Building an Econometrics Model for Pier Construction in an Indonesian Oil and Gas Company [1, 2]

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ABSTRACT

In the face of escalating global energy demands, the construction and management of pier infrastructure emerge as pivotal challenges, particularly for energy companies like Pertamina Patra Niaga in Indonesia. This paper aims to optimize pier construction management through the implementation of an OmniClass Work Breakdown Structure (WBS), addressing the critical need for standardized project management methodologies in complex, large-scale construction projects. By integrating a multidimensional WBS approach, akin to the hypercube or tesseract model, this study explores the enhancement of project planning, execution, and management. Employing a comprehensive literature review and case study analysis, the research investigates the efficacy of OmniClass WBS in facilitating better project coordination, cost estimation, and risk management. The findings underscore the significant advantages of adopting a standardized, multidimensional WBS, including improved data management and project outcome predictability. This paper concludes that the OmniClass WBS framework not only optimizes pier construction projects but also serves as a model for future infrastructure development endeavors within the energy sector

Keywords: WBS, Multi-Dimensional, Pier Construction, Project Management Classification, Best Practices, Building Information Modeling (BIM), Omniclass, MADM, ISO1908:2016, Coding Structure, Artificial Intellegence, Economtrics, Data Management, Data Engineering

INTRODUCTION

Global Energy Needs

Global energy needs are experiencing a significant increase, a phenomenon triggered by various population growth, economic expansion, and technological development. As the world's population increases, especially in developing countries, there is a rising demand for energy for daily needs, ranging from lighting and heating to transportation. Rapid economic growth in many countries also burdens on energy resources, as

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[2] This paper was originally prepared during a 6-month long Graduate-Level Competency Development/Capacity Building Program developed by PT Mitrata Citragraha and led by Dr. Paul D. Giammalvo to prepare candidates for AACE CCP or other Certifications. https://build-project-management-competency.com/our-faqs/

industries and commercial sectors require more energy to support their operations and expansion. According to the International Energy Outlook 2017 (IEO2017) released by the U.S. Energy Information Administration (EIA), global energy consumption is projected to grow by 28% from 2015 to 2040[3]. This projection includes estimates of energy demand based on region and primary energy sources, power generation based on energy sources, and carbon dioxide emissions associated with energy.

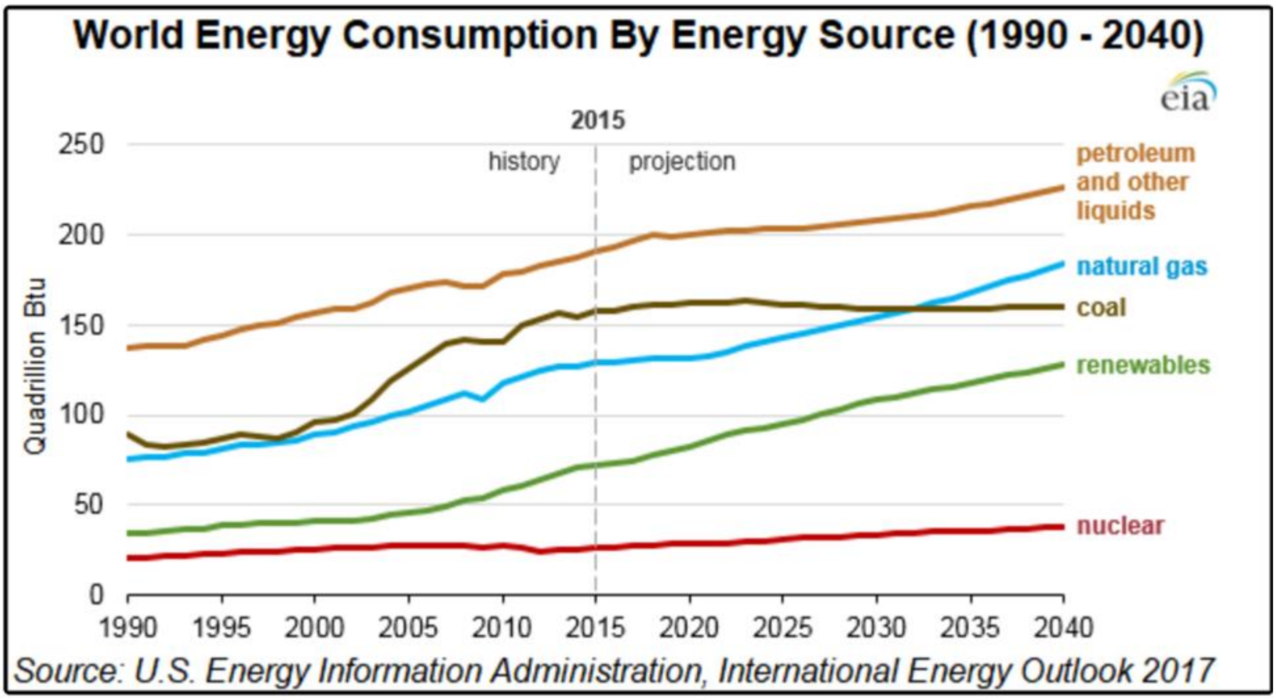


Figure 1 – World Energy Consumption [4]

This trend is also in line with the projected energy needs in Indonesia. According to a report from the Central Bureau of Statistics, by 2050, Indonesia's energy needs are expected to reach 2.9 billion barrels of oil equivalent (BOE), an increase from the 2040 projection of 2.1 billion BOE. This increase is influenced by economic and population growth, energy prices, and government policies [5]. Sectorally, the industry is expected to be the largest energy consumer, with an average annual growth of about 3.9%. infrastructure in all corners of Indonesia to meet its obligations effectively. This

[3] Davis, C. (2017, September 14). Global NatGas Fastest Growing Fossil Fuel to 2040 as Supply, Trade Soars, Says EIA. Natural Gas Intelligence. Retreived from https://www.naturalgasintel.com/global-natgas-fastest-growing-fossil-fuel-to-2040-as-supply-trade-soars-says-eia/
[4] Davis, C. (2017, September 14). Global NatGas Fastest Growing Fossil Fuel to 2040 as Supply, Trade Soars, Says EIA. Natural Gas Intelligence. Retreived from https://www.naturalgasintel.com/global-natgas-fastest-growing-fossil-fuel-to-2040-as-supply-trade-soars-says-eia/
[5] Mutia, A. (2021, Desember 3). Kebutuhan Energi Indonesia Diproyeksikan Capai 2,9 Miliar Setara Barel Minyak pada 2050. Databoks Katadata. Retreived from: https://databoks.katadata.co.id/datapublish/2021/12/03/kebutuhan-energi-indonesia-diproyeksikan-capai-29-miliar-setara-barel-minyak-pada-2050

commitment is made clear through the company's annual town hall meetings, emphasizing expanding storage capacity.

Other sectors, such as commercial, household, and related sectors, will also experience an increase in energy needs in line with economic and population growth. However, the transportation sector is expected to have a lower growth rate than the industry, at about 3.2% per year.

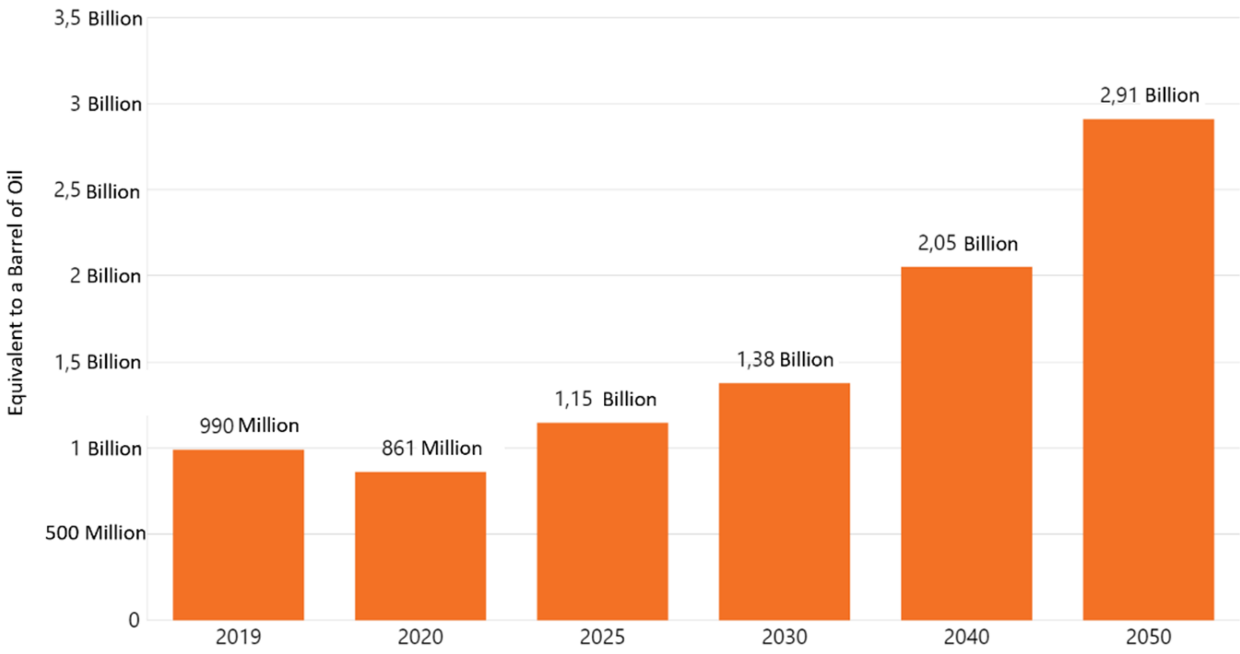


Figure 2 – Indonesia Energy Needs[6]

Regarding energy types, fuel consumption will still dominate, with an annual growth rate of about 2.8%. This is due to oil-field equipment's higher efficiency than other energy equipment. On the other hand, biodiesel usage is increasing as an alternative to fuel in sectors such as transportation, industry, commerce, and power generation. The development of electric-based technologies, such as electric vehicles, will also increase electricity demand by 2050, with a growth rate estimated at 4.7% per year. However, the Central Bureau of Statistics does not include biomass and biogas in the calculation of household energy needs.

As a major energy company in Indonesia, Pertamina plays a crucial role in developing adequate port facilities and infrastructure to meet the continuously increasing energy demand. Efficient and advanced ports are essential for supporting the distribution of fuel

[6] Mutia, A. (2021, December 3). Kebutuhan Energi Indonesia Diproyeksikan Capai 2,9 Miliar Setara Barel Minyak pada 2050. Databoks Katadata. Retrieved from: https://databoks.katadata.co.id/datapublish/2021/12/03/kebutuhan-energi-indonesia-diproyeksikan-capai-29-miliar-setara-barel-minyak-pada-2050

and other energy products and facilitating adequate transportation and logistics. Pertamina must focus on developing ports with the latest technology, ensuring high capacity and security, and optimal operational efficiency, including increased storage capacity and more advanced fueling facilities.

However, to optimize its fuel distribution activities, Pertamina faces challenges in the availability of receiving facilities or ports. More than 70% of Pertamina's currently operating port facilities are over 30 years old [7]. Therefore, the rejuvenation of facilities and the construction of new ports are necessary to optimize operational activities.

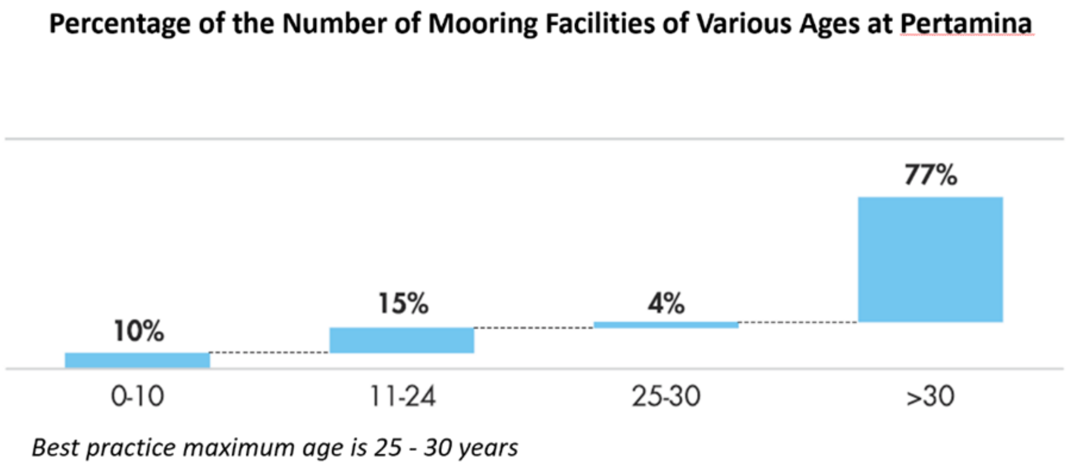


Figure 3 - Mooring Facilities Based Various Ages at Pertamina[8]

According to Pertamina's Infrastructure Master Plan to enhance fuel reception operations, there is a projection for adding pier infrastructure. The period from 2021 to 2029, the construction of 26 piers is planned. Therefore, a strategy for accelerating projects, especially pier construction projects, must be implemented.

[7] PERTAMINA (2023). Pertamina Infrastructure Master Plan. Retrieved from https://PERTAMINA.com/id/
[8] PERTAMINA (2023). Pertamina Infrastructure Master Plan. Retrieved from https://PERTAMINA.com/id/

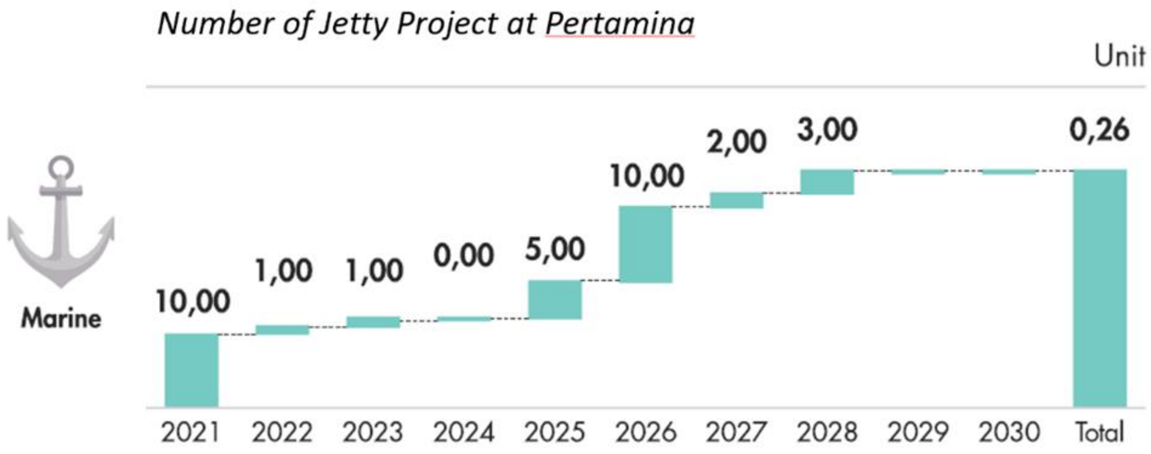


Figure 4 – Number of Pier Projects[9]

Structured Project Management Methodologies

PERTAMINA recognizes the importance of implementing structured project management methodologies, such as the Work Breakdown Structure (WBS), to enhance the effectiveness of pier construction project management. WBS divides complex work into smaller, more manageable components, organizing the project scope hierarchically for more efficient resource allocation, risk management, and progress monitoring. Standardizing the WBS is the best way to get a reliable database. The company can collect and share data between programs by standardizing the WBS. By standardizing the WBS, it will produce a better estimate of the cost, allowing the data to be shared across the company and lead to a more efficient project execution[10]

Standardizing the Work Breakdown Structure (WBS) is essential for creating a reliable database for Pertamina's pier construction projects, enhancing data collection and sharing across programs. This standardization leads to more accurate cost estimates, effective resource allocation, reduced budget risks, and improved project completion rates. Additionally, it fosters better communication and coordination within the company, which is crucial for the success and sustainability of large-scale projects like pier construction. It ensures that project stage can be monitored and managed more effectively, from initial planning to final completion, strengthening Pertamina's capability

[9] PERTAMINA (2023). Pertamina Infrastructure Master Plan. Retrieved from https://PERTAMINA.com/id/
[10] Wibowo, G. (2014, December). Why Adopt a Standardized 3D Work Breakdown Structure for Tangible Drilling Cost in Indonesia?

to manage these critical infrastructure projects. The purpose of this paper is to establish a standardized WBS for New Pier Construction Projects that can satisfy these ideas:

1. Provide an appropriate WBS/CBS for the New Pier Construction Project that satisfies the entire entity and phase of the project so that many related stakeholders can use it for the cost-building and scheduling process
2. Prepare a new "New Pier Construction" WBS architecture that can be easily implemented in the BIM system at PERTAMINA.

METHODOLOGY

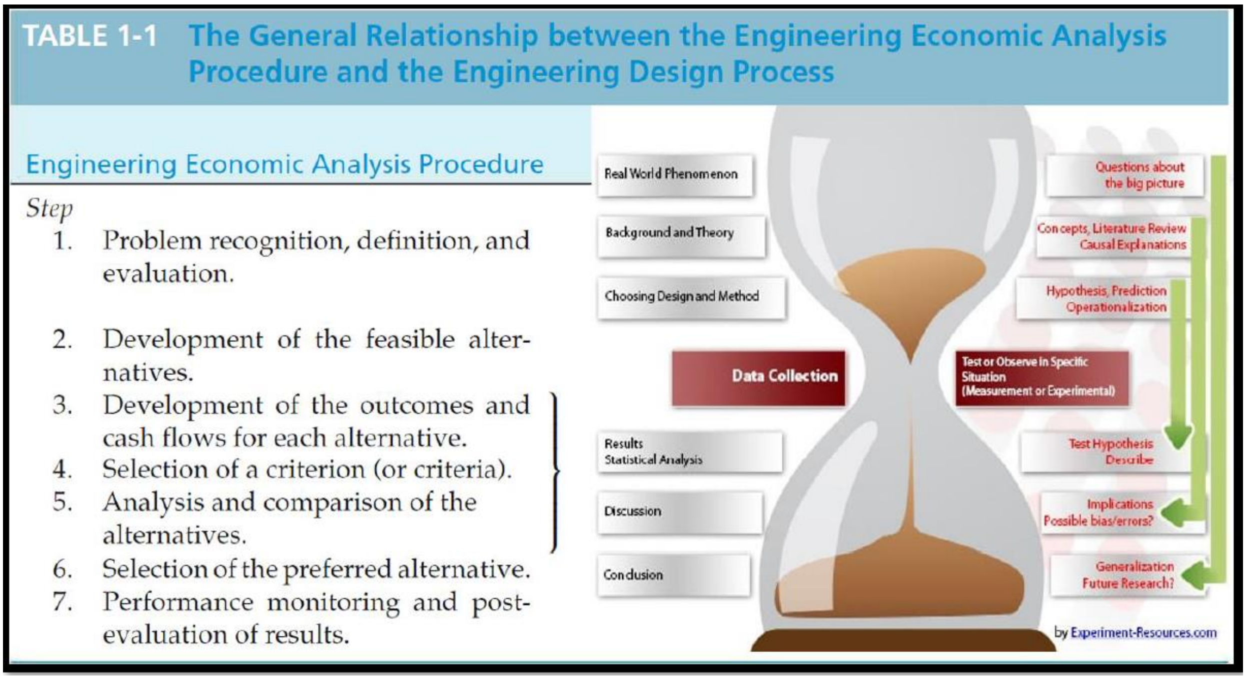


Figure 5 - Procedure of Engineering Economics Analysis[11]

As shown in Figure 5 above, "every research that follows the methodology of scientific work must have 4 points that need to be explained in detail:

1. **Problem Recognition** is a clear description of the identified essential issues; this step is followed by the Refining the Research Paper Question phase to break it down into more specific problems.
2. **Development of Feasible Alternatives** is a verification process using other researchers to review the results by replicating the experiment and assessing its reliability to develop a range of alternative possibilities.

[11] Sullivan, G. W., Wicks, M. E., & Koelling, C. P. (2019). Engineering Economy 17th Edition. Chapter 2 Cost Concepts and Design Economics, Page 31.

3. **The development of Outcomes** and Cash Flows for each alternative provides an entirely accurate description of the methods and tools used for data collection.
4. **Selection of a Criterion (or Criteria)** explains how raw data is compiled and analyzed."
5. **Analysis and Comparison of the Alternatives** is a thorough analysis and comparison of the feasible alternatives performed using the established criteria.
6. **Selection of the preferred alternative** is where a decision is made to choose the most suitable or preferred alternative that aligns with the project's goals and criteria.
7. **Performance monitoring and post-evaluation** results will be carried out after implementation to determine the performance and understand the effectiveness of the selected alternative.

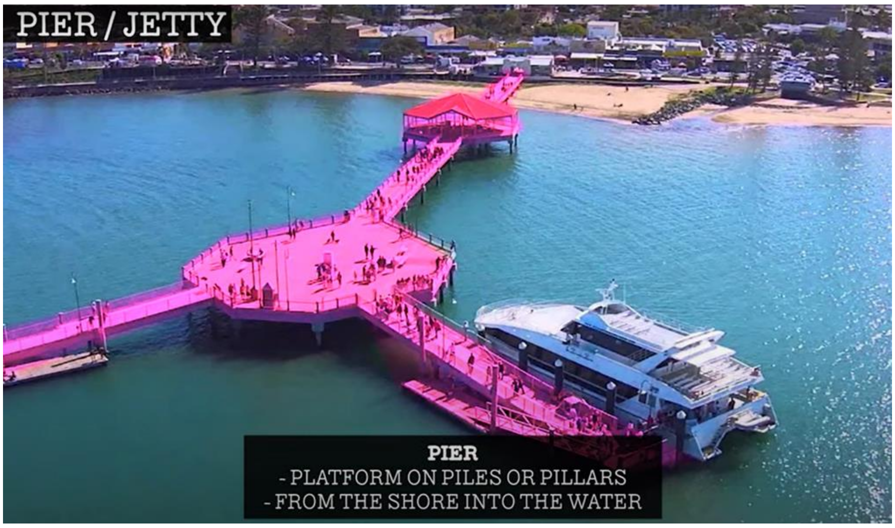
Step 1 – Problem Definition

As Indonesia's backbone of energy distribution, the piers constructed by PT Pertamina serve as crucial logistic nodes and critical elements in the national energy distribution network. Amidst the geographical complexity of Indonesia, consisting of thousands of islands, pier construction projects face a unique set of challenges, ranging from diverse environmental conditions to specific needs of the oil and gas industry. These difficulties are exacerbated by limitations in the existing Work Breakdown Structure (WBS), which often fails to accommodate the specific needs and stringent standards required in such projects. Through this paper, we will delve deeper into how a new approach to designing WBS can help overcome these challenges, enhance efficiency, and ensure the success of pier construction projects in the PT Pertamina work environment.

Pier Construction

Pier construction involves the development of a structure that extends into the water, typically from the land or shoreline. These piers serve as platforms for various activities, including the docking of ships, fishing activities, recreation, and, in the context of PT Pertamina, as a critical point for the distributing of energy products. "These structures must be designed to withstand various environmental conditions, such as waves, tides, and corrosion, as well as meet specific operational needs, such as support for heavy equipment and storage facilities" [12]

[12] Pile Buck Magazine. (n.d.). Pier & Wharf Construction Part I: Facility Planning. Retrieved [Tanggal Akses], from https://pilebuck.com/pier-wharf-construction-part-facility-planning/



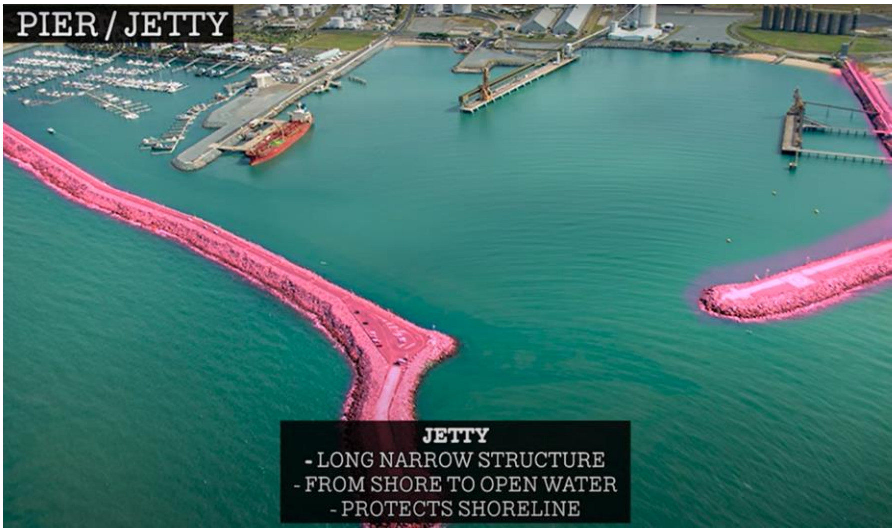


Figure 6 - Pier and Jetty Structure[13]

The fundamental difference between a pier and a pier lies in their function and orientation. Piers are typically built protruding into the water and are often used for various purposes, including commercial activities, recreation, and transportation. Piers can vary in shape and size and are often designed to facilitate access for both ships and pedestrians.

In contrast, jetties are usually constructed parallel to the shoreline and often serve as protective structures that regulate currents and waves to prevent coastal erosion or

[13] Youtupedia. (2022). Harbours, Ports, Quays, Wharves, Berths, Docks, Jetties & More. From https://www.youtube.com/watch?v=AEfsxLPF_cU

protect harbor's entrance. Jetties focus more on protective and navigational aspects, often used to control water flow and support ship landing and mooring activities.

In this paper, the author will focus on constructing pier structures in the PT Pertamina Patra Niaga environment. A clear understanding of both structures is essential for planning and managing practical pier construction projects, ensuring each structure is built according to its intended purpose and operational needs.

Work Breakdown Structure

In project management, the Work Breakdown Structure (WBS) is the backbone of planning and execution. WBS is a hierarchical representation of the work that must be performed to complete a project. The provided image exhibits a WBS in a much more complex context, illustrating a multidimensional approach akin to the Tesseract or "Hypercube" concept from geometry. The Tesseract, or a four-dimensional hypercube, offers a metaphor for the further development of WBS, where work is not only divided according to tasks and deliverables but also along additional dimensions such as time, cost, risk, and resources.

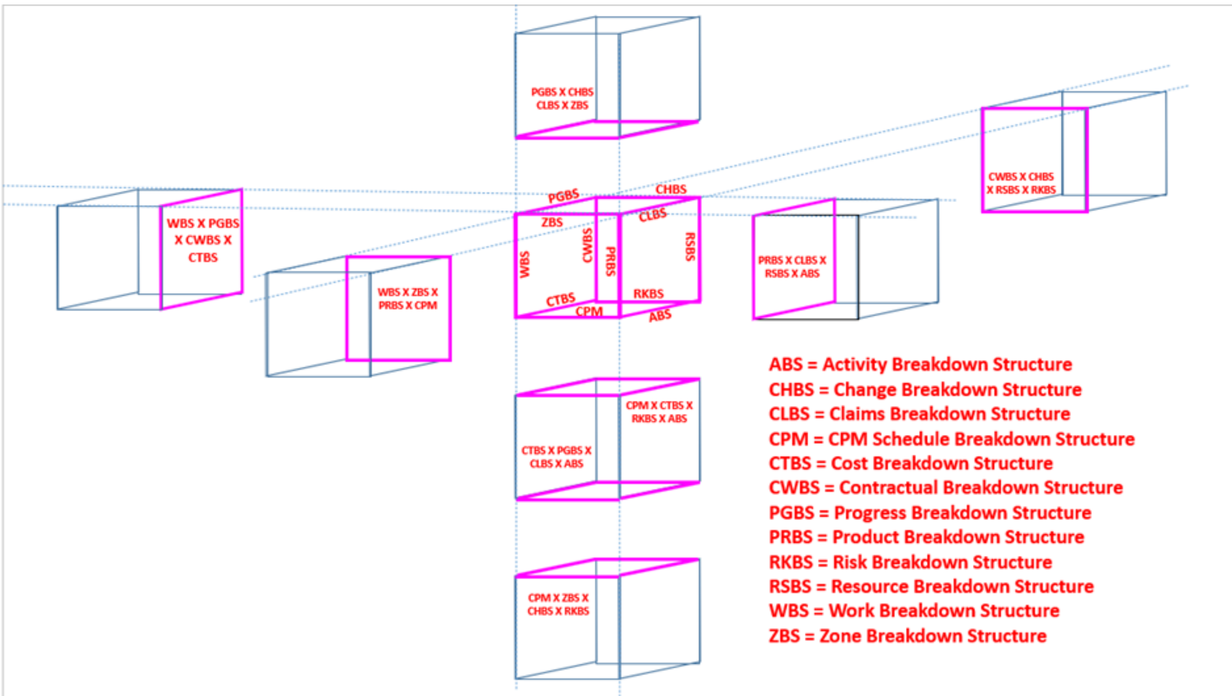


Figure 7. Multidimensional Work Breakdown Structures in Project Management[14]

The hypercube approach to WBS allows stakeholders to view the project from various angles and comprehend its components' interrelationships. It creates a framework for

[14] Leynaud, X., Giammalvo, P. D., & Moine, J.-Y. (2019). Multi-Dimensional Project Breakdown Structures – The Secret to Successful Building Information Modeling (BIM) Integration

more flexible and dynamic project management, enabling more effective handling of project complexity [15]. By integrating dimensions like Cost Breakdown Structure (CTBS) or Risk Breakdown Structure (RKBS), project managers can plan and monitor with more excellent care, enhancing precision in resource allocation and better identifying potential risks and opportunities.

In line with this, the difference between flat files and relational or object-oriented databases is a relevant in project data management. Flat file databases are simple, storing data in an unrelational format, such as in a large table or text file. This is often adequate for data with small volumes and simple structures. However, the primary shortfall of such systems is a lack of flexibility and efficiency as data grows and the relationships between data elements become more complex. [16]

Conversely, relational databases organize data into tables connected through foreign keys, allowing complex relationships between data and more efficient data retrieval. This structure reduces data duplication and facilitates maintenance. Moreover, object-oriented databases extend this concept by storing data as objects—data collection with attributes and methods. This allows for a more natural and consistent data representation with object-oriented programming paradigms, highly useful in modern applications that require complex data modeling and the capacity to handle diverse types of data with greater flexibility. [17]

Organizations can significantly improve project performance and outcomes by employing the hypercube metaphor in WBS and adopting the appropriate database approach for project data management. This ensures that every aspect of the project can be analyzed and managed synergistically and integrated, maximizing efficiency and effectiveness.

Step 2 – Feasible WBS Alternative

In efforts to enhance the effectiveness of construction project management, especially in a dynamic and complex environment like Pertamina, choosing the proper Work Breakdown Structure (WBS) becomes crucial. WBS not only acts as a tool to break down work into smaller, manageable components but also as a framework to integrate various aspects of the project, ranging from planning and cost control to responsibility allocation. In this context, this study will explore two promising WBS alternatives: OmniClass and ISO 19008:2016.

[15] Leoislabs (2016). Understanding 4D -- The Tesseract. From https://www.youtube.com/watch?v=iGO12Z5Lw8

[16] Relational database vs flat file (Differences & similarities). (2023, January 24). Retrieved from https://databasetown.com/relational-database-vs-flat-file-differences-similarities/

[17] Flat file versus relational database (Comparison). (2020, February 23). Retrieved from https://www.relationaldbdesign.com/basic-sql/module3/relational-versus-flatfile.php

OmniClass: Innovation in Project Classification

OmniClass, with its comprehensive classification structure, offers a holistic approach to managing project information. This section will delve deeper into how OmniClass can optimize the WBS structure, enhance coordination among teams, and facilitate more accurate decision-making in pier construction projects. "The OmniClass Construction Classification System (known as OmniClass or OCCS) is an internationally accredited WBS standard, developed to organize and retrieve construction industry information." [18]

OmniClass can be utilized as a relational or object-oriented database in construction project management, offering significant flexibility and efficiency. In its relational database form, OmniClass tables can be interconnected to manage various project aspects such as costs, responsibilities, and risks, enabling complex data interactions and in-depth analysis. As an object-oriented database, each OmniClass table acts as an object class, with entries serving as instances that allow for more dynamic data manipulation. This approach facilitates more effective project management, allowing users to filter, sort, and organize project data in a more flexible and integrated manner. [19]

OmniClass, as a comprehensive classification system for the construction industry, consists of 15 tables, each focusing on different aspects of construction projects. Here is a brief explanation of tables 11 through 49.

[18] OmniClass. (2020). About OmniClass. Retrieved from https://www.csiresources.org/standards/omniclass/standards-omniclass-about
[19] 1.4.1.4 unit 4- Managing scope. (2021, October 14). PTMC. https://build-project-management-competency.com/1-4-1-4-unit-4/

OmniClass Table	Description
Tabel 11	Construction Entities by Function: Classifies construction entities based on their function.
Tabel 12	Construction Entities by Form: Organizes entities based on their physical form.
Tabel 13	Spaces by Function: Classifies spaces according to their use.
Tabel 14	Spaces by Form: Organizes spaces based on their shape or configuration.
Tabel 21	Elements (includes Designed Elements): Focuses on the designed elements in a project.
Tabel 22	Work Results: Classifies work results, including materials, products, and construction methods.
Tabel 23	Products: Concentrates on products used in construction.
Tabel 31	Phases: Classifies project stages, from conception to completion.
Tabel 32	Services: Organizes services related to construction projects.
Tabel 33	Disciplines: Classifies disciplines involved in the project.
Tabel 34	Organizational Roles: Organizes organizational roles in the project.
Tabel 35	Tools and Equipment: Focuses on tools and equipment used in construction.
Tabel 36	Information: Classifies information related to the project.
Tabel 41	Materials: Organizes materials used in construction.
Tabel 49	Properties: Focuses on the properties or characteristics of materials, products, or systems used in construction.

Table 1 – Explanation of each table in OmniClass[20]

ISO 19008:2016: Standard for Cost Management [21]

ISO 19008:2016 provides a standard framework for cost management in construction projects. This standard emphasizes the importance of accurate and transparent cost control, a critical aspect in construction projects that often face challenges in cost estimation and control. This section explains how the implementation of ISO 19008:2016 can assist in developing a more effective WBS in terms of cost management and control,

[20] OmniClass. (2020). About OmniClass. Retrieved from https://www.csiresources.org/standards-omniclass/standards-omniclass-about
[21] OmniClass. (2020). Introduction and User's Guide. Retrieved from https://www.csiresources.org/standards/omniclassv

as well as how this standard can be integrated with other WBS approaches to achieve maximum efficiency.

"ISO 19008:2016 is a Standard issued by ISO, built upon the WBS standard called NORSOK Z-014" [22]and is currently used worldwide. In 1989, the NORSOK standards were created by three Norwegian oil giants: Norsk Hydro, Saga Petroleum, and Statoil". There are specific elements in the ISO 19008:2015 cost coding system. Here is a brief explanation for each:

PBS (Product Breakdown Structure):

PBS is a structure that breaks down the product or output of a project into smaller components or sub-components. In the context of the oil and gas industry, this could mean breaking down facilities or systems into smaller parts, such as pipe modules, processing units, or control systems.

SAB (Standard Activity Breakdown):

SAB is a method for classifying activities involved in a project. It includes various tasks and operations needed to build, maintain, or operate facilities in the oil and gas industry. SAB allows project management to identify, plan, and track specific activities related to the project.

COR (Cost Object Reference):

COR is a reference or code used to identify and track cost objects in a project. This could be a code assigned to a particular component, activity, or resource in the project. COR facilitates the allocation and tracking of costs to specific parts of the project, allowing for more detailed and accurate cost analysis.

ISO 19008:2016 aids in standardizing cost coding in the oil and gas industry, enabling organizations to be more efficient in planning, tracking, and controlling project costs. PBS, SAB, and COR are essential components of this system, allowing for a more structured and systematic breakdown and analysis of costs. [23]

Step 3 – Selection Criteria for WBS Selection

The author plans to use the Multi-Attribute Decision Making (MADM) technique to objectively evaluate and select the most suitable Work Breakdown Structure (WBS) for

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[22] Standard cost coding system (SCCS). (2012, May 2). Standard Norge. Retrieved September 2, 2023, from https://release.standard.no/en/sectors/energi-og-klima/petroleum/norsok-standard-categories/z-stand-cost-coding/z-0142/

[23] Standard cost coding system (SCCS). (2012, May 2). Standard Norge. Retrieved September 2, 2023, from https://release.standard.no/en/sectors/energi-og-klima/petroleum/norsok-standard-categories/z-stand-cost-coding/z-0142/

pier construction projects. This method will assess various WBS options based on criteria like cost efficiency, duration, quality, and safety compliance, ensuring a systematic approach for accurate and measurable decision-making to optimize project management effectiveness.

Attributes	Definition	Criteria
Phase	The main stages in the lifecycle of a pier construction project, starting from conception to completion	Design Phase
		Construction Phase
		Handover Phase
Engineering	Activities related to planning, design, and technical preparation before the start of physical construction.	Surveying
		Design
		Drawing
Construction	The physical execution phase where procured resources are utilized to build the pier structure.	Dredging
		Jetty Head
		Breasting Dolphin
		Mooring Dolphin
		Catwalk
		Mechanical Equipment
		Electrical Equipment
		Instument Equipment
		Safety Equipment
Completion	Activities required to finalize construction, including inspections, testing, and commissioning, until the project is ready to be operated or handed over to the owner.	Commissioning

Table 2 – Criteria for WBS Selection[24]

Step 4 – Selection Criteria

Taking into account the aforementioned attributes, the author intends to identify and choose relevant tables from each WBS that align with these specified criteria. The outcomes are to be presented in the following manner:

[24] Author

Criteria	CSI TABLE 11	CSI TABLE 12	CSI TABLE 13	CSI TABLE 14	CSI TABLE 21	CSI TABLE 22	CSI TABLE 23	CSI TABLE 31	CSI TABLE 32	CSI TABLE 33	CSI TABLE 34	CSI TABLE 35	CSI TABLE 36	CSI TABLE 41	CSI TABLE 49
Design Phase								1							
Construction Phase								1							
Handover Phase								1							
Surveying	1	1				1			1						
Design	1	1				1			1						
Drawing	1	1				1			1						
Dredging	1	1			1	1	1								
Jetty Head	1	1			1	1	1								
Breasting Dolphin	1	1			1	1	1								
Mooring Dolphin	1	1			1	1	1								
Catwalk	1	1			1	1	1								
Civil Offshore	1	1			1	1	1								
Mechanical Equipment	1	1			1	1	1								
Electrical Equipment	1	1			1	1	1								
Instrument Equipment	1	1			1	1	1								
Safety Equipment	1	1			1	1	1								
Commissioning	1	1													

Table 3 – Analysis of OmniClass Tables Using MADM Methodology[25]

Criteria	PBS	SAB	COR
Design Phase	1	1	
Construction Phase	1	1	
Handover Phase	1	1	
Surveying			
Design	1	1	1
Drawing	1	1	1
Procedures	1	1	1
Dredging	1	1	1
Jetty Head	1	1	1
Breasting Dolphin	1	1	1
Mooring Dolphin	1	1	1
Catwalk	1	1	1
Civil Offshore	1	1	1
Mechanical Equipment	1	1	1
Electrical Equipment	1	1	1
Instrument Equipment	1	1	1
Safety Equipment	1	1	1
Commissioning		1	

Table 4 – Analysis of ISO19008:2016 Tables Using MADM Methodology[26]

[25] Author
[26] Author

FINDING

Step 5 –Analysis and Comparison of Alternative

Based on the results above, the author has determined that both WBS standards can identify parts of the pier construction work, yet when comparing the two approaches, OmniClass is able to fulfill the entire standard WBS for pier construction according to the summary table below:

Criteria	Omniclass	ISO19008
Design Phase	1	1
Construction Phase	1	1
Handover Phase	1	1
Surveying	1	
Design	1	1
Drawing	1	1
Civil Works	1	1
Piping Works	1	1
Mechanical Works	1	1
Electrical Works	1	1
Instrument Works	1	1
Safety Works	1	1
Commissioning	1	1

Table 5 – Comparison between OmniClass and ISO 19008:2016[27]

Based on Table 5 above, after making a comparison using OmniClass and ISO 19008:2016, it was found that OmniClass can fulfill all the criteria of the WBS for pier construction. Therefore, the standard to be developed in the next step will use OmniClass.

Step 6 – Standardizing WBS

From the MADM outcomes presented in Table 3, the author has deduced the order of tables to be utilized for the WBS/CBS of this Pier Construction, ranked from the highest to the lowest, as follows: Tables 11, 12, 22, 21, 23, 32, and 31. The construction of the WBS and CBS will be attempted using these identified tables.

[27] Author

Criteria Fullfiled	Omniclass Title	Table		Omniclass Number
Pier Structure	Marine Transportation Terminal	11	Construction by Entities	11-51 21 00
Design Phase	Design Phase	31	Phase	31-40 00 00
Survey Report	Survey	22	Work Result	22-02 21 00
Surveying	Surveying	32	Service	32-35 47 23
Design	Design Data	22	Work Result	22-01 33 16
Calculating	Calculating	32	Service	32-35 57 43
Developing	Developing	32	Service	32-35 57 37
Shop drawing & Data Sheet	Shop Drawings, Product Data, and Samples	22	Work Result	22-01 33 23
Developing	Developing	32	Service	32-35 57 37
Construction Phase	Implementation Phase	31	Phase	31-60 00 00
Dredging & Dumping	Dredging	22	Work Result	22-35 20 23
Dredging	Excavating	32	Service	32-57 91 15
Dumping	Disposing	32	Service	32-57 91 19
Jetty Head	Jetties	22	Work Result	22-35 31 26 13 1
Pilling	Steel Piles	22	Work Result	22-31 62 16
Pile	Foundation Piles	23	Product	23-13 29 11 11
Construction	Constructing	32	Service	32-57 61 00
Inspection	Inspecting	32	Service	32-57 81 13
Structural Concrete	Structural Concrete	22	Work Result	22-03 31 00
Concrete	Precast Concrete Beams	23	Product	23-13 35 19 17
Construction	Constructing	32	Service	32-57 61 00
Inspection	Inspecting	32	Service	32-57 81 13
Breasting Dolphin	Jetties	22	Work Result	22-35 31 26 13 2
Pilling	Steel Piles	22	Work Result	22-31 62 16
Pile	Foundation Piles	23	Product	23-13 29 11 11
Construction	Constructing	32	Service	32-57 61 00
Inspection	Inspecting	32	Service	32-57 81 13
Structural Concrete	Structural Concrete	22	Work Result	22-03 31 00
Concrete	Precast Concrete Beams	23	Product	23-13 35 19 17
Construction	Constructing	32	Service	32-57 61 00
Inspection	Inspecting	32	Service	32-57 81 13
Mooring Dolphin	Jetties	22	Work Result	22-35 31 26 13 3

Table 6 – Proposed Codes for Pier Construction (1)

Criteria Fullfiled	Omniclass Title	Table		Omniclass Number
Pilling	Steel Piles	22	Work Result	22-31 62 16
Pile	Foundation Piles	23	Product	23-13 29 11 11
Construction	Constructing	32	Service	32-57 61 00
Inspection	Inspecting	32	Service	32-57 81 13
Structural Concrete	Structural Concrete	22	Work Result	22-03 31 00
Concrete	Precast Concrete Beams	23	Product	23-13 35 19 17
Construction	Constructing	32	Service	32-57 61 00
Inspection	Inspecting	32	Service	32-57 81 13
Catwalk	Metal Catwalk	22	Work Result	22-05 51 36 13
Pilling	Steel Piles	22	Work Result	22-31 62 16
Pile	Foundation Piles	23	Product	23-13 29 11 11
Construction	Constructing	32	Service	32-57 61 00
Inspection	Inspecting	32	Service	32-57 81 13
Structural Concrete	Structural Concrete	22	Work Result	22-03 31 00
Concrete	Precast Concrete Beams	23	Product	23-13 35 19 17
Construction	Constructing	32	Service	32-57 61 00
Inspection	Inspecting	32	Service	32-57 81 13
Catwalk Frame	Metal Catwalk	22	Work Result	22-05 51 36 13
Bar	Reinforcing Bars	23	Product	23-13 21 21 11 13
Construction	Constructing	23	Product	32-57 61 00
Inspection	Inspecting	32	Service	32-57 81 13
Civil Offshore	Buliding Modules	21	Element	22-13 42 00
Concrete	Precast Concrete Beams	23	Product	23-13 35 19 17
Construction	Constructing	32	Service	32-57 61 00
Inspection	Inspecting	32	Service	32-57 81 13
Mechanical Equipment	Facility fuel system	21	Element	21-04 30 10
Striping Pump	sump pump dishcarge piping	22	Work Result	22-22 14 19
Striping Pump	axial split pump	23	Product	23-27 17 11
Installation	Installing	32	Service	32-57 61 29
Inspection	Inspecting	32	Service	32-57 81 13
Sea water pump	submersible liquid pump	22	Work Result	22-43 21 39
Sea water pump	Centrifugal pump	23	Product	223-27 17 13
Installation	Installing	32	Service	32-57 61 29
Inspection	Inspecting	32	Service	32-57 81 13
Tower hose	Tower	22	Work Result	22-13 36 00
Tower hose	Tower	23	Product	23-19 7 21
Installation	Installing	32	Service	32-57 61 29

Table 7 – Proposed Codes for Pier Construction (2)

Criteria Fullfiled	Omniclass Title	Table		Omniclass Number
Inspection	Inspecting	32	Service	32-57 81 13
Sample Collector Tank	facility portable water storage tank	22	Work Result	22-22 12 00
Sample collector tank	tank and storage	23	Product	23-27 29 00
Installation	Installing	32	Service	32-57 61 29
Inspection	Inspecting	32	Service	32-57 81 13
Piping	Fuel piping	22	Work result	22-23 11 00
Piping	Piping	23	Product	23-27 39 00
Installation	Installing	32	Service	32-57 61 29
Inspection	Inspecting	32	Service	32-57 81 13
Electrical Equipment	Electrical	21	Element	21-04 50
Power cable	control electrical power cables	22	Work Result	22-26 05 23
Power cable	Ropes, wires and cables	23	Product	23-13 23 21
Installation	Installing	32	Service	32-57 61 29
Inspection	Inspecting	32	Service	32-57 81 13
Lightning	facility lighnting protection	22	Work Result	22-26 41 00
Lighting protection	Lightning protection	23	Product	23-35 39 15
Installation	Installing	32	Service	32-57 61 29
Inspection	Inspecting	32	Service	32-57 81 13
Grounding system	site grounding	22	Work Result	22-33 79 00
Grounding system	Electrical groduning devices	23	Product	23-35 39 11
Installation	Installing	32	Service	32-57 61 29
Inspection	Inspecting	32	Service	32-57 81 13
Instrument Equipment	Special instrument	21	Element	21-06 10 80
Instrument Cable	medium voltages cables	22	Work Result	22-26 05 13
Instrument Cable	Ropes, wires and cables	23	Product	23-13 23 21
Installation	Installing	32	Service	32-57 61 29
Inspection	Inspecting	32	Service	32-57 81 13
Field Instrument	instrumentation and control utilities	22	Work Result	22-33 09 00
Field instrument	General instrument and controls	23	Product	23-27 11 11
Installation	Installing	32	Service	32-57 61 29
Inspection	Inspecting	32	Service	32-57 81 13

Table 8 – Proposed Codes for Pier Construction (3)

Criteria Fullfiled	Omniclass Title	Table		Omniclass Number
Instrument accessories	Instrument and control for fuel	22	Work Result	22-33 09 50
Instrument accessories	Instrument equipment	23	Product	23-21 25 19 19
Installation	Installing	32	Service	32-57 61 29
Inspection	Inspecting	32	Service	32-57 81 13
Safety Equipment	Fire protection	21	Element	21-04 40
Fire fighting	Fire protection	22	Work Result	22-07 80 00
Fire fighting	Fire fighting equipment	23	Product	23-29 25 00
Installation	Installing	32	Service	32-57 61 29
Inspection	Inspecting	32	Service	32-57 81 13
Fireship connection	Fire protection specialist	22	Work Result	22-10 44 00
Fireship connection	Fire hose equipment	23	Product	23-29 25 15
Installation	Installing	32	Service	32-57 61 29
Inspection	Inspecting	32	Service	32-57 81 13
Fire extenghuiser	Fire extenghuiser	22	Work Result	22-10 44 16
Fire extenghuiser	Fire extenghuiser	23	Product	23-29 25 19
Installation	Installing	32	Service	32-57 61 29
Inspection	Inspecting	32	Service	32-57 81 13
Handover Phase	Handover Phase	31	Phase	31-70 00 00
Commisioning	Commissioning of Utilities	22	Work Result	22-33 08 00
Testing	Testing	32	Service	32-57 81 17

Table 9 – Proposed Codes for Pier Construction (4)

Guided by Table 7, a WBS can be developed for each project phase. The figures below display the suggested WBS structure for the respective phases.

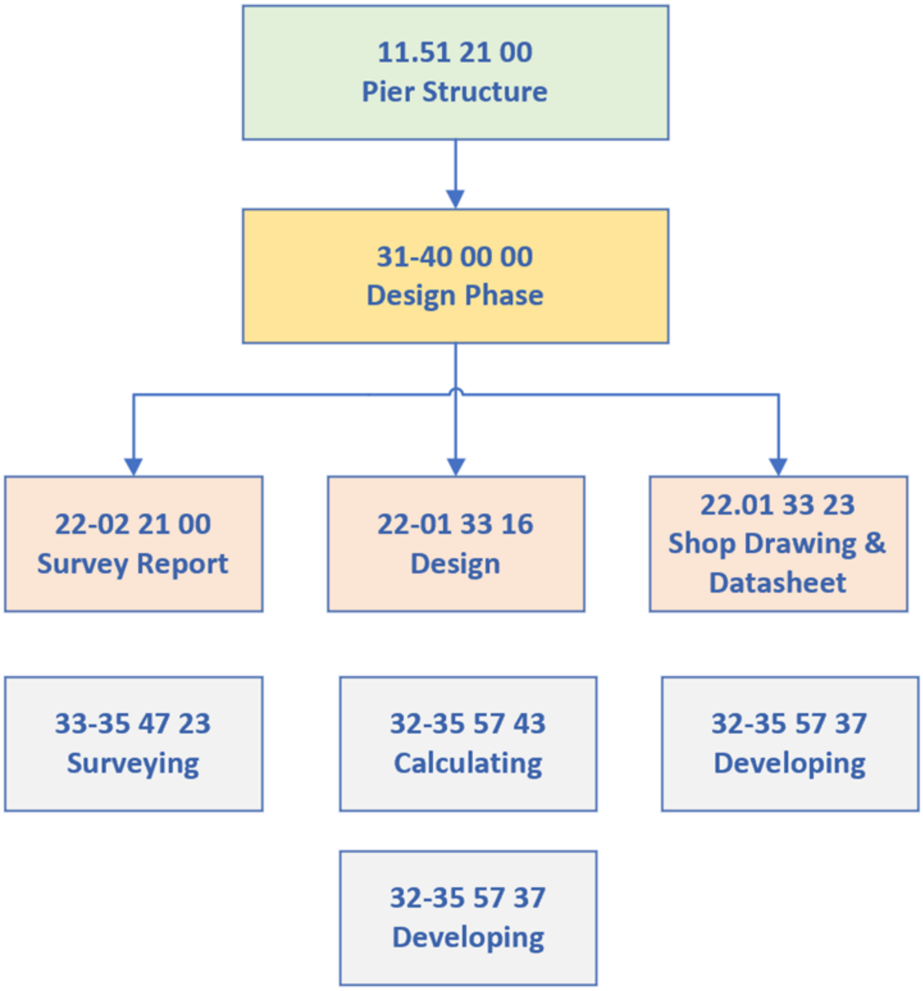

Figure 8 – WBS for Pier Structure (1)

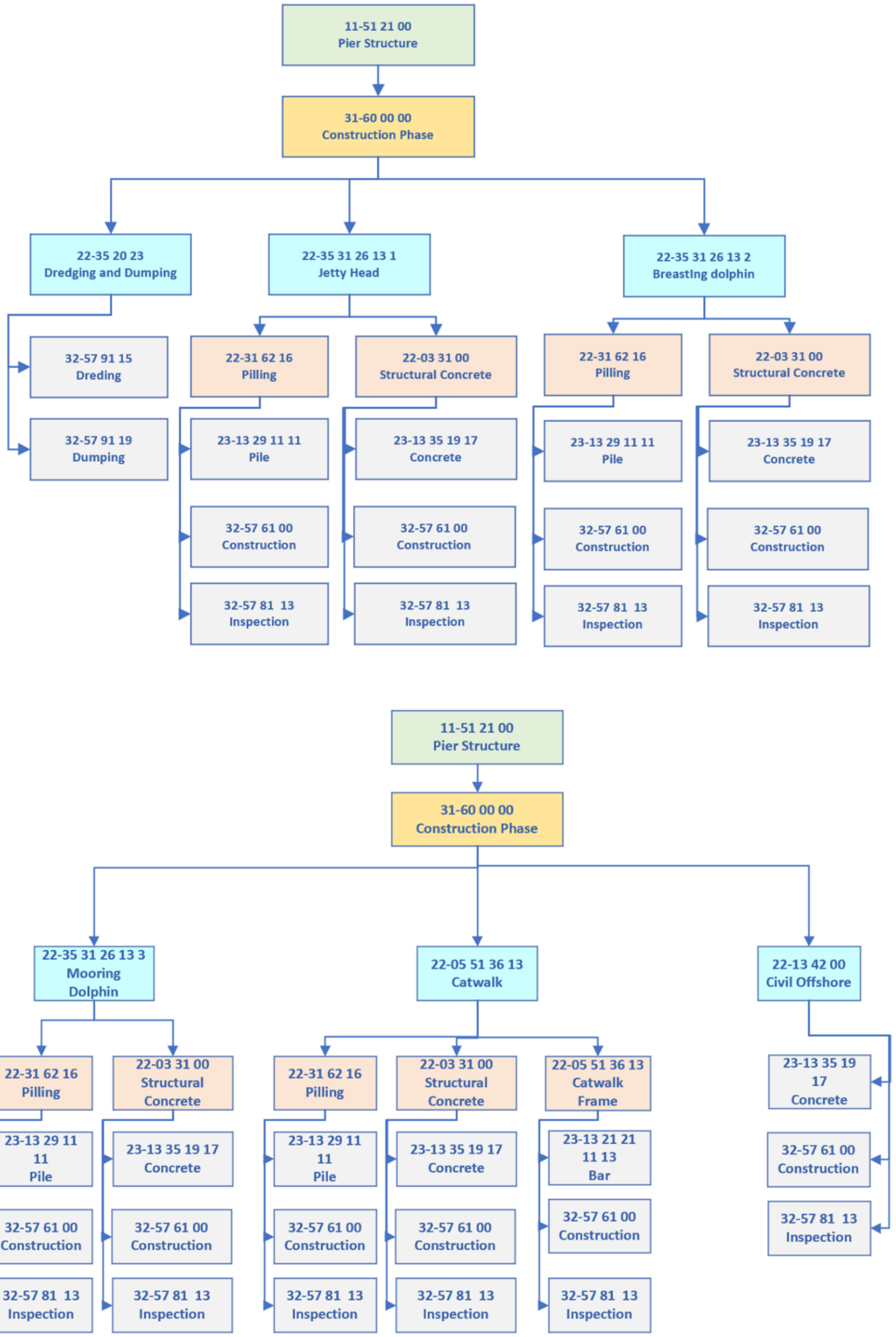

Figure 9 – WBS for Pier Structure (2)

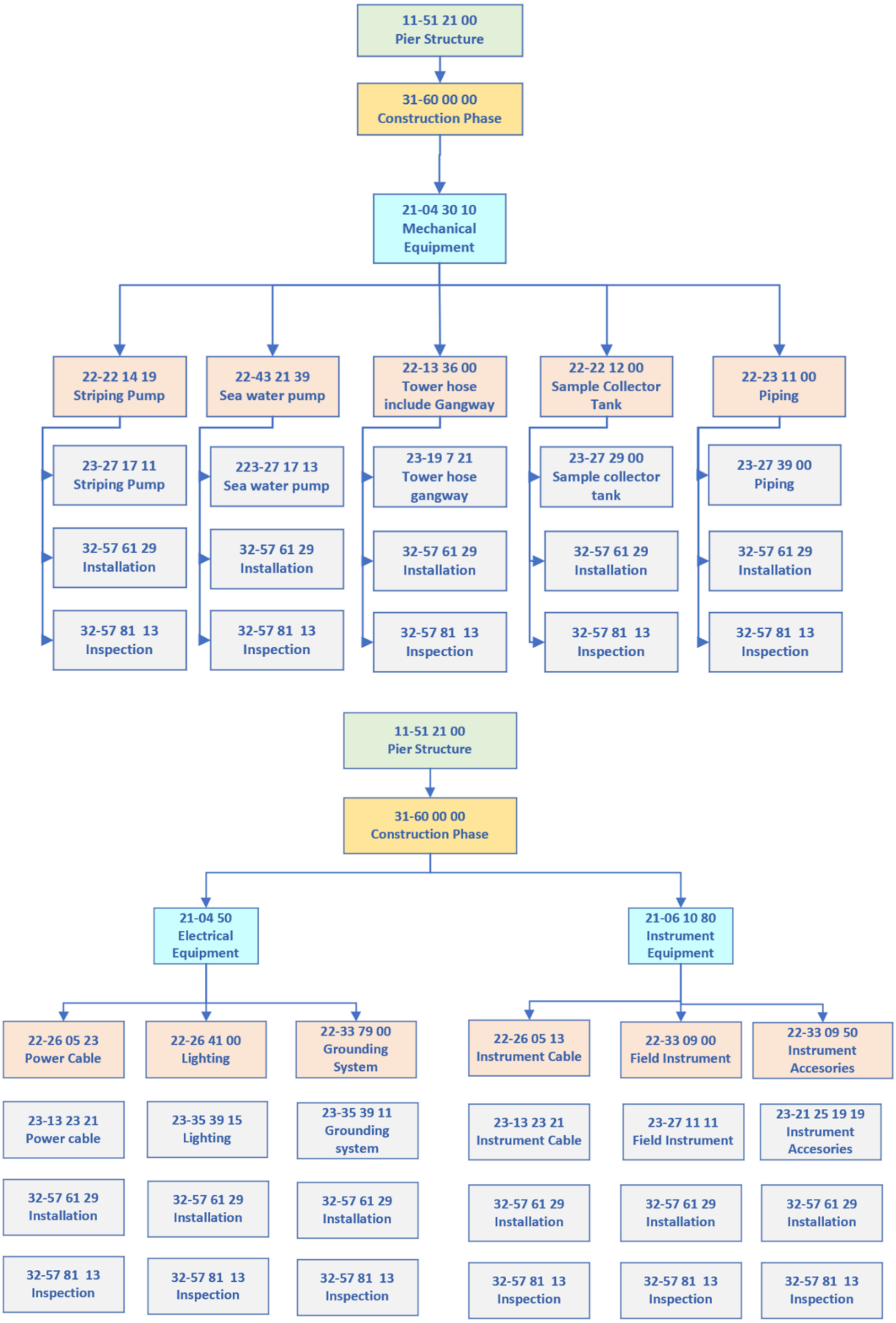

Figure 10 – WBS for Pier Structure (3)

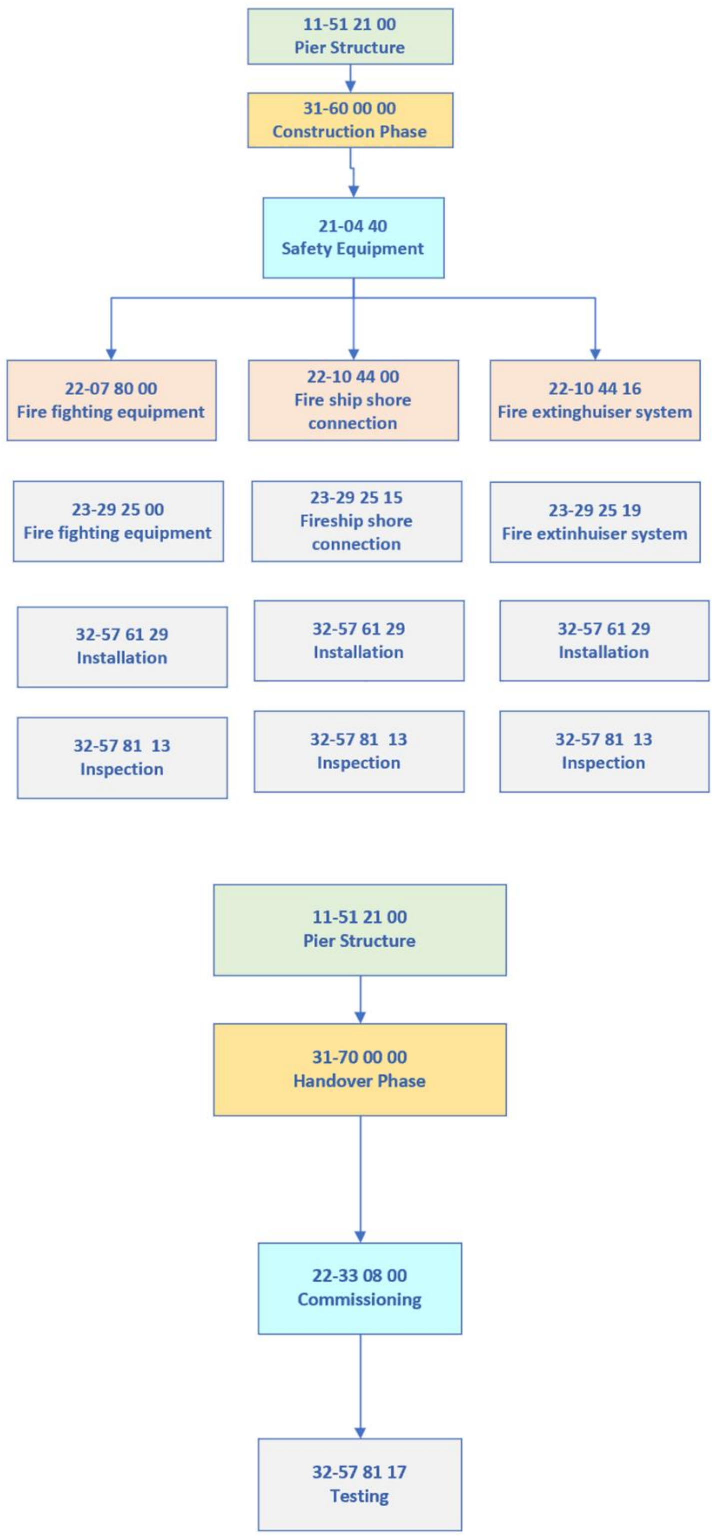

Figure 11 – WBS for Pier Structure (4)

Step 7 – Performance Monitoring

To ensure the effectiveness of WBS and CBS implementation in pier construction projects, the following steps are needed:

1. Pre-Implementation Evaluation: Compare the planned WBS with current practices to assess compatibility.
2. KPI Development: Identify KPIs that reflect the project's objectives and the standardization of WBS/CBS, including cost accuracy and resource allocation.
3. Regular Review Meetings: Hold routine meetings with all stakeholders to discuss progress and areas needing improvement in the WBS.
4. Team Training: Provide specialized training to team members on the use and benefits of WBS and CBS, ensuring a deep understanding of how they work and how they can be maximized in the project.
5. Technology Integration: Leverage the latest project management software that supports the integration of WBS and CBS, allowing for real-time monitoring and reporting that can enhance decision-making and project efficiency.

These steps will ensure that all elements of pier construction are effectively covered in the WBS, allowing for more structured and efficient project management.

FUTURE RESEARCH

In the development of research on pier construction using Work Breakdown Structure (WBS), this study has opened up opportunities for further exploration in several key aspects, including:

- **Comparative Studies**: Undertaking comparative analyses of WBS implementation across different locations with varying regulatory conditions to identify best practices.
- **Cost-Benefit Analysis**: Conduct in-depth examinations of different WBS strategies to discover the most cost-efficient approaches for pier construction.
- **Advanced Integration Techniques**: Exploring new methods to integrate WBS with the latest project management technologies.

This research suggests a multidimensional approach to enhancing pier construction projects, emphasizing the need for adaptable strategies that consider geographical and regulatory diversity, financial efficiency, and the potential benefits of technological integration.

CONCLUSION

Given the importance of pier infrastructure development for PT Pertamina Patra Niaga in supporting distribution operations, it's crucial to establish a WBS standard for the Pier Construction Project. Utilizing MADM tools, it was found that WBS can be designed using existing WBS Standards, such as Omni Class, tailored to the project's needs. The steps for developing WBS include identifying the specific needs of the project, selecting relevant coding structures, and testing the WBS structure in real conditions to ensure its effectiveness in the pier construction project at PT Pertamina Patra Niaga.

To ensure the successful implementation of WBS, consider adding the following points:

- Training and Competency Development: Conduct training sessions to ensure all team members understand and can effectively implement WBS.
- Continuous Evaluation and Feedback: Provide mechanisms for regular evaluation and feedback from all stakeholders, ensuring continuous adjustment and improvement of the WBS structure.
- Integration with Other Project Management Systems: Ensure WBS is well-integrated with other project management systems to facilitate information flow and coordination among teams.

These additional steps will support the successful implementation of WBS, enhancing project coordination and ensuring more efficient project goal achievement.

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