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Innovative

FRAMEWORK OF EXCELLENCE IN EXECUTING SHIPYARDS PROJECTS

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ABSTRACT

This technical paper presents key success factors and best practices in executing shipyards projects, focusing on the Engineering, Procurement, and Construction (EPC) phases framework. Each phase is analyzed with in depth practices and recommended success factors. References include official publications, real-world case studies, and academic journals to support practical implementation.

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INTRODUCTION

Shipbuilding projects require a high level of coordination and integration of various engineering, procurement, and construction activities.

Ensuring project success involves adopting industry-recognized best practices to enhance efficiency, reduce cost, and maintain quality.

Efficient management and execution of such projects require structured approaches supported by proven best practices. This paper focuses on optimizing performance using the EPC project model. This phase-based approach aligns with the PMBOK® Guide (PMI, 2021), which emphasizes tailoring project delivery to fit strategic and operational contexts

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LITERATURE REVIEW

The literature on shipbuilding project management emphasizes the integration of standardized frameworks, early stakeholder engagement, and digital transformation. According to the Project Management Institute (PMI, 2021), standardized frameworks such as PMBOK® help define project phases clearly, ensuring consistent quality, risk mitigation, and performance monitoring. This approach is especially critical in shipyards projects where complexity and interdependency are high.

Stakeholder early engagement and alignment in particular for the shipyard end users plays major role in successful shipyards projects (Anas S. Alamoush, Fabio Ballini, Aykut I. Ölçer, 2024). The stakeholders, when properly managed, lays a foundation for project success. In complex infrastructure projects like shipyards and port facilities, early engagement helps align the engineering design with long term operational needs.

Moreover, digital technologies are playing an increasingly central role. McKinsey & Company (2022) documented how digital procurement tools, Building Information Modeling (BIM), and integrated planning software reduce delays, enhance cost efficiency, and improve stakeholder communication. BIM, for instance, enables clash detection and 3D visualization, resulting in fewer design errors and smoother construction sequencing.

In sustainability-oriented research by DNV (2024) outlined future shipyard requirements under decarbonization mandates. These include efficient layout planning, green energy use, and waste minimization frameworks.
As a result, the literature supports a trend toward greater digitalization, risk-based planning, and sustainability-driven design in shipbuilding.

METHODOLOGY

This study uses a qualitative approach based on case study analysis and literature synthesis. Key success factors were derived from PMI guidelines, industry reports, and documented case studies of shipyard projects around the world.

SUCCESS FACTORS IN SHIPBUILDING PROJECTS

In this section, each of the main phases of the project is analyzed in terms of its importance along with the recommended best practices associated with that will eventually support the shipyard project management in efficient execution.

1. ENGINEERING PHASE

The engineering phase as the early phase of the project involves identifying the objective and defining the overall scope of the project. According to the industry's best practices, the engineering phase is further divided into two main phases, the conceptual phase and the detail engineering phase. During this phase, the project masterplan is defined, the basis of design and the project execution plans which will pave the road for the subsequent phases. Therefore, it is crucial to highlight that proper engineering and planning phase will determine the project success. Below are recommended key success factors to be considered during the engineering phase post securing the approval of the project execution plan:

- **Conduct Site Surveys Studies:** Before initiating any design work, it is vital to understand the physical characteristics of the shipyard location. Site investigations provide information on soil bearing capacity, groundwater levels, and subsurface conditions, which are crucial for designing foundations and marine structures. Bathymetric surveys reveal seabed depth and contours, helping engineers plan quay wall elevations and approach channels. In addition, the environmental impact assessment is very crucial to assess the shipyard location impact to both the surrounding areas and the sea coral reefs. These studies ensure that design assumptions are realistic and help avoid costly redesigns or construction delays.

- **Finalize the Operational Philosophy with Concerned Stakeholders:** The operational philosophy outlines how the shipyard will function upon completion, including workflow, logistics, equipment utilization, and safety protocols. Involving key stakeholders such as ship owners, operations teams, and safety officers ensures that design decisions align with real-world operational needs. Early consensus avoids changes during construction and improves overall project efficiency.

- **Finalize the Masterplan and Design Basis:** The shipyard masterplan should be structured around the logical flow of materials and ship sections from fabrication to assembly. This involves locating workshops, dry docks, and storage areas in a layout that reduces internal transport distances and handling time. Designing with an understanding of lean manufacturing principles ensures that bottlenecks and inefficiencies are minimized. Upon freezing the masterplan, the design basis should be commenced which include the marine, workshops, utilities and infrastructure design works.

- **Finalize early the Dredging, Reclamation and Marine Structure Design Package:** Depending on the location of the project, Dredging and Reclamation are often on the project's critical path and should be aligned with quay wall and berth design. Finalizing these packages early after completing the required site investigations allows for permit acquisition and mobilization of marine equipment. This ensures that marine access infrastructure is ready by the time it is needed for transporting heavy components or completed vessels.

- **Adopt Modular Design Principles:** Modularization in shipyard design means breaking down structures into transportable and prefabricated modules. These modules can be assembled off-site or in controlled environments, improving quality, reducing rework, and speeding up on-site assembly. This approach also enhances safety by minimizing work at heights and overwater.

- **Utilize Building Information Modeling (BIM) /Digital Twin :**BIM allows for real-time, multidisciplinary collaboration among architects, engineers, and project managers. It helps detect and resolve design conflicts early, provides 3D visualization of shipyard and facility layouts, and allows better planning of construction sequencing. BIM models also serve as digital twins for future operations and maintenance.

- **Conduct an Assessment for Green Energy Utilization:** The purpose of the assessment is to explore design opportunities with regards to optimal energy performance and life cycle costs that ultimately ensure a most energy efficient, sustainable, and economical design by identifying the industrial energy optimizations applications, renewables opportunities and potential green buildings.

2. PROCUREMENT PHASE

The Procurement Phase is essential for securing the materials, components, and subcontracted services necessary for shipyard construction and shipbuilding. Strategic procurement ensures that project timelines are met, budgets are adhered to, and quality standards are maintained. Procurement planning must consider global supply chains, lead times, and potential market fluctuations. Below are key procurements success factors to be considered which include but not limited to:

- **Develop a Comprehensive Procurement Strategy early in the Project:** A well-defined procurement strategy includes the sourcing plan, risk management approach, contract models, and supplier engagement policies. Early development ensures coordination with engineering timelines and allows for competitive bidding and negotiation. It also allows the project team to identify and mitigate procurement risks before they affect the schedule.

- **Pre-qualify Vendors and Suppliers based on Technical and Financial Capabilities:** Pre-qualification ensures that suppliers meet the necessary technical expertise, capacity, and financial stability to fulfill contract requirements. This step helps prevent poor performance, supply chain disruptions, or vendor default during execution. Pre-qualified vendors can also be benchmarked for performance on similar past projects.

- **Use Digital Procurement Platforms to Track Progress and Coordinate Deliveries:** Digital tools streamline procurement processes by automating tendering, contract management, and delivery tracking. They offer dashboards and alerts for overdue items, document compliance, and payment milestones. These platforms enhance transparency, reduce paperwork, and ensure stakeholders are aligned on delivery schedules.

- **Establish Clear Technical Specifications and Quality Control Measures:** Detailed specifications avoid ambiguity in vendor deliverables and support fair bidding processes. Additionally, including quality control procedures—such as factory acceptance tests (FATs), material certifications, and third-party inspections—ensures compliance with project standards.

Integrate Procurement Timelines with Construction Schedules: Aligning procurement activities with construction sequencing prevents idle time on-site and reduces the need for costly warehousing. Just-in-time delivery of long-lead equipment and materials ensures efficient resource utilization and cash flow management.

3. CONSTRUCTION PHASE

The Construction Phase is where physical implementation occurs, involving land development, structural works, utilities, equipment installation, and commissioning. Effective construction management ensures that the project is executed safely, within budget, and according to quality and schedule requirements. It is the most resource-intensive phase and requires seamless coordination across disciplines. Below are recommended success factors during the construction:

- **Implement robust construction planning and scheduling using Critical Path Method (CPM) and Earned Value Management (EVM):** Advanced scheduling tools like CPM and EVM enable better resource allocation, track progress, and provide early warnings for delays. This structured approach enhances decision-making, helps control costs, and maintains project momentum by identifying and focusing on critical tasks.

- **Establish a Site-Specific HSE (Health, Safety, and Environment) Management System:** Construction sites, especially near marine environments, involve elevated risks such as working at heights, over water, and with heavy equipment. An HSE system tailored to the specific hazards of the shipyard project ensures regulatory compliance, minimizes incidents, and fosters a safety culture among workers.

- **Ensure Quality Assurance and Quality Control (QA/QC) Processes are Integrated:** A proactive QA/QC framework ensures that materials and workmanship meet project standards. Regular inspections, third-party audits, and test protocols help detect and resolve issues early, avoiding costly rework or operational disruptions.

- **Adopt Prefabrication and Preassembly wherever Feasible:** By fabricating components off-site or in controlled environments, projects can achieve higher quality, reduce waste, and minimize weather-related delays. Preassembled units are then installed on-site efficiently, reducing time and labor requirements.

- **Coordinate Closely with Suppliers and Logistics Providers for Just-In-Time Delivery:** Aligning procurement activities with construction sequencing prevents idle time on-site and reduces the need for costly warehousing. Just-in-time delivery of long-lead equipment and materials ensures efficient resource utilization and cash flow management.

- **Deploy Construction Management Software for Real-Time Monitoring and Reporting:** Tools like Primavera P6, MS Project, and Power BI provide dashboards, daily logs, inspection checklists, and resource tracking. These tools enhance visibility, enable faster issue resolution, and facilitate reporting to stakeholders in real time.

SHIPYARDS PROJECTS CONTRACTING STRATEGY

Selecting the right contracting strategy is crucial to the success of shipyard projects and plays major role on the successful shipyards return on investment (ROI). The challenge that normally being faced by the project management team is to sucre an optimum execution plans to design, procure and build the shipyards as they often involve complex interfaces, specialized equipment, and significant infrastructure. Considering the most suitable contracting strategies currently in the market is either EPC / LSTK (Lump Sum Turnkey) or Procure- Build which can be differentiated as follow:

Strategy	Best For	Pros	Risks
EPC / LSTK (Lump Sum Turnkey)	Large shipyard projects with well-defined scope	Single-point responsibility, cost and schedule certainty	Limited flexibility, costly if scope changes, risk premiums and requires experts PMO
Procure-Build (PB) (design is done by others)	Complex or fast-track projects need flexibility. Mid-sized or performance-based infrastructure	Simplified delivery, faster execution, reduced claims	Higher owner risk, coordination intensive, Risk of design shortcuts, limited Contractor design input

A hybrid approach is often most effective in shipyard development. It spreads risk and allows focused control on critical components, however, for each specific shipyard project, the project team is advised to explore the alternatives options of contracting strategies and to assess each option in terms of cost, schedule, interfaces, scope magnitude, risks, capable executers and local content availability in order to select the best approach of either a single package or multiple ones using the hybrid strategy . Below are recommended strategies:

Component	Recommended Strategy
Marine Structures	LSTK or Procure-Build
Dredging & Reclamation	LSTK or Procure-Build
Ship Lift / Cranes	Supply + Install contracts with O&M supervision
Workshops & Buildings	LSTK or Procure-Build
Utilities & MEP	Separate LSTK Package

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BEST PRACTICES CASE STUDIES

Several best practices were cited world wide shedding the lights on the efficient shipyards operations and implemented lessons learned by the shipyards executers and operators ,below section highlights some of these best practices that emphasize on how crucial for the project team at the early phase factors to consider such as but not limited to stakeholders engagement, proper master planning and innovative design as follow:

CASE STUDY 1: NON-METALLIC UTILIZATION – MARITIME PROGRAM AT KING SALMAN INTERNATIONAL COMPLEX OF MARITIME INDUSTRIES AND SERVICES

The maritime program at King Salman International Complex in the Kingdom of Saudi Arabia which is the largest shipyard in the Middle East consists of multiple production and maintenance zones for commercial ships and offshore rigs. The piping networks at the project are more than 300 KM of utilities piping system which is considered massive quantities where the project successfully utilized non-metallic for piping networks that are found cheaper than alternatives, locally sources and environmentally friendly as it is produced at lowered carbon emissions.

CASE STUDY 2: MODULARIZED SUBSTATIONS – MARITIME PROGRAM AT KING SALMAN INTERNATIONAL COMPLEX OF MARITIME INDUSTRIES AND SERVICES.

At the same project location mentioned above, the Maritime program implemented large scale modularization concept for electrical buildings. The main benefit of modular buildings is reducing the installation and commissioning times by providing offsite pre-manufactured, pre-assembled and pre-tested product by one pre-qualified supplier, thus reducing total construction time by %25-20. A cost avoidance of %25 realized by deploying electrical modularized buildings in the Maritime program.

CASE STUDY 3: HYUNDAI HEAVY INDUSTRIES – ASSEMBLY BLOCK OPERATIONS MANAGEMENT

Hyundai Heavy Industries (HHI), as one of the well-known shipyards operators in the world, implemented the Ship Assembly Block Operations Optimization (SABOO) project to enhance assembly block operations. By diagnosing workflow inefficiencies and developing a real-time monitoring prototype, the shipyard optimized block transportation and storage. This initiative resulted in productivity improvements and reduced operational downtime which support the recommended best practice of the importance of finalizing the operation philosophy of the shipyards which ultimately support the project team to optimize the shipyard.

CASE STUDY 4: SIMULATION-BASED MASTER PLANNING IN SHIPBUILDING

In South Korea, a simulation-based planning system reorganized shipyard master planning processes through integrated models. This enabled more accurate validation of layout decisions and efficient resource allocation, supporting streamlined shipyard development.

CASE STUDY 5: THEORY OF CONSTRAINTS IN NIGERIAN SHIPBUILDING

Nigerian shipbuilding applied the Theory of Constraints (TOC) to address inefficiencies related to poor infrastructure and limited technical resources. TOC helped prioritize investments, manage bottlenecks, and improve performance by strategically aligning resources to critical project stages.

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CONCLUSION

Executing shipyards projects requires a structured and disciplined project management approach. By following best practices across the Engineering, Procurement, and Construction (EPC) phases, stakeholders can enhance project predictability, control risks, and ensure the timely and cost-effective delivery of infrastructure. This report emphasized the importance of early planning, stakeholder alignment, technological integration, and proactive risk management. Incorporating real-world case studies and international standards, including guidance from the Project Management Institute (PMI), reinforces the relevance and applicability of these practices. As maritime industries continue evolving with sustainability and digital transformation, shipyards must continually adapt their practices to stay competitive and deliver value to stakeholders.

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