties. 4. All the parties agree to the plan with recorded evidence of an agreement, e.g. MoM.

	Effective IAPS Meetings: How effective are the IAPS meetings to drive delivery and performance improvements?	1. The Asset/LOB does not conduct IAPS meetings or meetings are generally arranged at short notice on an ad-hoc basis. 2. Meeting agendas are generally not circulated.	IAPS meetings are in place, but there is no structured TOR, meetings inputs/preparedness and outcomes	**Minimum Requirements:**1. The IAPS meetings are effectively managed by the Plan Owners with clearly signed off meeting TORs in place and meeting objectives achieved. 2. The TORs include meeting objectives, standing agenda, meeting frequency and dates, minimum input requirements, mandatory attendees and distribution list for each plan.3. Mandatory attendees do attend the meetings (90% attendance) and are prepared to contribute and challenge for effective decisions and meeting outcomes4. Meeting delegates are given full authority and are well prepared to contribute to the meetings	1. In addition to Range 3 statements, meeting attendees do participate and feel included.	1. In addition to Range 3 statements, Meeting TORs and attendees list are regularly reviewed and updated to ensure the meeting objectives are met, and meeting outcomes and plan can deliver the asset/business promises.

Data	**Data Requirements and Quality Metrics:** To what extent are the data quality standards and metrics defined and applied?	There are no documented IAP data quality standards in place. There are no IAPS data quality metrics in place.	1. Not all Functional plans exist in the IAPS planning database 2. Data is not completely populated in all mandatory fields (Activity Unique ID, Activity Name, Plan - MT or ST or both, Planned Start Date, Planned Finish Date, Asset, Facility, Function, Activity Readiness Status, Shared Resource)	**<u>Minimum Requirements</u>** 1. All Functional Plans exist and reside in the IAPS planning database (P6) to support effective integration. 2. The Functions and their planners hold their activity planning data at the level of detail prescribed at each planning level. 3. All projects and their activities in Primavera P6 have values populated in mandatory fields (Activity Unique ID, Activity Name, Plan: MT or ST or both, Planned Start Date, Planned Finish Date, Asset, Facility, Function, Activity Readiness Status, Shared Resource) 4. Based on the OU or specific activity, additional fields can be populated (Location, Duration, POB, Activity Owner, Exclude from	The following criteria should be met in addition to those mentioned in range 3: 1. Data is consistent between Functional Plan and IAPS 2. Data is consistent between Functional Plan in IAPS planning database and in the application used by the function 3. Validation rules set up in the IAPS planning database are valid across all plans to enable smooth and efficient consolidation to produce IAPS	1. Consistency in Range 4 statements where evidence supporting this for at least the preceding 12 months. 2. Data quality Metrics are in place to measure the quality of IAPS data against data quality standards. 3. Data quality Metrics and identified discrepancies are communicated to relevant IAPS staff and Functions' Planners. Actions are taken to address the identified discrepancies.

				IAP KPI, System Condition/Production impact, Comments) 5. The data quality standards are communicated to all relevant IAP staff, and Functional Planners and activities submitted in IAP are checked monthly against the data quality standards. 6. Data quality assurance steps are documented and embedded in relevant IAP process documentation		

	Data Governance and Integrity: To what extent are Information & Data (I&D) Value Owners actively managing data quality? To what extent are changes to the published IAPS controlled by the IAPS planner?	1. The ownership of IAPS data and Functions' Plan inputs into IAPS is not formally assigned 2. Non-IAPS Planners (e.g. Function Planners) are able to make changes to published IAPS plans	1. I&DVO roles are senior business roles and usually assigned to asset process owners. 2. Only some I&D value owners and focal points are assigned in IAPS and function teams. 3. No clear segregation in role & responsibility in maintaining Functional Plans vs IAPS	1. The role of I&D Value Owner is formally assigned within the IAPS team and Functions' planning team. 2. I&D Value Owners are trained and understand their responsibilities for data quality. 3. The I&D value owners review the quality of data regularly. 4. IAPS planners are in control of most of the planning and published IAPS data. 5. Any change to the activities in the approved IAPS is done through the Change Control process.	1. I&D roles are formalized in job descriptions and annual GPAs of IAPS and functions' planning teams. 2. I&D roles are adequately resourced. 3. On-boarding & off-boarding of I&D roles is performed consistently. 4. Any approved change in Functional Plan is consistently recorded in function application, Functional Plans and IAPS planning database following the change control process	1. Evidence and metrics trends support Range 4 for at least the preceding 12 months. 2. I&D value owners initiate cleansing and/or improvements to data capture, update & QC procedures as required 3. Consistency across function application, Functional Plan, and IAPS 4. I&D Value Owners have data quality metrics included in their GPA

Systems	**IAPS Systems:** To what extent are systems in place to support the IAPS process?	1. There is no standard IAPS system in place. 2. There are no controls on plans and data in place.	The management of IAPS is accomplished through the use of multiple Functional Activity Plan systems (Excel, MS Project, Primavera P6, SAP, and custom solutions) with limited consolidation.	**<u>Minimum Requirement:</u>** 1. The Functions' Activity Planners provide plan information into a standard solution (Primavera P6), allowing the management of IAPS to be performed in a single tool. 2. Knowledgeable users are in place and known within the organization. 3. IT training guides and job aids exist. 4. Individuals know who to and how to engage for tool support. 5. Tool owners, sponsors, custodians are known at Asset and Group level. 6. Some improvements/automation in data gathering, freezing, reporting, publishing, alerting, etc. 7. An IAPS IT toolset is in place with auditable records.	Primavera P6 is used for all Functional planning across all time horizons and integrated/automated with all planning systems such as SAP/Maximo, etc	1. Functional Activity Planners provide plan information into the approved Global Planning Toolset (Primavera P6 or SAP), and the plan information is integrated into a single IAPS. 2. Impress is used as required where SAP mastered work activities (Maxavera and Maximo if appropriate) are input into Primavera P6 to ensure alignment of required activity data requirements such as work activity dates between source systems and to minimize re-work for ST and IS plans. 3. Superusers or

						advanced users are in place and meet with peers. 4. Detailed IT training guides and job aids exist. 5. Tool support and governance is routine practice. 6. There is a maximum of automation in data gathering, freezing, reporting, publishing, alerting, etc. 7. IAPS tools are aligned with Functions' Plans tools in terms of data definition, coding and synchronisation (automated for bi-directional data transfer) 8. An IAPS IT toolset is in place, enabling effective and efficient IAPS

						with auditable records.

	Integration with Work Management System: To what extent are the ST and Integrated Schedule (VST) plans integrated with the work management systems	There is no integration of the IAPS planning tool (Primavera P6) and Work Management System tool (SAP)	1. There is limited integration of WMS and IAPS processes and systems 2. Roles and responsibilities for the creation, acceptance and approval of Work Orders (WO) are unclear 3. Manual workflow for moving WO from WMS (in SAP or Maximo) to IAPS and back again, is fully documented with clear roles and responsibilities	1. IAPS planners have an automated process to move IAPS activities WO from WMS into the ST plan which is run regularly to prepare for ST and Integrated Schedule (VST) meeting cycles 2. Work Management system contains All Work, e.g. "All executable activities at an operational facility." 3. ST Plans contain IAPS activities frozen for the Integrated Schedule (VST) 4. The Integrated Schedule (VST) Plans contain all work and is frozen for the 14-day look ahead 5. The Frozen 14-Day plans are over-ridden only by emergency or urgent break-ins 6. Non-emergency/Non-urgent break-ins are scheduled in the ST time horizon or beyond	Activity Readiness criteria are applied to work orders (WO)/ activities by the Activity Owner to reflect the readiness of work for execution at appropriate points (ST, IS, 2W)	IAPS planners have an automated process to move IAPS activities WO from WMS into the ST plan and back again which is run regularly to prepare for ST and Integrated Schedule (VST) meeting cycles

	IAPS Performance Measurement and Calculation: Are systems in place to automate and measure IAPS quality and performance?	1. There are minimum tools/ systems in place to measure the IAPS quality and performance. 2. The performance data generated can be manually manipulated.	1. There are standard tools/ systems in place to measure the IAPS quality and performance. 2. The performance data generated can be manually manipulated.	1. IAPS quality and performance tools are in place, and measurements are automated through the IAPS Portal. 2. IAPS tools readily generate the Data for measurement of the IAPS quality and performance, thereby preventing any manipulation of the data.	In addition to Range 3 statements, at least 1 Range 5 Statement is met	1. IAPS quality and performance tools (IAPS Portal) are in place and regularly used to evaluate current performance and identify areas to improve performance. 2. The IAPS quality and performance tools are viewed as a trigger to initiate actions to improve the effectiveness of IAPS performance. 3. IAPS Performance data generated by the systems is high quality and allows for cross OU performance comparisons.

Organisation Structure, Roles & Responsibilities	**Organisation Structure:** How is the asset organisation setup supporting the IAPS process?	There is no clear reporting structure/line of sight for the IAPS Planner in the Asset/Business organisation structure	There is an organisational structure with the IAPS role identified, but the IAPS Planner is not reporting through the Asset or Business	There is a clear IAPS organisation in place with the IAPS Planner reporting through the Asset/Business organisation structure	There is the clear IAPS organisation in place with the IAPS Planner reporting through a mix of the Asset/Business organisation structure and the IAPS Plan Owner	There is the clear IAPS organisation in place with the IAPS Planner reporting through the IAPS Plan Owner
	IAPS Roles & Responsibilities: To what extent are the roles involved in the IAPS process clearly defined, responsibilities documented and adequately resourced to deliver the plan?	1. There is not clearly defined and documented IAPS roles and responsibilities. 2. Even when defined and documented, these roles are not adequately resourced to deliver the IAPS plan.	1. IAPS roles are defined and documented but not adequately resourced to deliver the plan.	**Minimum Requirements:** 1. The IAPS roles and responsibilities are clearly defined in a RASCI and documented. 2. The responsible parties' roles and responsibilities are communicated with up to date job descriptions. 3. The roles are adequately resourced to deliver the right IAPS plans.	1. All of Range 3 statements are met with at least 1 of the Range 5 statements are met with evidence	1. Key process stakeholders, including process owners, plan owners, planners and contractors, are being included in procedures, assurance and feedback exercises. Active engagement is in place. 2. All roles and each step and sub-step within the IAPS process is identified and performed in line with the applicable RACI

People	**Resourcing, Development & Competence:** How is the resourcing and competence of IAPS Planners, Function's Planners and other IAPS relevant roles managed?	1. IAPS roles have not been formally assigned or resourced. 2. The IAPS competence programme has not been implemented. 3. No training has been given.	1. Some critical IAPS roles have been resourced 2. IAPS Competence programme is in place; training has been provided but follow up coaching has not been implemented	**Minimum Requirements:** 1. There is an adequately staffed IAPS organisation in place, championed by asset leadership and staffed by competent individuals with clearly defined roles. 2. Job competency profiles and individual training plans designed to close JCP gaps are in place and linked to the global IAPS training staircase. 3. Job descriptions incorporating IAPS requirements exist for key IAPS roles 4. The majority of the planners have done their competence assessment and an agreed gap closure plan in place. 5. Clear objectives for personnel performance have been set 6. Onboarding training is provided to all new IAPS planners, and there is an adequate transition time	1. People are enabled and supported in performing their roles effectively by management, with tools and technology 2. Gap analysis is generated, but Asset performance interventions or coaching activity doesn't align with gaps. Gaps are not analysed to understand the underlying causes of rectification. 3. A clear sense of professional development and career path for planning community	1. There is a fully staffed IAPS organisation in place, championed by asset leadership and staffed by competent individuals with clearly defined roles. 2. Succession planning is done for key IAPS roles, and potential candidates are identified in advance. Leadership allows for adequate transition time between outgoing/incoming IAPS staff. 3. There is a clear link between the gaps and the training plans for individuals. Formal assessments are completed as a

				between outgoing/incoming IAPS leads. 7. Staff have been trained to use the IAPS tools.		condition for staff progressions. 4. Staff development, training and succession are regularly reviewed to identify improvements and implement them. 5. Leadership provide a clear pathway to further career development opportunities for successful IAPS staff. There is a clear Employee Value 6. A proposition in place for all IAPS positions, and this attracts top talent. 7. Insight into business management provided by IAPS. The role is seen as a crucial foundation step for

						future business leaders

	Coaching: To what extent do IAPS Planners/Leads and Supervisors make time to coach IAPS roles?	The IAPS Leads, Supervisors and senior staff do not commit sufficient time to coach other IAPS roles.	There is a formal coaching program in place but not adequately utilised or implemented	1. There is a formal coaching program in place, IAPS practitioners have received training, developed on the job coaching skills and put aside time to coach. 2. The IAPS Leads, Supervisors and senior staff have coaching experience and regularly provide coaching to the other IAPS roles in the Asset.	1. All of Range 3 statements are met with at least 1 of the Range 5 statements are met with evidence	1. Gaps used to inform interventions and coaching needs to improve compliance with IAPS process requirements. 2. The IAPS Leads, Supervisors and senior staff regularly spend the required amount of time on coaching their staff and is reflected in the GPA. 3. All new IAPS staff have been assigned a mentor and meet with them regularly. Mentor/mentee have developed an agreed plan for ensuring mentee development.