COVERSHEET

THE UNIVERSITY OF WESTERN AUSTRALIA

School of Engineering

Assignment, Report & Laboratory Coversheet for Individual & Group Assignment

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UNIT NAME PROJECT MANAGEMENT		**UNIT CODE** GENG5505
TITLE/TOPIC OF ASSIGNMENT GROUP REPORT		**NAME OF LECTURER/TUTOR** COSIMO FAIELLO
DATE/TIME DUE 12PM MONDAY APRIL 17TH	**DATE/TIME SUBMITTED** SUNDAY APRIL 16TH	

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FMG Echo-Indexer

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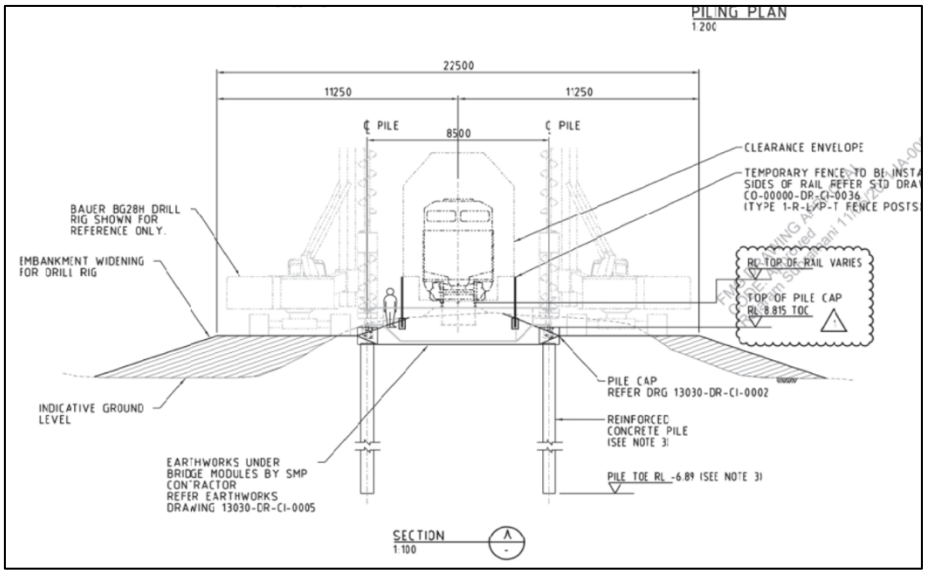

1 Executive Summary

This report critically analyses the installation and commissioning of an Echo Indexer at Fortescue's Port Hedland facility, from a project management perspective. Section A provides the background to the project. It is explained that an indexer is a mobile platform that pushes two ore cars at a time into an unloading cabin, where a tippler is responsible for tipping and unloading the ore cars. However, at the Port Hedland facility, the train unloading facilities were not designed for the train's two final ore cars. This created issues according to the triple bottom line framework – social issues included poor safety and time inefficiency, and economic issues were related to delays in train unloading and costs of this. Consequently, the installation of an Echo Indexer was proposed to fix these.

Section B identifies project management issues related to the project. PMBOK standards are used to analyse each of the four project life cycle stages. In the concept stage, issues arose with different international electrical standards which could have been avoided with improved procurement management. During the planning stage, poor communication management further caused difficulties with differing international electrical standards, and dissatisfactory human resource management resulted in difficulties removing the rail. This rail difficulty was experienced in the execution stage, which presents an opportunity to improve the scope and cost managements. Poor quality management during this stage also resulted in the installation of additional pipes and components that were not part of initial plans, however these were not known until the finalisation stage. Slow modifications to the indexer in the finalisation stage also presents an opportunity to improve quality management.

In Section C, recommendations are provided to prevent and mitigate these issues discussed. The PDCA cycle can be used to assist with quality management during the execution stage, so the installation of additional component can be properly documented and managed (hence prevent cost blowouts). The use of an RACI and Stakeholder Management Plan can improve stakeholder and communications management. Improved costs management can also help prevent over-budget expenditure, such as with the additional components installed that were not initially budgeted for.

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1.1 List of Figures

1.2 Wordcount Breakdown

Section	Recommended	Actual
A: Background	1,500	1,547
B: Analysis	2,500	2,732
C: Recommendations	2,000	1,951
Total	6,000±5%	6,230

1.3 Acknowledgements

We would like to thank Fortescue Metals (FMG) and Raj Subramani, for allowing us to analyse this project. In particular, thank you to Raj for providing us with relevant project documentation, and for giving up his time in conducting an interview with us regarding his experiences project managing the Echo Indexer project. Raj works at FMG as a Project Manager. The interview we conducted with him is included in appendix 3 – although it should be noted his answers are paraphrased from our perspective and understandings, and do not represent a comprehensive reflection on the project from Raj or FMG.

2 Section A: Background

2.1 Fortescue Metals Group Ltd

Fortescue Metals Group Ltd (FMG) is one of Australia's leading Iron Ore exportation businesses, shipping 189MT of product in the previous financial year (Fortescue Metals, 2022). FMG prides itself on consistency and the conduction of its business endeavours in tune with its core values and principles. These values being Safety, Integrity, Family, Enthusiasm, Empowerment, Courage and Determination, Frugality, Generating Ideas, Stretch Targets, and Humility (Fortescue Metals, 2023a).

The business exports multiple commodities, with each commodity being of a different chemical composition. Each of these commodities are extracted from the company's mine sites in the Pilbara region of Western Australia. Notable operations of the business are the mines at Chichester Hub, Solomon Hub, Western Hub, and Iron Bridge. All the product collected from these mines are transported to a port distribution plant which loads the product to bulk carriers, which then deliver the product to the clients. The port distribution plant is located in Port Hedland, Western Australia, where the incoming product is freighted through means of a locomotive and a train of ore cars (Fortescue Metals, 2023b). The plant consists of a variety of fixed and mobile assets, which are used to transport the ore from the trains to the ships.

The fixed assets directly incorporated with ore handling, encapsulate structures such as train unloaders, conveyors, transfer stations and sample stations. Mobile assets primarily are the balance machines which are used to deposit and reclaim the product – Stackers, Reclaimers and Ship loaders.

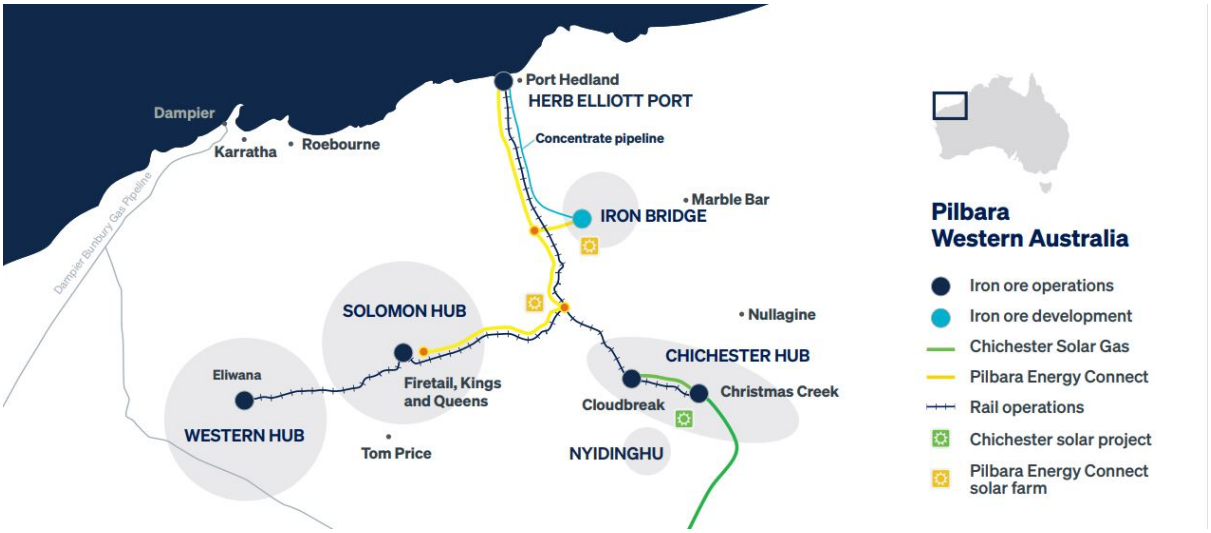


Figure 1 - FMG Operations Overview (Fortescue Metals, 2023b)

2.2. Project Overview

The project being analysed is the installation and commissioning of an Echo Indexer, used at the exit of the Train Unloaders, to cycle through the entire train of ore cars without the requirement of additional compressor cars at the back of the train.

To gauge the reasoning behind initiating the project, and the value of implementing the changes that the project imposes, we must first understand the procedure of unloading the trains upon arrival to Port Hedland.

2.2.1 Train Unloading

As the fully loaded trains embark upon Port Hedland, they are first directed into a locomotive service yard to secure a pair of compressor cars to the end of the lines. Following this stage, the train is escorted through to the Train Unloader facilities (TUL). The train unloaders operate through a pair of tippler cells, in which a pair of ore cars are cycled through. The procedure is kickstarted by the ore cars being positioned at the entrance of the train unloader. An indexer, which is a mobile mechanical platform which runs on its own set of rails, is used to push two ore cars into the unloading cabin at a time. The indexer achieves this by extending a set of arms underneath an ore car, clamping onto the car's structural frame, and feeding the car through to the unloader.

Figure 2 - General Calbrandt Indexer (Calbrandt, 2023)

Once the ore cars are in line with both tippler cells, a set of four wagon clamps are actuated from the unsecured to the secured position and clamps down on all four corners on each ore car. Once the pair of ore cars are adequately secured on their tracks, the tippler cell rotates the entire car to an inverted position, tipping out all the product in the process. Once all the product has been tipped, the cell returns to its neutral position, the wagon clamps disengage, and the indexer goes to cycle the next two ore cars through the tippler cell to reinstate the tipping process.

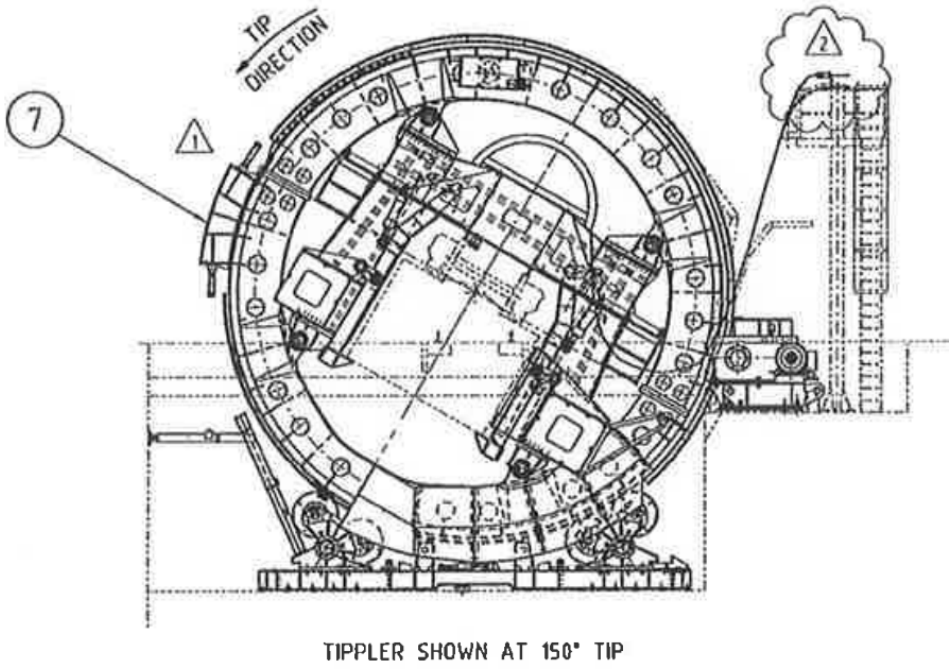


Figure 3 - Front view of Train Unloader Tippler Cell

When the indexer reaches the final two cars, and pushes them through the tippler cells, the train of empty ore cars will be left stagnant, as there are no more ore cars for the indexer to cycle through. To solve this issue in the past, the business had opted to employ the two compressor cars at the back of the train of ore cars. These compressor cars have the capability of propelling the empty train of ore cars out of the train unloading facility. Thus, the final two cars that the indexer will cycle through are the compressor cars, and following the final indexing, the train is left to the compressor cars to propel them away.

2.2.2 Issues Raised

Issues and complications are identified when a process or operation unnecessarily compromises the business core values and principles, as well as providing added incentives to the three pillars that contribute to the TBL Framework (Triple Bottom Line), Social, Economic and Environmental areas (Miller, 2020). The inclusion of the two compressor cars to the train of ore cars poses the following complications when assessed in a TBL framework:

2.2.2.1 Social

The action of coupling and decoupling compressor cars onto the trains, requires manual input and handling. Often, the business aims to focus most of its operations on automation and drive away from manual input from its personnel. The aim of transitioning to automated processes is to increase safety and time-efficiency. Many of the injuries to personnel across the business occur because of poor manual handling – lifting techniques, poor posture, and tool injuries, as well as dehydration, coming from working in the Pilbara's harsh climates. As well as this, manual labour often at times poses a greater duration to tasks than if there was an automated counterpart. Due to the additional requirement to incorporate manual labour to couple and decouple compressor cars; these pose an increased risk to personnel injury, and further results in an increase in process downtime. Thus, the core values of Safety, Frugality and Stretch Targets are compromised.

2.2.2.2 Economic

When the train of ore cars are transported to PHE, there needs to be time allocated to couple the compressor cars to the back of the train, and this requirement results in offline time. This additional offline time compromises on the values of Frugality and Stretch Targets. In the business, if there are any instances where the processes are delayed, these delays will build up and effectively lead to less-than-optimal exportation rate at the Port. This unoptimised exportation rate directly opposes Frugality and Stretch Targets. In addition, the requirement of using additional compressor cars in the operation of unloading the trains results in thorough maintenance and upkeeping of these assets, in which if an alternate solution was pursued, these additional costs and resources could be saved, or dedicated elsewhere which could be more beneficial to the business.

2.2.2.3 Environmental

There were limited environmental benefits that could be reaped by exploring alternate solutions in place of the current operations.

2.2.3 Solution

To address the above concerns, the business opted to engage a third party (Calbrandt) to design a secondary indexer, called the Echo Indexer, which they would install at the exit of the Train Unloading Facility. This would solve the problem of having to attach two compressor cars at the end of the train, as the indexer at the exit of the facility will now be used to cycle the end two cars through the train unloader. The project scope from FMG is to install the design at the exit of the TUL, see appendix 1. The installation of the Echo Indexer was elected to be undertaken during the line 'shutdown', which is a scheduled period of time that the Train Unloader is offline, and thus would not be holding any of the operational processes. The total time allocated for the installation was 160 hours and was deemed successful and commissioned within that time, however there were setbacks experienced that could have resulted in a swifter project timeframe. Such setbacks were the misinterpretation of the AS/NZS electrical standards that Calbrandt (a US-based contractor) had to ensure their designs complied with, the installation of additional underground pipes and other components that were not part of initial designs, troubles removing sections of rail to install the Echo Indexer, as well as teething issues during the Indexers first months of operation.

2.3 Stakeholders

PMBOK defines a project stakeholder as a 'person or entity that may or may not gain and benefit from the project, but can materially affect its outcome' (Hartley, 2018).

Through investigation of the project, it can be identified that the stakeholders exist both internally, and of direct relation to the project, as well as those external to the project, in which the parties are indifferent to the outcome, but still influence the operations taking place and the overall outcome.

2.3.1 Internal Stakeholders

The internal stakeholders are identified as those directly involved in the concepting, planning, execution, and finalisation of the project. These stakeholders will be the primary focus of this report, as they are the parties that are impacted by the project, and thus require to be engaged to ensure a successful progression of all project stages. Fortescue Metals Group is the primary stakeholder of the project, along with contracting companies Calbrandt, CIVMEC, and BG&E, who undertook the execution of the project.

2.3.2 External Stakeholders

External stakeholders for this project are the Australian / New Zealand regulatory bodies who define the standards and regulations that all operations must abide by, the Western Australian Government, and more specifically the Port Hedland Community councils, whom ensure that all operations that are conducted on their area do not compromise the social, economic and environmental state of their area.

3. Section B: Analysis

3.1 Introduction to the Project Life Cycle

The project life cycle is a sequence of stages from the commencement of a project to completion. By analysing the Echo Indexer project at each life cycle stage, the chosen project can be critiqued from a project management perspective, and appropriate recommendations can be suggested to improve the project outcome. The four key project life cycle stages are: conceptualisation, planning, execution (which includes monitoring and controlling), and finalisation (including evaluation) (Hartley, 2018). The indexer project stages are devised from the project schedule, excerpt in appendix 2, of which they key dates are shown in figure 4 (Fortescue Metals, 2021a).

Activity	Date
Mobilisation and Site Access	May 2021
Delivery of Indexer and all other free issue items to site	Early August 2021
Shutdown Construction Works (160 hrs shutdown time, 136 hrs tool time)	31/08 12 PM to 6/9/2021 4 pm
Punch listing and Handover	6/09/2021 4 pm
MDR submission	20/09/2021

Figure 4 - Key Project Dates (Fortescue Metals, 2021c)

- Concept – formation of project by discussing preliminary goals, benefits and problems. For the Echo Indexer project, this included the drafting of scope, feasibility and procedural documentation which was completed by early May 2021.

- Planning – project is planned and arranged, resources assigned, and objectives and schedules created. This included the revision of schedules, objective and design documentation, health and safety training, contracts signed, and pre-shutdown works on site completed, for the Echo Indexer. These were undertaken between May and August.

- Execution – the actual project is undertaken and completed during this stage; all tasks are monitored, controlled, and corrected and compared to planned schedules. This involved the shutdown stage when the indexer was installed, and occurred between the 31st August to the 6th September 2021.

- Finalisation – following the project's completion, deliverables are handed to the client and administrative tasks finalised. For the Indexer, this included site clean-up, product inspections and post-project completion evaluation documentation, throughout September.

The project management body of knowledge (PMBOK) standards are a global set of management criteria to analyse performance during the various project management stages (Hartley, 2018). The 10 processes all require investigation, documentation, discussion and review, initially and ongoing through the life cycle. These 10 criteria will be used throughout this case study analysis to critically analyse problems encountered in each life cycle stage. A list of the PMBOK standards and a description of each are displayed in the table below (Hartley, 2018).

PMBOK STANDARD	*DESCRIPTION AND PROCESSES*
SCOPE	Requirements – determine and manage project deliverables and expectations.
TIME	Schedule – determine, implement and manage project schedule.
COST	Budget – identify, analyse and adjust project costs.
QUALITY	Technical excellence – manage quality planning, assurance and improvement procedures.
HUMAN RESOURCE	Performance – determine resource needs, performance issues and evaluation.
COMMUNICATIONS	Information – ensure timely and appropriate collection of information though formal or semi-formal structures.
RISK	Probability and impact – identify, assess, treat, monitor and control positive and negative project risks.
PROCUREMENT	Agreements and contracts – manage procurement activities.
STAKEHOLDER	Vested interest – identify, plan and control stakeholder engagement.
INTEGRATION	Unified application – integrate and manage all project management areas.

3.2 Concept Stage

3.2.1 Procurement Management

Calbrandt was awarded the contract to design the Echo-Indexer for FMG. Issues arose from Calbrandt due to misunderstandings between international countries. As a result, extra costs were incurred by FMG to ensure all supplied equipment was up to the Australian AS/NZS 3000:2018 electrical standards. These additional costs were communicated to us from an interview with FMG's project manager from this project. The questions asked, and interpreted and paraphrased answers, are displayed in appendix 3. These standards set out requirements for all electrical installations in Australia (Standards Australia, 2018). These costs would not have been incurred, had the manufacturer ensured complete due diligence in meeting these standards. Had FMG identified a suitable vendor for the equipment, this issue could have been avoided. Whilst it may be the case that Calbrandt is the most suited supplier, no such evaluation or analysis was conducted by FMG.

Had FMG done a more thorough procurement management process during the conceptualisation stage of this project, a more suitable supplier could have been identified (such as local vendor who is aware of all relevant standards and their implementations). A key element of successful project is that alternative solutions are identified and discussed (Hartley, 2018). By not implementing this, the procurement management during the conceptualisation stage was insufficient.

3.2.2 Scope Management

FMG is to be commended for its scope management work during the conceptualisation stage of the project. It was through a stringent procedure and undertaking of scoping work, that set FMG up for success in the final three stages of the project.

Any project on a mine site that directly affects the production of the site is required to undergo a thorough initial scoping and feasibility study. In terms of mistakes, a mining company can often not afford to make them with such critical projects. As a result, this project was thoroughly scoped out and conceptualised sufficiently. According to PMBOK, this encapsulates “directing exactly how the scope will be dealt with throughout the project” (Hartley, 2018).

The scope of work completed for this project captured multiple key frameworks and initiatives. These include, but are not limited to, technical requirements, project purpose, inclusions and exclusions, a WBS and differing levels required, performance requirements, key site details, and more (Fortescue Metals, 2021c). This non-exhaustive list captures the exceptional due diligence done by FMG in the initial scope of the project. A general layout of the planned Indexer system is displayed below, in figure 5, demonstrating the detailed scope of works. Due to this, the project’s requirements and desired purpose was well-defined and verifiable. All stakeholders held the same expectations surrounding the project, and this was paramount in successful completion.

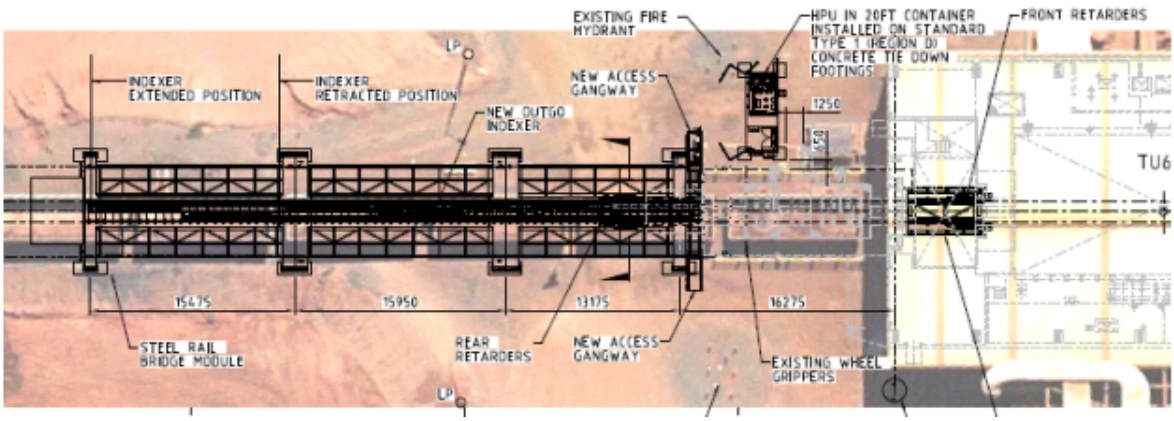


Figure 5 - General Indexer System Layout (Fortescue Metals, 2021c)

3.3 Planning

3.3.1 Communications Management

Leading up to the execution stage, issues arose due to an improper understanding of the AS/NZS 3000:2018 standards from Calbrandt. Due to the high-voltage nature of the Echo Indexer, it is required to be followed, with serious consequences for failing to comply (Fortescue Metals, 2021d). A major reason for this failure was due to poor communications management between the client (FMG), and the contractor (Calbrandt).

FMG for the most part had impeccable communications management during the planning stage. Weekly meetings were held between all stakeholders, formal scope reviews and change processes were followed, a project charter was developed, and meeting minutes were succinct and distributed. All of these are key elements to successful communications management during the planning stage (Hartley, 2018). Within these elements, the AS/NZS 3000:2018 standards were identified as key constraints for the project by Calbrandt (see appendix 4).

The issue arose however due to improper communication from FMG around their expectations of how the standards are to be met. No formal document, meeting or register was provided to Calbrandt that set out each FMG expectation related to the standards, and how this could be practically met in the project.

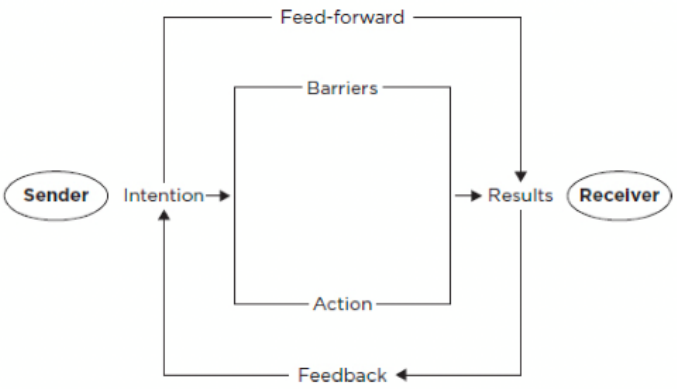


Figure 6 - Communications Barriers

Figure 6 highlights the issue faced. Whilst FMG (the sender) had clear intentions when communicating the scope, Calbrandt (the receiver) received filtered information. Calbrandt is a US company and thus apply their own interpretation and perspective, which causes barriers. The result Calbrandt acts on then is not the intended that FMG meant.

3.3.2 Human Resources Management

When the Echo-Indexer was being installed, extra costs arose due to unforeseen extra work required to remove sections of rail. Civmec had to bring in extra labour, and the stakeholder that had to foot the cost of this burden was initially not clear. The costs that FMG was to cover were debated with Civmec. In the end, FMG agreed to cover all costs due to the underlying issue being a result of FMG negligence. This issue would not have surfaced, had FMG had a more stringent human resources management plan, that not only incorporated contingencies for extra-labour hire, but also who the cost burden would fall of (dependent on the context of the issue).

To effectively meet the PMBOK standard of HRM, multiple frameworks and procedures should be followed to ensure the project is a success (Hartley, 2018). FMG took many steps to ensure the contractor workforce was well suited to the project. A health and safety plan for all workers was established in their "Health, Safety, Environment and Security Plan". This was shared and distributed with all contractors to ensure they were aware of all controls in place to protect them. Their "Personnel Training and Qualifications Matrix" was an important framework which ensured all contractors were licensed and legally able to complete the task they had to do. However, according to PMBOK, 2013, the project manager needs to also "communicate potential consequences to stakeholders for failing to acquire the necessary

resources", and "evaluate potential resources against the ambit of legal... criteria covering their assignment" (Hartley, 2018). Within these requirements, contingencies for extra labour-hire should have been captured. The responsibilities and burdens should have been set out in an agreed upon document which would ensure both FMG and Civmec have the same expectations. It was partially due to this requirement being missed, that FMG incurred unforeseen extra costs.

3.4 Execution

3.4.1 Scope and Cost Management

Given the difficulties implementing this new TUL indexer technology in Australia with an international manufacturer, such as time zone and electrical regulation differences, scope identification and refinement was completed adequately during the concept and planning stages. However, despite the existence of various planning and designing documents, there is room to improve the project scope creep techniques during the execution stage. A lack of scope modification resulted in budget blowouts due to additional components and difficulties removing the rail (from appendix 3).

The installation of additional underground pipes and components was not updated on FMG's necessary scope and design documents, given it was not discovered until the finalisation stage. Hence the FMG project managers were not aware of the design inclusions. These inclusions were necessary to complete the project, however, because the initial designs did not completely consider Australia's electrical installation regulatory framework or the resource unavailability of existing hardware. Scope creep should be encouraged under this situation due to the difficulties with modifying an existing international TUL indexer design in Australia to meet FMG's requirements, however it can be difficult to manage properly with a lack of documentation or formal change process. With no formal identification of the creeping scope during this execution stage, it created difficulties with the project's cost management. Budgets were not updated to account for these additional components and installation costs. Consequently, these costs had to be paid in excess of the budget, as there was no opportunity for cost management to reallocate funds before the completion of this stage.

In contrast, costs were effectively managed with the other major issue encountered – difficulties removing existing rail. Removing train rails at the location of the new indexer was not considered an issue in scope planning documents, but proved to create the most difficulties with the project. During an interview with FMG's project manager for this project, they were very concerned that this setback could derail the entire operation. The existing rail could not be removed by methods initially tried. The execution stage had a timeframe of 160 hours of shutdown time (including 136 hours of tool time, as shown in figure 7) and any delays to beyond the shutdown time would bare significant costs on FMG because all trains and mined materials would not be able to be transported. Given FMG's project manager realised delays to the transportation of materials could cost the company significantly, they increased the human resources (which cost more than initially planned) to try different techniques to remove the rail, which eventually succeeded (and the project was completed during the shutdown period). Despite exceeding the budget, the costs bared by FMG to do this was significantly less than what could have occurred if the project exceeded the shutdown period, so cost management here is deemed to be managed effectively.

Despite this, the project is estimated to be $600,000 over budget, mainly due to the two issues mentioned, so there is room to improve scope and costs management techniques (over-budget estimation from appendix 3).

Activity ID	Activity Name	Original Duration	Start	Finish	Budgeted Labor Units	Total Float
Level 5 Shutdown - Detailed Activity		160.0h	31-Aug-21	06-Sep-21	1470.50	2.0h
SHD-1000	Shutdown Commence	0.0h	31-Aug-21*		0.00	3.0h
SHD-1010	Isolation	6.0h	31-Aug-21	31-Aug-21	0.00	3.0h
SHD-1020	Shutdown Completion	0.0h		06-Sep-21*	0.00	0.0h

Figure 7 - Modified Excerpt from Project Schedule Displaying Shutdown Timeframe (Fortescue Metals, 2021a)

3.4.2 Quality Management

Given the small 160-hour timeframe to install an entirely new TUL indexer, there are possibilities for quality management techniques to be ignored, including a lack of attention given to the physical requirements (shortcuts are taken to complete the project) and process requirements (more important tasks are prioritised) during the execution stage.

Despite the existence of engineers and superintendents during all day shifts, all project management personnel failed to formally document the existence of additional pipes and components that were not part of the initial indexer design. This either indicates a lack of

physical quality management – if quality checks were not completed adequately with the necessary attention to detail as project tasks were completed, or a lack of process quality management – as no formal documentation of quality control was completed. Because there was no formal documentation of quality control for every project task, it is difficult to determine the exact cause of problem. However, FMG's project manager confirmed during an interview (appendix 3) that functional testing of the indexer was completed during each task. This included operational testing, temperature checks, and no-load and load tests. Because of this, it is inferred poor process quality management is the cause of a lack of quality documentation related to the installation of additional pipes and components. Additionally, it is assumed quality assurance relating the installed product to the initial design was not documented because of the rushed timeframe the project team had to install the indexer, so other tasks were prioritised. Depending on perspective, this may not be an issue as extensive quality control is expensive and the produced product satisfies FMG's requirements. However, since there is a discrepancy between the initially documented designs and the final product, this can cause additional issues (such as the increased costs due to these components) that could have been avoided with improved quality management techniques.

3.5 Finalisation

3.5.1 Stakeholder Management

Following the successful completion of the project, contracts between FMG, the local installation contractor Civmec, and international manufacturer Calbrandt (all ar[illegible]akeholders) were settled and paid out. All parties benefitted from the initial agreed upon exchange of values, goods, and services. The final TUL indexer design constructed was deemed a success since it operated as intended – there was a 20-minute reduction in unloading time per train, so the project was expected to be paid off in 12 months' time (from appendix 3). A post-project completion evaluation was conducted (as described in appendix 3). In particular, FMG reflected on their involvement and interactions with Calbrandt and Civmec. FMG claimed they successfully communicated and negotiated with both contractors throughout the project. Despite this, they also reflected that stakeholder management could be improved (by

addressing the difficulties associated with the differences in time zones and interpretations of the Australian electrical standards) in the earlier stages with plans to limit these risks. Formal documentation of stakeholder reflection, communication and negotiation in the completion evaluation is evidence of successful stakeholder management during the finalisation stage (Hartley, 2018). Consequently, these ensured all project goals from all parties involved were satisfied, so contracts were fulfilled.

3.5.2 Quality Management

Further monitoring of the TUL indexer was required post-shut down. There were teething issues for multiple months after installation. These existed because the indexer design was a new, innovative design for Australia that had not been utilised before. Therefore, there were unknowns during its installation, and teething issues during its first few months of operation was expected. In order to fix these issues, only the software had to be modified – there were no issues with the installed hardware (as found in the post-project completion evaluation). Consequently, modifications could be conducted on the proxy server online, rather than waiting for another shutdown period. This can be considered effective quality management as all teething issues were eventually removed during the finalisation stage, with the post-project evaluation and quality management. However, the long timeframe taken to complete these (about three months, appendix 3) can also be viewed as an area for improvement. The performance guarantee verification took longer than the planned one week, as shown in figure 8. As the TUL indexer was (mostly) operating as intended and train transportation times reduced, additional FMG projects may have taken priority to complete. This resulted in a longer time period before the indexer was completely operational issue-free and for the project to be deemed completed.

Activity ID	Activity Name	Original Duration	Start	Finish	Budgeted Labor Units	Total Float
Post Shutdown works		166.0h	06-Sep-21	20-Sep-21	45.00	4.0h
PSHUT-1000	Performance guarantee verification	48.0h	06-Sep-21	13-Sep-21	0.00	63.0h
PSHUT-1010	Site Clean-up & de-mobilisation	45.0h	06-Sep-21	10-Sep-21	45.00	125.0h
PSHUT-1020	Construction MDR submission & QA/QC finalisation	108.0h	06-Sep-21	20-Sep-21	0.00	3.0h
PSHUT-1030	Lessons learnt, HSE & Project Close out reports	48.0h	06-Sep-21	13-Sep-21	0.00	63.0h

Figure 8 - Modified Excerpt from Project Schedule Displaying Post Shutdown Works (Fortescue Metals, 2021a)

4. Section C: Recommendations

4.1 Communications Management

Issues arose due to miscommunications between FMG and Calbrandt with regards to requirements surrounding the AU/NZS 3000 standards. It is recommended that FMG should employ communication tools that would ensure that can match each required standard against a practical method and benchmark for Calbrandt to meet. This would ensure the final product meets all Australian standards. We recommend that FMG take a two-fold approach, by following a written document with verbal communication in the form of a meeting. This would take the form of FMG providing Work Instruction and Compliance Documentation to Calbrandt, and then holding a meeting to run through these.

This two-fold approach would ensure that Calbrandt is able to attribute each AU/NZS 3000:2018 standard to a practical outcome that FMG has provided. This will ensure that Calbrandt cannot misinterpret the Australian standards which apply to this project. Essentially, this will reduce the barrier of communication between the two parties, and providing a reference to Calbrandt should they require any further clarification.

The documents can be drafted by including each standard that applies to the project (the compliance documentation), and then this will be matched with a description and visual imagery of how FMG requires this standard to be met. This structure provides a checklist to Calbrandt that they can run through to ensure all relevant standards have been met. Figure 9 demonstrates an excerpt that the combined documents should contain.

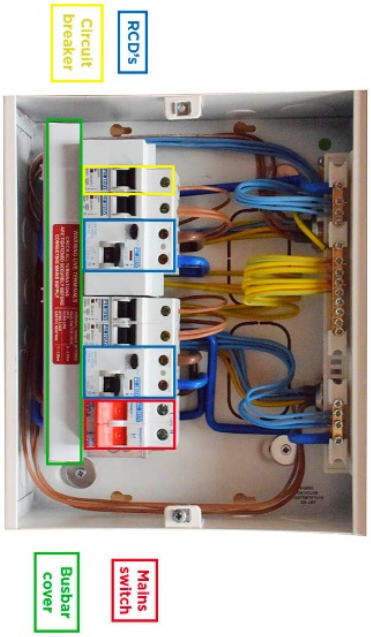
Compliance Documentation		Work Instruction	
Standard	**Phrase**	**Description**	**Diagram**
2.6.3 - Protection requirements of RCD's.	Requirements for installation of RCD's in commercial and industrial applications.	FMG must ensure all Arc-Flash Detection Devices are rated to no less than their corresponding RCD. This will need to be clearly visible on inspection and marked on the hardware.	 (Electrician Courses, 2019) FMG requires visual confirmation of "RCD" and "AFDD" to ensure standard is met.

Figure 9 - Excerpt of Compliance Documentation and Work Instruction

This table would then be discussed in a meeting, with both Calbrandt and the relevant FMG subject matter expert (SME). The SME can step through each line item, ensuring Calbrandt understands what FMG is required to see to ensure the standard has been met. To ensure minimal room for interpretation which would lead to standards not being met, we recommend the following key tools to be used in the meeting:

- Use of plain, unambiguous English language.
- Ensure same terms are used consistently and in reference to the same item.
- Provide an agenda before the meeting so Calbrandt has time to become familiar with the document.
- Encourage open communication and discussion about the document.
- Maintain a register that logs all clarifications (for future reference).
- Maintain concise minutes detailing decisions made and key points of discussion. Circulate minutes after meeting.

By maintaining a two-fold approach to the interpretations issue, FMG should be able to ensure that Calbrandt knows exactly what FMG is required to see to ensure standards have been met. This dual method of communication should ensure that once Calbrandt has built the Echo Indexer, they are able to run through the standards list from the same perspective FMG will. This will ensure that upon delivery to site, FMG will not have to spend money on labour and parts to maintain the Echo Indexer to their required standards.

4.2 Quality Management

There is room for FMG to improve their quality management, so the inclusion of additional indexer components can be discovered earlier in the project and budget issues during the finalisation stage avoided. During section B, it was inferred poor process quality control due to a lack of project documentation related to the additional components was the reasoning for this issue.

In order to continually control quality improvement, it is recommended that FMG can employ the PDCA cycle and formally document its use, particularly during the audits and inspections of the indexer during the execution stage. The PDCA (plan, do, check, act) cycle is a four-step iterative management method to continuously control and improve project processes and products (Hartley, 2018). The first phase, as shown below in figure 10, is planning. Planning involves identifying and understanding the problem. Secondly, the 'do' phase involves implementing a solution and testing it. Next, checking includes analysing the project results against criteria defined in the planning. Acting is then implementing the best solution. This is an iterative process so is continually monitored and updated.

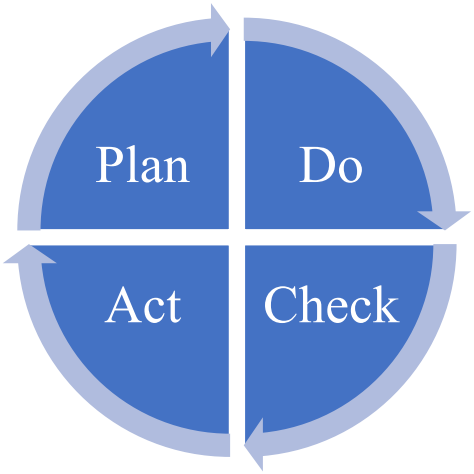


Figure 10 – PDCA Cycle

By implementing a PDCA process, the "process of monitoring and recording the results of executing the quality activities to assess performance and recommend necessary changes" can be achieved, which is what PMBOK identifies quality management as (Hartley, 2018). Furthermore, this process can validate a change in project execution from that designed in the planning stage, which allows continuous improvement in the project process and outcome.

In relation to FMG's Echo Indexer project, use of the PDCA cycle was somewhat incorporated at different stages of the project (for example during the functional testing to ensure the indexer operated as required, with the load case scenarios considered outlined in appendix 5), however deliberate use of the cycle can improve their quality management. Its usage can be documented at each functional testing opportunity at an installation milestone during the execution stage. The PDCA cycle can be implemented as follows:

- Plan: involves gathering design documents related to the section of indexer installed, with the goal of comparing the planned indexer design to that installed (this is separate to the actual functional testing conducted – which was functionality based).
- Do: conduct inspections to assess the installed indexer product at each installation stage.
- Check: compare whether the installed product matches that as described in the designs.
- Act: formally note down any changes between the planned and actual products, update designs if differences exist (and are justified), and notify required project managers.

By conducting this PDCA cycle at each functional testing opportunity, formal documentation can exist regarding the justified differences between the planned and actual indexer designs, and the project manager can update project designs and budgets to reflect these changes. By doing this during the execution stage, the inclusion of additional pipes and components will not come as a surprise to FMG's project managers during the finalisation stage, removing the issue of feature creep. They can also modify budgets and costs to accommodate these changes so a budget blowout does not occur. Consequently, a PDCA cycle would demonstrate improved quality management.

4.3 Cost Management

In addition to the PDCA process, improved cost management can help with the $600,00 additional costs from the underground pipes and components not initially planned for (from appendix 3). Upon proper documentation of justified design changes during the execution

stage, cost management can help refinance planned budgets, avoiding potential cost blowouts. This can be achieved with time-phased budgeting.

Time-phased budgeting is a method of publishing project cash flows over certain time periods, in a simple and clear format (Hartley, 2018). This is used to help coordinate and control project activities, so necessary planning and decision making can be conducted to ensure smooth project execution (Hartley, 2018). Project management software exists to implement this, but a simple table is also sufficient. Furthermore, project budget analysis compares the project's planned and actual expenditures over a time frame. This ensures an easy analysis of fund allocation to control budget changes during the project (Hartley, 2018).

An example of a time-phased budgeting table FMG can use is shown below in figure 11, with budget analysis. The top row displays the relevant time periods of the project, while the left column splits the overall project into smaller tasks. The remaining cells in figure 11 are filled with the project's planned and actual expenditure for that task over that month. The actual cost can be compared to that initially planned, so that if a difference occurs, future budgets can be modified to accommodate this change. For example, with the Echo Indexer project, FMG's project management would notice a difference in the 'shutdown' heading during September, as actual costs are greater than planned (due to the additional components). They can then analyse the planned expenditure of future sections (such as 'clean-up'), and conduct required corrective actions by refinancing accordingly (reducing the budget remaining). This then ensures the project is completed under the initial overall budget cost.

	June		**July**		**August**		**September**	
Phase	Budgeted	Actual	Budgeted	Actual	Budgeted	Actual	Budgeted	Actual
Pre-works: establishment & piling								
Pre-works: civil works								
Pre-works: assembly								
Shutdown								
Post shutdown: clean-up								
Total								
Cumulative								

Figure 11 – Example of time-phased budgeting for FMG

4.4 Stakeholder Management

FMG did not employ any formal stakeholder management plan. Whilst key stakeholders were identified throughout the four stages of the project, they were only referred to independently. As shown in Section B of this report, stakeholder management and communications management both saw issues arise due to a lack of PMBOK standards being applied.

It is recommended that FMG should formally create a combined RACI and Stakeholder Management Plan. The combination of the two frameworks would ensure that FMG has the effective tools and processes in place to manage stakeholder expectations, have open channels of communication, and to ensure all stakeholder expectations are met.

The RACI framework is used first to categorise all stakeholders into respective activities (Hartley, 2018).

These are as follows:

- Responsible – stakeholder required to do activities.
- Approve – stakeholder to approve the decisions.
- Consult – stakeholders to be consulted prior, during or after actions.
- Inform – stakeholders who must be kept in the loop with decisions.

Once all stakeholders have been categorised in this manner, a Stakeholder Management Plan can be utilised to further build in valuable information on how to consult, communicate and engage with all the project stakeholders (Hartley, 2018). This plan would include a range of details, from level of support the stakeholder has for the project, to potential overlaps between stakeholders and methods of communicating changes to them.

The following were identified as project stakeholders, and these will be used for demonstrating how FMG could implement the above two frameworks.

- FMG
- Calbrandt
- BG&E Resources
- Civmec
- Port Hedland Community Council
- Australia/New Zealand Standards

	Activities			
	Conceptualisation	Planning	Execution	Finalisation
FMG	A	A	A	R A
Calbrandt	R	C	C	C
BG&E	R	R	C	C
Civmec	I	R	R	R
Council	I	I	I	I
Standards	C	C	C	C

Figure 12 – RACI Framework for Echo-Indexer Project

Figure 12 demonstrates a simple RACI framework for the project. This provides a basis for FMG to then create a stakeholder engagement plan.

Stakeholder	Responsibilities	Information Required	Format	Frequency	Who
FMG	Determine overall business objective.	Quality management, planning documents, design registers, performance testing, budgets.	Meeting	Daily.	Project manager.
Calbrandt	Design of indexer.	Site information, design requirements, current technology.	Meeting and Reports	Weekly.	Project manager.
BG&E	Scope of indexer at site.	Site information, design requirements, current technology.	Meeting and Reports	Monthly.	Project manager.
Civmec	Installation of indexer.	Site information, design requirements, current technology, FMG requirements.	Meeting, Reports, Walkthroughs	Daily.	Project manager, site maintenance team.
Council	Approval of project.	Scope of design and work.	Meeting and Report	Once-off.	Project manager.
Standards	Consult for standards to adhere to.	Nil.	Nil.	When required.	Project manager.

Figure 13 – Stakeholder Management plan for Echo-Indexer Project

Figure 13 demonstrates a simple stakeholder management plan for the project. This captures all key stakeholders, methods, and how they should all be engaged.

Stakeholder and communications management was noted as issues during the project. Increased levels of labour were required because of miscommunications (such as around the AS/NZS Standards). As a result, the above frameworks would capture the required information

that all parties need. This would ensure both FMG and stakeholders have the same expectations and are working to the same goal. These tools serve to bolster FMG's stakeholder management as related to the PMBOK, 2018 standards.

5. Conclusion

Effective project management techniques were employed by FMG to install the Echo Indexer. The project involved the commissioning and installation of the indexer, which was designed to improve train ore unloading speeds to maximise profits and limit time inefficiency. The project was deemed a success, as all initial outcomes and requirements were satisfied. This included the fulfilment of contracts between FMG, Civmec, and Calbrandt, and an estimated project payoff in 12 months for FMG. The project management team from FMG should be commended due to the successful project completion. Among others, scope and time were managed exceptionally during the planning stage. This ensured a clear schedule could be followed during the execution stage, with precise tasks to be completed under realistic time frames. As a result, the indexer was installed within the 160-hour shutdown period, and extension of this shutdown time was avoided, which would have costed FMG significantly. The project manager from FMG claimed the project was completed as successfully as could be realistically expected – analysis of project documentation and interviews support this.

During the project analysis, it was found each PMBOK standard was addressed for each project life cycle stage – concept, planning, execution and finalisation. Despite this, there is room for improvement. In the concept stage, improved communication and procurement management can help limit issues with differing international electrical standards. Compliance documentation can improve such communication. Misjudgements of human resources during the planning stage caused difficulties removing the rails. Additional underground pipes and components installed during the execution stage increased costs. Improved quality and cost management (by utilising the PDCA cycle and time-phased budgeting, respectively) can reduce this increased expenditure. Furthermore, these issues can be limited with improved stakeholder management, such as by employing the RACI framework. Despite this, installation of the indexer was managed exceptionally well, and given the limited shutdown timeframe, no significant project management issues were present.

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FORTESCUE METALS 2021c. Scope of Works - Port Hedland Echo Outgo Indexer TU601 – SMP and EIC Construction.

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7. Appendices

Appendix 1: Excerpt from Scope of Works (Fortescue Metals, 2021c)

1.1 Overview

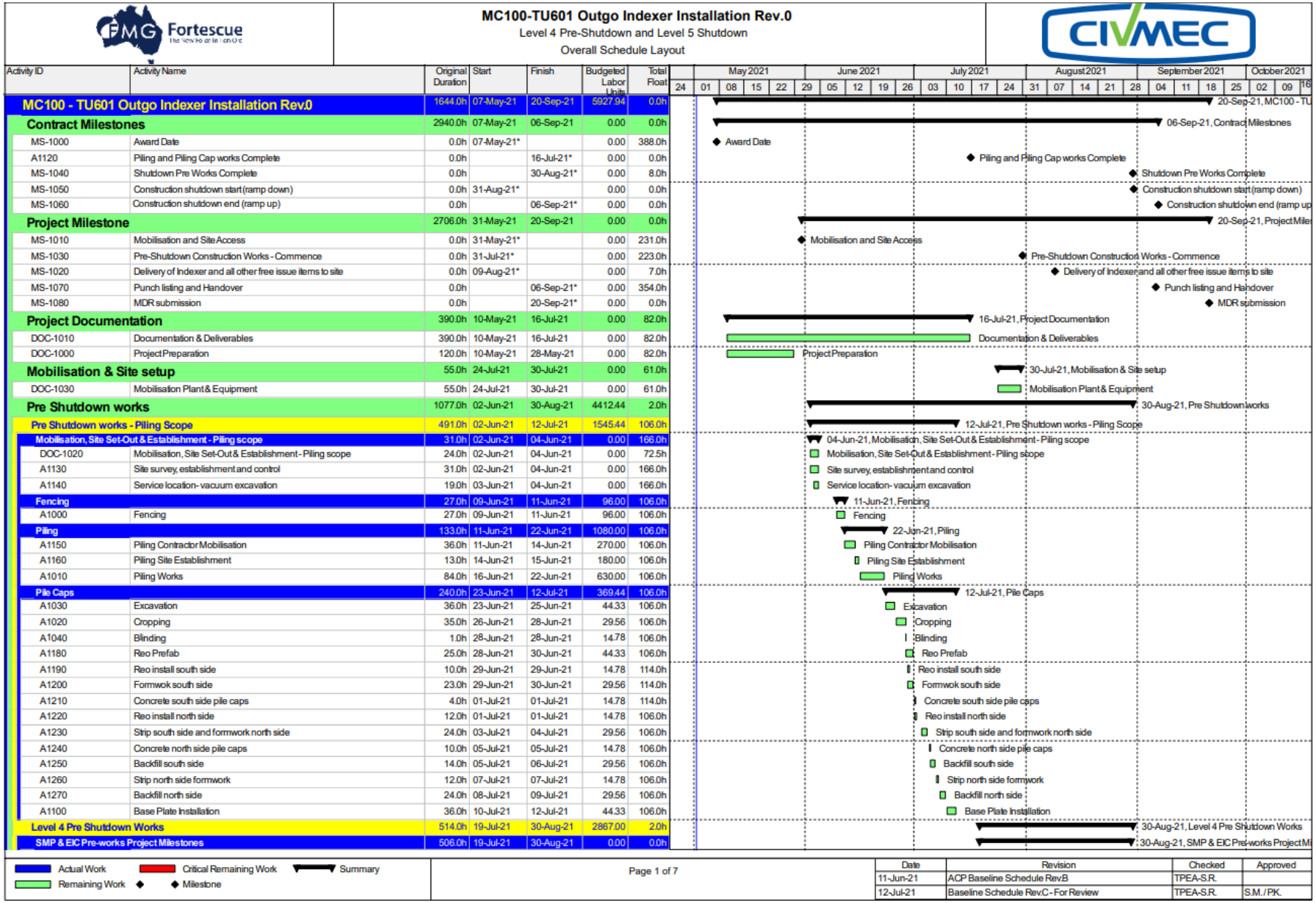
The Principal would like to install an outgo indexer to train unloader number 1 at Anderson Point Port South of Port Hedland. The indexer will be used to spot the last two wagons in a rake in the car dumper and will also be used as a back-up indexer in the event of a break down occurring on the main indexer. This will eliminate the requirement to have 2 compressor cars attached to the end of each train.

The Principal has received a proposal from Calbrandt, a specialist vendor based in the USA for a suitable indexer system. The Calbrandt indexer system comprises the indexer unit, a retarder unit, and the associated HPU's. The indexer utilises hydraulic cylinders to actuate a wheeled trolley running on guide rails with "dogs" that extend upwards to engage on the wagon wheel axles.

The detailed design has been completed for the TU601 Indexer based on the Calbrandt equipment to be supplied and the existing train unloader facility arrangement.

This Scope of Work (SOW) relates to completion of the civil, SMP, and E&I works required as per the detailed design documentation.

Appendix 2: Excerpt from Project Schedule (Fortescue Metals, 2021a)



MC100-TU601 Outgo Indexer Installation Rev.0
Level 4 Pre-Shutdown and Level 5 Shutdown
Overall Schedule Layout

Activity ID	Activity Name	Original Duration	Start	Finish	Budgeted Labor Units	Total Float
MC100 - TU601 Outgo Indexer Installation Rev.0		1644.0h	07-May-21	20-Sep-21	5927.94	0.0h
Contract Milestones		2940.0h	07-May-21	06-Sep-21	0.00	0.0h
MS-1000	Award Date	0.0h	07-May-21*		0.00	388.0h
A1120	Piling and Piling Cap works Complete	0.0h		16-Jul-21*	0.00	0.0h
MS-1040	Shutdown Pre Works Complete	0.0h		30-Aug-21*	0.00	8.0h
MS-1050	Construction shutdown start (ramp down)	0.0h	31-Aug-21*		0.00	0.0h
MS-1060	Construction shutdown end (ramp up)	0.0h		06-Sep-21*	0.00	0.0h
Project Milestone		2706.0h	31-May-21	20-Sep-21	0.00	0.0h
MS-1010	Mobilisation and Site Access	0.0h	31-May-21*		0.00	231.0h
MS-1030	Pre-Shutdown Construction Works - Commence	0.0h	31-Jul-21*		0.00	223.0h
MS-1020	Delivery of Indexer and all other free issue items to site	0.0h	09-Aug-21*		0.00	7.0h
MS-1070	Punch listing and Handover	0.0h		06-Sep-21*	0.00	354.0h
MS-1080	MDR submission	0.0h		20-Sep-21*	0.00	0.0h
Project Documentation		390.0h	10-May-21	16-Jul-21	0.00	82.0h
DOC-1010	Documentation & Deliverables	390.0h	10-May-21	16-Jul-21	0.00	82.0h
DOC-1000	Project Preparation	120.0h	10-May-21	28-May-21	0.00	82.0h
Mobilisation & Site setup		55.0h	24-Jul-21	30-Jul-21	0.00	61.0h
DOC-1030	Mobilisation Plant & Equipment	55.0h	24-Jul-21	30-Jul-21	0.00	61.0h
Pre Shutdown works		1077.0h	02-Jun-21	30-Aug-21	4412.44	2.0h
Pre Shutdown works - Piling Scope		491.0h	02-Jun-21	12-Jul-21	1545.44	106.0h
Mobilisation, Site Set-Out & Establishment - Piling scope		31.0h	02-Jun-21	04-Jun-21	0.00	166.0h
DOC-1020	Mobilisation, Site Set-Out & Establishment - Piling scope	24.0h	02-Jun-21	04-Jun-21	0.00	72.5h
A1130	Site survey, establishment and control	31.0h	02-Jun-21	04-Jun-21	0.00	166.0h
A1140	Service location- vacuum excavation	19.0h	03-Jun-21	04-Jun-21	0.00	166.0h
Fencing		27.0h	09-Jun-21	11-Jun-21	96.00	106.0h
A1000	Fencing	27.0h	09-Jun-21	11-Jun-21	96.00	106.0h
Piling		133.0h	11-Jun-21	22-Jun-21	1080.00	106.0h
A1150	Piling Contractor Mobilisation	36.0h	11-Jun-21	14-Jun-21	270.00	106.0h
A1160	Piling Site Establishment	13.0h	14-Jun-21	15-Jun-21	180.00	106.0h
A1010	Piling Works	84.0h	16-Jun-21	22-Jun-21	630.00	106.0h
Pile Caps		240.0h	23-Jun-21	12-Jul-21	369.44	106.0h
A1030	Excavation	36.0h	23-Jun-21	25-Jun-21	44.33	106.0h
A1020	Cropping	35.0h	26-Jun-21	28-Jun-21	29.56	106.0h
A1040	Blinding	1.0h	28-Jun-21	28-Jun-21	14.78	106.0h
A1180	Reo Prefab	25.0h	28-Jun-21	30-Jun-21	44.33	106.0h
A1190	Reo install south side	10.0h	29-Jun-21	29-Jun-21	14.78	114.0h
A1200	Formwok south side	23.0h	29-Jun-21	30-Jun-21	29.56	114.0h
A1210	Concrete south side pile caps	4.0h	01-Jul-21	01-Jul-21	14.78	114.0h
A1220	Reo install north side	12.0h	01-Jul-21	01-Jul-21	14.78	106.0h
A1230	Strip south side and formwork north side	24.0h	03-Jul-21	04-Jul-21	29.56	106.0h
A1240	Concrete north side pile caps	10.0h	05-Jul-21	05-Jul-21	14.78	106.0h
A1250	Backfill south side	14.0h	05-Jul-21	06-Jul-21	29.56	106.0h
A1260	Strip north side formwork	12.0h	07-Jul-21	07-Jul-21	14.78	106.0h
A1270	Backfill north side	24.0h	08-Jul-21	09-Jul-21	29.56	106.0h
A1100	Base Plate Installation	36.0h	10-Jul-21	12-Jul-21	44.33	106.0h
Level 4 Pre Shutdown Works		514.0h	19-Jul-21	30-Aug-21	2867.00	2.0h
SMP & EIC Pre-works Project Milestones		506.0h	19-Jul-21	30-Aug-21	0.00	0.0h

May 2021 | June 2021 | July 2021 | August 2021 | September 2021 | October 2021
24 01 08 15 22 29 05 12 19 26 03 10 17 24 31 07 14 21 28 04 11 18 25 02 09 16

20-Sep-21, MC100 - TU
06-Sep-21, Contract Milestones
Award Date
Piling and Piling Cap works Complete
Shutdown Pre Works Complete
Construction shutdown start (ramp down)
Construction shutdown end (ramp up
20-Sep-21, Project Mile
Mobilisation and Site Access
Pre-Shutdown Construction Works - Commence
Delivery of Indexer and all other free issue items to site
Punch listing and Handover
MDR submission
16-Jul-21, Project Documentation
Documentation & Deliverables
Project Preparation
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Mobilisation Plant & Equipment
30-Aug-21, Pre Shutdown works
12-Jul-21, Pre Shutdown works - Piling Scope
04-Jun-21, Mobilisation, Site Set-Out & Establishment - Piling scope
Mobilisation, Site Set-Out & Establishment - Piling scope
Site survey, establishment and control
Service location- vacuum excavation
11-Jun-21, Fencing
Fencing
22-Jun-21, Piling
Piling Contractor Mobilisation
Piling Site Establishment
Piling Works
12-Jul-21, Pile Caps
Excavation
Cropping
Blinding
Reo Prefab
Reo install south side
Formwok south side
Concrete south side pile caps
Reo install north side
Strip south side and formwork north side
Concrete north side pile caps
Backfill south side
Strip north side formwork
Backfill north side
Base Plate Installation
30-Aug-21, Level 4 Pre Shutdown Works
30-Aug-21, SMP & EIC Pre-works Project M

Actual Work | Critical Remaining Work | Summary
Remaining Work | Milestone

Page 1 of 7

Date	Revision	Checked	Approved
11-Jun-21	ACP Baseline Schedule Rev.B	TPEA-S.R.	
12-Jul-21	Baseline Schedule Rev.C - For Review	TPEA-S.R.	S.M./ PK.

Appendix 3: Questions and our paraphrased answers from our interview with FMG's project manager for this Echo Indexer project

Question	Answer
What major issues did FMG find during the whole project (from getting Calbrandt design to during/after the shutdown)?	Working with Calbrandt – time zone issues between the two of them. They are not across all the standards that Australia requires – particularly on the Electrical side of things – stricter than the international code. Big challenges in the design review and scoping section. Even though 100% of detail, still needed reworking. Compliance to Australian Standards – was in the scope management, but the interpretation was the issue – they see the standard different. All listed in scope of work – interpretation across borders was different. A lot of preparation work for the shut – most issues were picked up before the shut. Day and night coverage 40 people per shift. All done within the shut – key was due to proper planning. Lose time to even just preparing for the shut (such as isolation).
From a project management perspective, how were these issues addressed?	Addressed above. Any extra time planned in? 6-12 hours maximum over the shut time allowed. Contractors can be sourced extra if required. Right superintendent on day shift – communicate with night shift. Engineers support over the shut – some issues come up from a practical sense.
Were any other designs considered outside of Calbrandt?	Echo indexer idea – part of the research. One of the graduates started thinking this was very expensive (the current one), could we reinvent cheaper – they found Calbrandt and they had the right solution. Main reason to switch – lots of incidents when you stop, decouple trains – manual operation and consumes 45 mins of times before train into TUL, after unloading – needs to be decoupled from compressor to loco, manual operation presents safety risk too. To reduce cycle time and reduce safety issues – this technology was invented to ensure this. Very innovative solution.
What non-safety risks were discussed and what was the process for this?	Risk review as part of the business case – when you change operations --> safety, cost analysis (spend v benefit (time, money)) --> pay off in 12 months (20 minute saving per train). Simulation was done to justify pay-off time. Dollar values around the future cash flows. Eliminating compressor car, safety and cost benefits.
Where there any additional costs incurred by the contractor that were passed on to FMG?	Installation contract. Changes during installation from the drawings that Calbrandt provided (such as underground the TUL was different to what was seen initially). Civmec costs incurred extra at $600,000. Budget did not include this extra cost – business case was justified quickly. How to avoid that extra incurred cost – went back to checking improvements and lessons learned – if there are no drawings available, could have surveyor see what underground equipment was there. They concluded – they did what they could do with the 2 checks done. Drawings showing underground services was the root cause.
What quality control was conducted by FMG during shutdown period to ensure installation satisfied desired quality/requirements? Evidence of monitoring, controlling, and correcting? What were any issues related to these communications	The concern – the rail could not get off during the shut. The existing rail needed a 200m section to be removed. This could not come off and required multiple due diligence checks to remove the rail. Concern was an extension in shut by 10 odd hours. Completely new product to Australia. Commissioning needs to happen during the shut (can't wait until next shut) - critical to do during the shut. Commissioning process --> manual checks and completely different to any other technology. Before shut – needed to have commissioning check sheets and plans from Calbrandt. Ran the indexer in their workshop to understand

	the machine and the control process. Lots of instruments needed to be installed onto the indexer to monitor, such as temperature. Proper structure completion check. Functional Testing – start motor and make sure running ok, and all temperature checks all good. No load trial – without loading hydraulic cylinder, move by itself. Load test – bring the train and start engaging the echo indexer. Simulated first in the Calbrandt workshop and then physically checked during the shut. If the commissioning falls behind schedule: plan B – start to run the operation and when an opportunity between trains exists – go back and recommission the indexer, plan c – wait for next shut (every 3 month) until finishing commissioning. Teething issues – issues for 2/3 months after as innovative design. Still slack, dragging etc... had to calibrate things such as proxy and what not to get it perfect. Done online and not during the shutdown.
Was team performance monitored during the shutdown period?	Large team. Work performed is expected. No action taken against anyone – few AOD's from contractors that tested positive – had to be removed from site. All teams' performance was excellent.
During shutdown period, what were communication methods between project managers and worker/contractors executing project? Was this effective?	Handovers, pre-starts --> they are all documented, project manager goes through the task list --> very well documented in the planning. This will be split into hourly basis for the shift, so we know everything to get job done. Ensure JHAs and take control is done as well (done during prestart). End of shift debrief also occurred. This all passed through to night shift, and night shift will take over. Night/day shift overlaps so they can talk to one another and go through the work. Good communications process to integrate the two teams. Any delays – were talked through and solutions suggested. Whole integrity of the team was good. Handover notes were registered, and inspection checks done as a job completed.
During shutdown/installation period, were there any decisions made that were not initially considered in planning phase?	Rail delay removing and underground services. Refer to above.
Were contracts satisfied between contractor and FMG (or were they too ambiguous)? Did the final product meet that requested?	Pipes which weren't part of initial designs. Did meet final product requested. Always a push/pull during negotiation. Civmec satisfied and Calbrandt too.
Was some sort of post-project evaluation/finalisation completed? Acknowledgement of completion of deliverables?	Post project completion evaluation was had. All requirements satisfied and parts operating as intended. Not being used all the time – other issues with the train currently. This project has done what it was meant to do. 100% capacity use not there due to other issues on site.
Additional notes	CI's done on each stage of the project. Weekly report was done to see what plan is and hold accountable. What is stopping the plan from moving forward. Issues with bringing Calbrandt materials from US to AUS. Lots of use of other teams such as procurements. Coordinate so much with contractors, logs and Calbrandt, Civmec locally and site – to ensure the material on site at the right time. Some cables were not the right cables even once it was on site and inspected then. The cables were available on the market – could get them on to site – if not there, system could be installed but no commissioning would be available. Without reading AS3000 requirements – electrical installation standards – need to be closely followed to ensure no safety/other risks. Need right contractor/sparky so that they have the right AS3000 certificate. Even with proper planning – still some failures, need to respond positively. Proactive planning turns the issues from 40 to 4 when it comes to overseas issues.

Appendix 4: Standards published by a national or international peak body applicable to this project, acknowledged in Scope of Works document (Fortescue Metals, 2021c)

Document Number	Title
100-SP-DC-0002	Vendor Data Specification
100-SP-EL-0001	Electrical Design Criteria
100-SP-EL-0002	Earthing and Bonding
100-SP-EL-0003	Lightning Protection Systems
100-SP-EL-0008	Electrical Installation
100-SP-EL-0009	Preferred Electrical Equipment
100-SP-EL-0010	Testing and Commissioning of Electrical Installations
100-SP-EL-0013	Low Voltage Induction Motors
100-SP-EL-0014	High Voltage Induction Motors
100-SP-IN-0001	Preferred Instrumentation Equipment
100-SP-IN-0002	Instrumentation and Control Design Criteria
100-SP-IN-0004	Good Coding Practices
100-SP-IN-0008	FMG Process Control System Tag Naming Convention
100-SP-IN-0014	Instrumentation

6.4.5 Inground services

All underground cable installation will be designed to conform to AS3000 and FMG Specifications.

Common trenches for power and communication will be used in conformance with standards to minimise cost.

All cable routes will be marked with route marker posts to provide warning and identification.

Appendix 5: Load Case Matrix for load case scenarios considered during operational testing (Fortescue Metals, 2021b)

	Steel Self Weight	Floor Live Load (Q)	Mech Operating - Locomotive	Mech Operating - Wagon	Mech Operating - Indexer	Wind Load (ult)	Thermal Temp Effect	Accident loads
Unfactored Load Value kN	563	322	2158	223	444			672
Code Reference	AS1170.0	AS1170.0	AS5100.2	AS5100.2	AS1170.0	AS1170.0	AS1170.0	AS1170.0
Failure Mode / Limit States	**Partial load factor**							
Ultimate Limit State (Dead Load)	1.35	1.35						
Ultimate Limit State (Locomotive)	**1.2**	**1.5**	2.24					
Ultimate Limit State (Locomotive + cyclonic wind)	1.2	0.6	1.60			1.0		
Ultimate Limit State (Locomotive + thermal)	1.2	0.6	2.24				1.0	
Ultimate Limit State (Wagons + indexer pull)	1.2	1.5		2.24	1.5			
Ultimate Limit State (Wagon + cyclonic wind)	1.2	0.6		1.6		1.0		
Ultimate Limit State (Wagon + Indexer pull + ops wind)	1.2	1.5		2.24	1.5	0.101		
Ultimate Limit State (Wagons + indexer pull + Thermal)	1.2	0.6		2.24	1.5		1.0	
Serviceability Limit State (BridgeDeflection)	1.0	1.0	1.67	1.67	1.0	0.439	0.8	
Accidental Limit State (Wagons Derailing)	1.0	1.0	1.0					1.0
Accidental Limit State (Wagons brakes on)	1.0	1.0	1.0					1.0
Fatigue Limit State (Locomotive)	1.0	1.0	1.4					
Fatigue Limit State (Wagon)	1.0	1.0		1.4	1.0			
Factored Load kN	760	483	4834	499	667			672

8. Group Meetings

Meeting Minutes – 07/03

Date	07/03/2023	**Time**	5pm-5:30pm
Chair	Jevon	**Location**	EZONE North 102A
Attendees	Jevon, Matt, Mikayil, Rigzin, Sonia		

Agenda	**Discussion**	**Action (what, who, by when)**
Team introductions	• As we all attended the practical class, we held our meeting afterwards. • Team introductions were completed	

Discuss project ideas – each member to suggest 1 project	• Each member suggested 1 potential project that can be researched:
	  ○ Jevon: Allianz Stadium Redevelopment
	  ○ Matt: Iron Bridge Magnetite Mine
	  ○ Mikayil: FMG Echo Indexer
	  ○ Rigzin: Bellevue Railcar Manufacturing Facility
	  ○ Sonia: Warradarge Wind Farm	

Finalise a single project selection	• FMG's Echo Indexer project was unanimously chosen as the team's number 1 project. • This is because: Mikayil can easily access project documents, and he has background knowledge of FMG, seems somewhat interesting to all members, relatively small project timeframe that should reduce difficulties. • We require some method to share project files and documents.	Write description of Echo Indexer Project **MIKAYIL 9/3** Submit project summary page **JEVON 10/3** Discuss file sharing options **ALL 14/3**

Team member approval
Jevon – 8/3 Matt – 8/3 Mikayil – 8/3 Rigzin – 8/3 Sonia – 8/3

Team Reflections	
Did meeting achieve its objectives?	Yes. As we didn't know one another, it was a friendly environment as we introduced ourselves. All group members appear excited by the project ahead and are looking forward to starting it. We successfully agreed on a number 1 project.
Was it successful in all aspects?	Yes. There is no early friction amongst the group, and a decision was able to be reached quickly regarding our desired project. This ensured a quick meeting that addressed all agenda points.
Were there any matters which could have been handled better?	No, we easily agreed on pursuing the Echo Indexer project. All members agreed with this, so no disagreements arose.
Issues/problems encountered, and how they were resolved.	We realised we require some method to organise and share project files, to be resolved next meeting.

Meeting Minutes – 14/03

Date	14/03/2023	**Time**	2pm-4pm
Chair	Matt	**Location**	EZONE North 202C
Attendees	Jevon, Matt, Mikayil, Rigzin, Sonia		

Agenda Item	Discussion	Actions (what, who, by when)
MS Teams for file management	• Decided against the use of MS Teams • Move all files to OneDrive – able to create folders, and more efficient in file management.	Create shared OneDrive folder **MATT 18/3** Migrate current Teams files to OneDrive **MATT 18/3**
Discussion of our chosen project	• Overview of project was given by Mikayil • Project summary has been sent through to all team members	
Review requirements of project	• Discussion of the three project sections • Decision for Mikayil to head Section A, given his localised knowledge of the project and the team.	Draft Section A and share with the team **MIKAYIL 28/3**

Delegate project tasks	• The following are all project decisions made.
	• Jevon is to create the general structure of the report, essentially creating a word document.
	• Mikayil is to head Section A: Case Study Writing
	• What information will be required:
	  ○ Scope of Work
	  ○ Each stage of the project lifecycle defined, in the context of this project. Rigzin to head this.
	  ○ Documents related to the 4 stages.
	  ▪ CONCEPTUALISATION à OEM design documents, research background (such as cost benefit analysis, tph increase, etc…)
	  ▪ PLANNING à Planning team documents (multiple teams in this arena)
	  ▪ EXECUTION à All FMG documents related to the 150hr shutdown, review of the shifts, shift handovers, commissioning. Both planning document analysis, and project team member interviews.
		Source FMG project documents and sort into relevant project phase **Mikayil 21/3**
		
		Finish Case Study A (a draft will be fine) **Mikayil 28/3**
		
		Granulate the 4 dot points in section B with more detail **Jevon 21/3**
		
		Create report document **Jevon 21/3**
		
		Understand each section within every stage (every stage has management elements) – **Rigzin 21/3**
		
		To do team objectives and team meetings objectives **Sonia 21/3**

	▪ FINALISATION à Review meetings, post-install analysis, testing, metric analysis	
Additional discussion and concerns	• Once we have all the documents and we all understand requirements. Rough outline for next fortnight is: o Week 3 = source documents and understand project o Week 4 = write up rest of section A	
Confirm next meeting	• Next Tuesday, similar time. TBC with Mikayil work schedule. o Discuss Section A: Triple Bottom Line o Other 4 to be assigned one project stage to review (for section B)	• All to confirm time availabilities for Tuesday 21/03 between 2pm and 4pm **ALL**

Team member approval
Jevon – 15/3
Matt – 15/3
Mikayil – 15/3
Rigzin – 15/3
Sonia – 15/3

Team Reflections	
Did meeting achieve its objectives?	Yes, given such a large project, it is easy to feel overwhelmed. This meeting felt beneficial for all team members as breaking down the project into manageable tasks makes this project appear a lot more achievable. All agenda items were discussed and action items were assigned. As we have a project with will receive access to documents, we feel we are making good progress at this time.
Was it successful in all aspects?	Yes. All members understand the requirements of the project report. We were also introduced to the Echo Indexer project and have a better understanding of what an indexer is (having previously had no idea). Discussion amongst members was encouraging, and group dynamics are improving as we get to know one another more.
Were there any matters which could have been handled better?	Before the meeting, an MS Teams channel was created for file sharing. However, in the meeting it was decided to use OneDrive due to improved functionality. The MS Teams channel creation proved to be a waste of time, so further discussion regarding group decisions needs to be made during meetings.
Issues/problems encountered, and how they were resolved.	An issue raised is our lack of knowledge regarding the project, so further documentation is required.

Meeting Minutes – 21/03

Date	21/03/2023	**Time**	2pm-4pm
Chair	Mikayil	**Location**	EZONE North 102A
Attendees	Jevon, Matt, Mikayil, Rigzin, Sonia		

Agenda	**Discussion**	**Action (what, who, by when)**

Project schedule creation	• Mikayil has sourced necessary project management documents from FMG regarding the Echo Indexer project during the week and shared them with the group.
	• Need to agree on time to finish the report and previous stages (such as drafts).
	  o First draft of your section B and C: **Saturday 8 April**
	  o Integration of Parts: **Study Break** → Important so we can make the report sound coherent.
	  o Finalise all auxiliary parts to report: **Study Break**
	  o Report Due: **Monday 17 April**
	  o Recording Interview: **17-20 April**
		Questions register for FMG project manager **MATT 28/3**
		
		Read through FMG's project documents to gain better understanding of project **ALL 28/3**

Discussion of report content – how to judge issues for section B, specifically what to include in section C	• Jevon has read the textbook → he has taken us through and summarised key PMBOK standards and project life cycle, as per last weeks' actions. Notes document shared with group.
	• Section B is where we point out what went wrong.
	  o We have headings for only the major PMBOK standards not met
	  o Initially, we have an overall table to show that we have considered why all stages are either met/not met the PMBOK standards.
	  o Analyse each requirement that shows a PMBOK standard is met → if majority not → issue that we must critique.
	  o From other comments, don't just state what is wrong/missing with FMG's project – say WHY it is wrong too.
	• Section C you carry over from your section B stages.
	  o Do not restate all the issues from section b, go right to the recommendations.
	  o Make sure to say HOW we can implement the recommendations in the context of the project as opposed to just saying do it.	

	• You need to analyse each of the 10 PMBOK standards per stage, and only analyse/critique the major flaws.	

Divide up report writing	• 2 people across stages B and C, they work with each other – can divide up further, but ensures there is someone to check over your work.
	• Jevon and Sonia
	  ○ Finalisation
	  ○ Execution
	• Matt and Rigzin
	  ○ Planning
	  ○ Conceptualization
	• Mikayil is a free floater to help with clarifying stuff. Also finish section A.
	• You get 1000 words per your 2 stages for part B.
		Finalisation and execution for section B written **JEVON & SONIA 4/4**
		Planning and conceptualisation for section B written **MATT & RIGZIN 4/4**
		Continue progress of section A **MIKAYIL 4/4**

Expectations of section B written responses - use of PMBOK standards	• If there exists issue in project → what PMBOK standards were not met during what lifecycle stage • If an output is lacking/an issue – relate that to a PMBOK standard where an input was not met • If PMBOK standard not addressed – relate to output that could have been improved • Pose a hypothetical issue that FMG could have had, and its impact on the TBL, then say what effective PMBOK methods they used to make sure it didn't happen. • You can have 2 or 3 issues that are a result of multiple failures of PMBOK standards throughout all stages of the project lifecycle.	

Expectations and review of section A written response	• Agreed upon structure consists of:
	• Project background
	• Project justification
	  ○ TBL is good way to do it.
	  ▪ Economic = money saved
	  ▪ Social = safety
	  ▪ Environmental = not much, but was considered
	  ○ Go over more than just the economic impact.
	• Key Stakeholders	

	○ Who and what they were • Issues/competencies to relevant further discussion	

Team member approval
Jevon – 22/3
Matt – 22/3
Mikayil – 22/3
Rigzin – 22/3
Sonia – 22/3

Team Reflections	
Did meeting achieve its objectives?	Yes. All agenda items were discussed and action items allocated. Not only was effective research conducted during the week, but planning of the group's report structure has made significant progress. This further creates a clear view of the tasks to complete and expectations of all team members.
Was it successful in all aspects?	Yes. Following on from last week where we analysed the overall project in detail, we have conducted research during the week (such as reading the textbook) to understand how to actually achieve these. This means all members now better understand how to satisfy the report requirements. Furthermore, we now have access to significant documents from PMG's project manager that relate to the project, which we need to read. These documents seem useful and just what we needed, and the group is very grateful for the ease at which we gained access to them. All team members are satisfied with progress made and the sharing of required information during this meeting.
Were there any matters which could have been handled better?	It was agreed the meeting took longer than required to cover our information, as some agenda topics were unnecessarily stretched out, so we plan on conducting a shorter meeting next week.
Issues/problems encountered, and how they were resolved.	We discussed the delegation of report writing work, which appears a bit premature given we haven't read project documents. Also, some of us are busy this-coming week with other assessments. To resolve these, a longer timeframe of 2 weeks was given to complete initial sections A and B writings.

Meeting Minutes – 28/03

Date	28/03/2023	**Time**	2pm-4pm
Chair	Rigzin	**Location**	EZONE North 102A
Attendees	Jevon, Matt, Mikayil, Rigzin, Sonia		

Agenda	**Discussion**	**Action (what, who, by when)**
Recap of previous week	• Everyone has discussed their work during the previous week, and key milestones achieved/worked towards. • Team agreed everyone has made good progress towards this project and the report, on track for completion at due date.	
Planning for FMG project manager meeting	• Planned date is Thursday 30 March at 3pm. • Room for meeting was booked, EZONE Central 102A • Mikayil to lead the meeting given it his boss we are meeting with • Everyone to brainstorm questions that they need answered for the project, and to fill out the register. • Team to meet 2:30 to organise and do final preparations for meeting.	• Add questions and brief description to TQ Register **ALL 30/3**
Project Check-In	• Team has finalised structure of all sections. • Confusion rose surrounding finalised structure, due to revision of FMG provided documents. SOLUTION: Tie back to the issues that will be presented in the FMG meeting. • Everyone is on good track. • Sonia and Jevon to peer-review Section B: Conceptualisation and Planning • Matt and Rigzin to peer-review Section B: Execution and Finalisation • Mikayil to review all section B to ensure that we are sticking to the facts, and that all information provided by FMG has been represented accurately.	• Peer review Conceptualisation and Planning, Section B: **Sonia and Jevon 4/04** • Peer review Execution and Finalisation, Section B: **Matt and Rigzin 4/04** • Review all section B to ensure stated facts are in-fact true: **Mikayil 4/04**

Section C Brainstorm	• We have agreed to provide four recommendations in the report, to address the 4 major issues the project had faced. • Recommendation 1: Communications Management – to mitigate the issue surrounding interpretations of the AS/NZS 3000:2018 Electrical Standards. Matt to handle this. • Recommendation 2: Cost Management – to mitigate the issue surrounding the extra $600,000 spent during the shut. Jevon to handle this. • Recommendation 3: Stakeholder Management – to mitigate the stakeholder issues surrounding contractual obligations. Sonia to handle this. • Recommendation 4: Quality Management – to mitigate the quality control issues during the finalisation stage. Mikayil and Rigzin to handle this.	• Summarise Recommendation 1 and provide to team for review **MATT 7/4** • Summarise Recommendation 2 and provide to team for review **Jevon 7/4** • Summarise Recommendation 3 and provide to team for review **Sonia 7/4** • Summarise Recommendation 1 and provide to team for review **Mikayil and Rigzin 7/4**

Team member approval
Jevon – 29/3
Matt – 29/3
Mikayil – 29/3
Rigzin – 29/3
Sonia – 29/3

Team Reflections	
Did meeting achieve its objectives?	Yes. We aimed to prepare for our meeting with FMG and also to ensure we are good for finalising our report to a draft standard. We ran through these two items and have cleared any issues that team members have had, and also ensured we have SMART goals to achieve both.
Was it successful in all aspects?	Yes. We met our objectives and did so in a way that all team-members worked together. Everyone agreed that our meeting was very time-efficient this week, and that we stuck to the provided agenda. As a team, no one felt as though they left the meeting with unanswered questions.
Were there any matters which could have been handled better?	The agenda was provided a bit late to the team, due to a miscommunications error around the expectations of when the agenda should be provided. It did not lead to anyone being unprepared for the meeting, however the difference in expectations has been handled and agreed upon.

Issues/problems encountered, and how they were resolved.	With regards to the aforementioned agenda issue, we have agreed the agenda is to be provided 24hrs in advance. This will ensure sufficient time to propose changes to it, and for all team members to prepare relevant discussions and questions.

Meeting Minutes – 7/04

Date	7/04/2023	**Time**	2pm-4pm
Chair	Sonia	**Location**	EZONE North 102A
Attendees	Jevon, Matt, Mikayil, Rigzin, Sonia		

Agenda	Discussion	Action (what, who, by when)
Recap of previous week	• Everyone has discussed their work during the previous week, and key milestones achieved/worked towards. • Team agreed everyone has made good progress towards this project and the report, on track for completion at due date.	
Review of Draft Report	• Everyone has provided a detailed draft of their sections. • It was agreed that there was overlap between Jevon's Section B and Matt's Section B work with regards to communications management issues. Agreed that this to be moved to planning issue, and for Jevon to refocus on stakeholder engagement issues. • It was agreed that cost management should focus on time-based budgeting for a better mitigation technique for Section C. Mikayil to revise. • References and figures need to be properly entered in the word document. • Appendices to be properly indexed.	• Fix issue with Communications/Stakeholder Issue **MATT AND JEVON 11/4** • Incorporate time-based budgeting for cost management recommendations **Mikayil 11/4** • Ensure references properly done **ALL 11/4** • Finalise bibliography **Sonia and Rigzin 11/4** • Properly index appendix **Mikayil 11/4.**

Review of FMG Meeting	• Agreed that meeting was a success • Confirmed all major issues discussed have been referenced throughout the report. • Mikayil has captured major issues in Section A • Section B, all sections have been divided up and include the issues. This is between Matt, Jevon, Sonia, and Rigzin. • Meeting to be placed in appendix.	• Add FMG meeting minutes to appendix **Rigzin 11/4**
Report Finalisation	• Agreed for report to have all content on 12/4. This leaves time to ensure formatting correct. • Review discussion to take place: Everyone to read and edit report, in review mode in Word. Any major issues to be raised in the group. No final meeting to do this. This will be a continual process over the 12-15th of April. • Matt to submit report on 16 April	• Ensure multiple revisions of report and to raise any concerns and major edits done **ALL 15/4** • Submit report **MATT 16/4** • Add cover sheet to report **MATT 16/4** • Sign cover sheet **ALL 16/4**

Team member approval
Jevon – 7/4
Matt – 7/4
Mikayil – 7/4
Rigzin – 7/4
Sonia – 7/4

Team Reflections	
Did meeting achieve its objectives?	Yes. We aimed to finalise the report and ensure everyone was on the same page. We finalised the report and all team members are in agreeance that the content of the final report are good. We spent time discussing major concerns and issues with the report and worked through all of them and provided solutions.
Was it successful in all aspects?	Yes. The team is happy with both what was achieved and how. We are all very comfortable as a team now, and we all work very well together. We agree that everyone is comfortable in providing their voice and opinions, and that this is done in a constructive manner.
Were there any matters which could have been handled better?	Yes, the delay in regular meeting time meant we had 9 days between meetings. This was a positive as it allowed us to provide a greater level of work to discuss in the meeting.

Issues/problems encountered, and how they were resolved.	We encountered overlap of content between sections. We moved fast, and had a brainstorm as to what section this content should be in. We agreed that the issue was regards to communications management in the planning phase, and thus should be discussed there and in reference to that. We also decided that another stem issue was stakeholder management, and this was to replace the removed content in the execution discussion in section b.

CONTENT ASSESSMENT CRITERIA

Marking	Very Poor		Fair		Good		Excellent	
Executive Summary (Maximum 1 page)								
Clarity & conciseness	0-1.5	2	2.5	3	3.5	4	5	
Executive Summary - Total								**/5**
Section A: Case study writing (Approx. 1,500 words)								
Clarity & conciseness of project background	0	4	5	6	7	8	10	
Quality & relevance of research material (i.e. info/facts)	0	4	5	6	7	8	10	
Total Section A								**/20**
Section B: Case Study Analysis (Approx. 2,500 words)								
Introduction (clarity of purpose & conciseness)	0-1.5	2	2.5	3	3.5	4	5	
Use & relevance of theories, models & frameworks	0	4	5	6	7	8	10	
Depth of analysis, clear & logical argument	0	4	5	6	7	8	10	
Total Section B								**/25**
Section C: Recommendations to the case (Approx. 2,000 words)								
Use & relevance of theories, models & frameworks	0	4	5	6	7	8	10	
Relevance & justification of recommendations	0-2.5	3	3.5	4	5	6	7.5	
Insight & synthesis, clear & logical argument	0-2.5	3	3.5	4	5	6	7.5	
Total Section C								**/25**
Conclusion (Maximum 1 page)								
Logical summary	0-1.5	2	2.5	3	3.5	4	5	
Conclusion - Total								**/5**
Table of contents (compulsory), references & appendices								
Appropriate table of contents, appendices & references	0-1.5	2	2.5	3	3.5	4	5	
Table of contents, references & appendices – Total								**/5**
Group meetings (agenda & minutes)								
Relevance & consistency of issues & outcome	0	4	5	6	7	8	10	
Clarity, conciseness, team reflections and leadership	0-1.5	2	2.5	3	3.5	4	5	
Group meetings (agenda & minutes) - Total								**/15**

TOTAL

GROUP

MARK

70.5 **/100**

Some really good aspects to this report. Section C was great and section B was pretty good. However, section A was very poor. So much unnecesary information didn't satisfy the requirements of that section. The Conclusion and executive summary were good.