Traditional Project Management PW Assignment Offshore Desalination Skid (DESAL-90P)

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EXECUTIVE SUMMARY

This report presents the comprehensive planning and management of an industrial project, developed in the context of the "Industrial Project Management A" course. The project was executed using traditional (Waterfall) project management methodologies, with the goal of delivering a detailed and integrated plan that covers all phases from engineering design to final testing.

The project is titled: Offshore Desalination Skid (DESAL-90P) and involves the end-to-end delivery of a reverse osmosis desalination skid for offshore use.

The work includes a structured breakdown of the project through Work Breakdown Structure (WBS). Activities were defined with explicit precedence relationships, enabling the development of a coherent time management analysis.

A full resource and cost breakdown analysis was conducted using real-world assumptions and project constraints. The cost estimation allowed for evaluating cumulative effort, financial exposure, and potential optimization strategies.

Furthermore, the project included the definition of a cash flow plan, identifying funding needs and timing of expenses, which proved critical in assessing the sustainability of different organizational approaches.

The planning also addressed risk management, with a preliminary identification of key risks and mitigation strategies, and progress evaluation strategies.

Although the working framework was based on a Waterfall model, the project itself was intended to be developed using an Agile methodology. Consequently, Agile practices were applied during the group collaboration phase.

Key-words: Project Management, Desalination, Offshore, Reverse Osmosis, Waterfall, Agile, Work Breakdown Structure, Cost Estimation, Risk Management

CONTENTS

1 PROJECT CHARTER

The Project Charter was developed at the conclusion of the planning phase, rather than at the beginning. This choice was intentional: by first completing the full breakdown of tasks, structure, scheduling, and resource analysis, the scope and objectives of the project became clearer and more grounded in the actual complexity of the work. Defining the charter retrospectively allowed for a more accurate and comprehensive summary of the project's boundaries and key deliverables.

This approach also ensured alignment between the strategic goals and the operational details identified throughout the planning process. The finalized charter consolidates the refined understanding of stakeholders, constraints and success criteria, effectively bridging theoretical planning tools with the practical needs of project execution.

The complete project charter can be found in the attachments [1].

2 SCOPE DEFINITION AND WBSS

The scope of the project covers the complete lifecycle of an industrial system, from initial process engineering through procurement, construction, and testing of the final assembly. The final objective is the end-to-end delivery of a reverse osmosis desalination skid for offshore use, designed to provide 20 m^3/day of potable water for 90 personnel, in compliance with WHO and IECEx standards.

The scope includes engineering, procurement, assembly, FAT with third-party certification, and full documentation delivery. Out of scope are post-deployment activities, such as on-site integration, operational training, and long-term maintenance, which are assumed to be managed in a separate phase by the client.

The scope was defined through a detailed decomposition using three alternative Work Breakdown Structures:

- **WBS1: Phase-Oriented** Organizes activities sequentially by project phases: Engineering, Procurement, Construction, and Testing.
- **WBS2: System-Oriented** Structures the work according to functional systems: Process, Piping, Structural, and Electrical and Control.
- **WBS3: Location-Oriented** Breaks down the project by physical modules: Skid Frame, Piping Module, Process Equipment Zone, and Control and Instrumentation Panel.

Although WBS2 [2] was regarded as more professional, WBS1 was selected to enable a simpler and more linear execution of the project, taking into account the team's relatively limited experience in this area. Also the third WBS [3] was not selected as deemed more appropriate for a project mostly based on construction.

The project includes approximately 70 interconnected activities, each linked by defined precedencies. Each Work Package (WP) includes:

- **Estimated duration and required resources** Each work package specifies the expected time frame for completion and details the human, material, and financial resources necessary for execution.

- **Logical dependencies enabling scheduling and critical path identification** Predecessor and successor relationships are defined for each work package, supporting the development of the project schedule and identification of the critical path.

3 ORGANIZATIONAL BREAKDOWN STRUCTURE (OBS)

The Organizational Breakdown Structure (OBS) [4] was developed to define the distribution of responsibilities and to ensure accountability throughout all the phases of the project. It complements the Work Breakdown Structure by mapping each work package or group of activities to the organizational units responsible for their execution.

Out of the project stakeholders we identified in the project charter, the following were left out of the OBS:

- Sponsor: while finances the project, is not involved in its development.

- Customer Representative: communicates with the project manager but doesn't have a formal hierarchical position.

- Certifying Body: contributes to the project but is not part of the organization.

Each WBS element was cross-referenced with the OBS to clarify ownership and facilitate delegation of responsibilities [5]. This linkage supports not only planning but also later phases of project control, risk management, and change handling.

By aligning the WBS with the OBS, we ensured that all deliverables have a designated owner and that no scope elements are left unassigned, an essential condition for effective execution in a complex multidisciplinary project environment.

4 WORK PACKAGE DESCRIPTION

Each work package (WP) in the project represents a self-contained unit of work with clearly defined deliverables, responsible parties, resource allocations, and dependencies. The WP structure was derived from the WBS and refined to ensure completeness and traceability in both scheduling and cost estimation.

The purpose of this section is to present a standardized overview of selected work packages that cover the major functional and temporal segments of the project. This degree of detail ensures clarity in execution, aids progress tracking, and allows efficient allocation of both human and material resources.

PFD - Heat and Mass Balance

Description: Defines process flow and thermodynamic balances of the system.
Estimated Duration: 13 working days
Resources Involved:

- External Engineering: €2,500.00 for engineering services

Dependencies: No Predecessor
Responsible Unit (OBS): Technical Manager
Risks / Notes: As the initial Work Package, any delay at this stage will have a cascading impact on all downstream engineering and procurement activities.

3D Model

Description: Full 3D representation of skid layout and components.
Estimated Duration: 20 working days
Resources Involved:

- External Engineering: €6,000.00 for engineering services

Dependencies: P&ID
Responsible Unit (OBS): Technical Manager
Risks / Notes: This WP enables the issuance of key construction documents. It relies on accurate input from equipment engineering and procurement, particularly regarding dimensions, weights, and service access requirements. Supplier delays may compromise the model's accuracy and disrupt project flow.

Pump Procurement

Description: Purchasing of pump equipment.
Estimated Duration: 150 working days
Resources Involved:

- Supplier €7,000.00

Dependencies: Filter Data Sheet
Responsible Unit (OBS): Package Manager
Risks / Notes: Delays in receiving the final Filter Data Sheet may postpone pump selection and ordering. Inaccurate or incomplete specifications can lead to mismatched selections and require costly rework. The long supplier lead time (150 working days) makes schedule adherence critical. Early engagement with the vendor is essential to manage documentation, certifications, and delivery logistics. Coordination with the 3D design team is required to ensure spatial compatibility with the skid layout and utilities.

Structures Prefabrication

Description: Assembly of structural steel components.
Estimated Duration: 5 working days
Resources Involved:

- Internal Manpower : 4 people at €50 per hour (for this project)

Dependencies: Structures DWG; Steelworks & support Material Procurement
Responsible Unit (OBS): WorkShop Manager
Risks / Notes: This Work Package initiates the construction phase and may serve as a milestone for the second client invoicing. Timely availability of drawings and steel materials is critical to avoid disruption of workshop activities.

Final Tests

Description: Full system validation and compliance tests.
Estimated Duration: 1 working day
Resources Involved:

- Internal Manpower : 4 people at 50€/hr (for this project)
- Third Party : €3,000 for Certifying Services

Dependencies: Automation Tests; Assembled Skid FAT
Responsible Unit (OBS): QC Manager
Risks / Notes: This Work Package closes the project and includes the opportunity for formal delivery. The successful execution of tests and handover of the Documentation Pack may trigger the final invoicing to the client.

The short description for each WP can be found in the CBS-WBS cross-reference table in the attachments [6].

5 COST ESTIMATION

The project's cost estimation was conducted by aggregating resource-based costs at the work package level, using data defined in the Work Breakdown Structure and refined through the Cost Breakdown Structure (CBS). Each task was associated with one or more resource categories, including:

- Materials
- External Engineering
- Supplier-provided
- Internal Manpower
- Internal Engineering

These were estimated either as lump-sum values (e.g., for procurement items and subcontracted services) or time-phased allocations (e.g., for internal labor and engineering hours).

The overall cost structure divided in main categories is presented in Figure 3.

The total projected cost of the project amounts to approximately €299,577.00s, broken down into:

- **Total Cost:** €299,577.00
- **External Costs:** €264,097.00 (approximately 89%), covering materials, external engineering, and supplier-provided items.
- **Internal Costs:** €35,480.00 (approximately 11%), covering internal manpower and internal engineering.

This distribution reflects the industrial nature of the project, where most of the value is embedded in externally sourced equipment and services.

The CBS helped validate consistency between WBS items and cost drivers, enabling cross-checks between time scheduling, deliverables, and financial expectations. Costs were also used as inputs for resource profiling, cash flow planning, and the S-curve analysis to ensure alignment across planning layers.

For the detailed cost breakdown refer to the excel file attached [6].

6 RESOURCE, SCHEDULING AND TIME MANAGEMENT

6.1 Resource definition

Resource management in this project was structured around the identification, allocation, and time-distributed usage of five main resource categories: Materials, External Engineering, Supplier, Internal Manpower, and Internal Engineering. Each activity in the work plan was linked to one or more of these resources, with corresponding cost and workload estimates derived from realistic industrial assumptions. All resources were evaluated in terms of monetary cost.

The allocation strategy distinguishes between:

- **Internal resources:** e.g., internal engineering effort, which is allocated and consumed steadily over the duration of a task, typically measured
- **External resources:** e.g., supplier costs, which are incurred at specific points in time, such as the start or end of the procurement phase.

6.2 Scheduling definition

Using the defined network of dependencies, a full forward and backward pass was executed to determine the early start (ES), early finish (EF), late start (LS), and late finish (LF) for each activity, thereby identifying the critical path and available float.

Refer to the attachments for the complete network diagram [7].

6.3 Analysis and Possible optimizations

Two scheduling strategies were compared:

- **Early Start Plan:** This plan focuses on starting tasks as early as possible, thereby minimizing the overall project duration.
- **Late Start Plan:** This plan allows tasks to start later, potentially reducing early resource and financial exposure.

Accordingly, two different GANTT charts were developed and compared in terms of time management effectiveness and financial exposure issues.

The early start approach [8] revealed a high financial and resource exposure during the initial and middle stages of the project. However, it also highlighted significant free float in non-critical activities, offering flexibility to optimize the allocation of resources and delay certain purchases or efforts without impacting the final delivery date.

On the other hand, the late start approach [9] reveals the availability of enough free float to significantly impact the financial exposure, by shifting it towards the end of the project.

In a real-case scenario, effective optimization of task scheduling would be essential. The delay of specific tasks, particularly internal ones, would likely reduce early financial exposure.

We can also observe how the two approaches impact the resource profile and S-curve of the project, as shown in Figures 4, 5, 6, and 7. Also available in the attachments [10, 11, 12, 13].

7 CASH FLOW AND PROJECT BALANCE

As previously stated, internal costs are allocated continuosly in time while external resource are paid in lump sums, more specifically:

- If the cost is lower then €7,500.00 , the cost is allocated at the delivery.
- if the cost is higher then €7,500.00 , 50% of the sum is paid upfront and 50% at delivery.

To mitigate financial strain, the modification of the supplier payment structure from the 50%-50% split (upfront and at delivery) to a more back-loaded scheme (e.g., 30% upfront, 70% at delivery) can be considered. This adjustment could significantly reduce early cash outflows while maintaining supplier commitment.

A detailed cash flow analysis was carried out to assess the financial feasibility and sustainability of the project across its duration. The following payment scheme for the project's delivery is assumed:

- 20% at the beginning of the project.
- 40% at the midterm, most likely following a review of the progress with the client.
- 40% at the end of the project.

The resulting cashflow is hereby represented in Figures 8 and 9 for the early start and late start scenarios, respectively. Also available in the attachments [14, 15].

The analysis of the cashflow showed that the project would benefit from a more regular payment structure. Therefore, a set of potential milestones was identified to support a more consistent payment schedule:

- Production of 3D model and drawing, that could be shown to the client for approval before components' ordering.
- Logic map definition and feedback from the client, before committing to the control system and ordering the flow computer.
- Structure assembly completion (to ensure adequacy of the skid with the client), before painting and instrumentation installation.

8 RISK MANAGEMENT

The risk management for the project was conducted using a structured, quantitative approach. The core of the method relied on the calculation of a Project Classification Index (IC), which integrates three key impact areas: Economic (IE), Strategic (IS), and Risk (IR). Each of these dimensions was assessed in terms of impact, with the final index computed as: $IC = (IE \cdot PIE) + (IS \cdot PIS) + (IR \cdot PIR)$.

The risk identification and evaluation phases produced a categorization into four main areas:

- **TR - Technical risks:** errors in engineering deliverables, design rework.
- **PR - Procurement risks:** supplier delays, component unavailability.
- **CR - Construction risks:** site conditions, labor productivity issues.
- **MR - Managerial risks:** coordination failures, scope creep.

Each identified risk was evaluated based on its probability of occurrence and potential impact, along with the possibile mitigation strategies and their respective cost. The complete risk register is available in the attached file [16].

This comprehensive analysis allowed for a precise and informed mitigation plan organization and contingency management. The elected action for each risk item is either:

- Accept: accept the risk and its consequences.
- Transfer: shift the negative impact to a third party. Usually involves the payment of a risk premium.
- Mitigate: reduce the probability of the adverse event. Usually has a cost.

Contingency amounts, distributed across the relevant Work Breakdown Elements (WBEs), were determined under the assumption that any risk item with a probability of occurrence greater than 70% would require full impact allocation as contingency.

Risk monitoring would be conducted periodically throughout execution, with the possibility of introducing corrective actions or updated contingency plans when necessary. This ensures that risk management remains a continuous and adaptive process.

9 PROGRESS EVALUATION

Progress evaluation has been designed to monitor the development of the project and detect deviations in a timely manner so that corrective actions can be adopted. One of the chosen methods for progress evaluation is the Earned Value Analysis (EVA) method, which is used to assess the performance of the project in terms of cost and schedule. To achieve this, the progress of each Work Package (WP) must be tracked and compared with the planned progress. Different methods can be used for different types of WP:

WP Area	**Tracking Method**	**Reason**
Engineering	50/50	Progress is assessed at midterm reviews (50% completion) and at the end of the WP (100% completion). This approach can be used for engineering tasks where the original plan (and therefore cost and time) might change once the team starts working on the WP due to unforeseen complications.
Procurement	Milestone-based	Progress is assessed at key milestones: placing order, payment, order arrival.
Construction	Level of effort	Progress is assessed based on the amount of work completed relative to the total effort. Useful in construction where unexpected issues can impact time and costs.
Testing	0/100	Progress is assessed as either 0% or 100% based on the completion of tests.

Comparing the Planned vs. Actual Timeline using Gantt chart overlays was deemed insufficient for the DESAL-90P project since it does not provide a clear understanding of the project's performance in terms of cost and schedule. It has been observed that the finances of the project would actually benefit from delayed starts of some tasks. Solely basing the evaluation on timing would incorrectly push the project towards greater financial exposure.

Earned Value Analysis (EVA) Application

Earned Value Analysis (EVA) has been deemed the most suitable method. Below is an example of how it could be applied to the DESAL-90P project.

Assume the project is at Day 100, and the following hypothetical data has been collected:

Metric	**Value**
Planned Value (PV)	€120 000
Earned Value (EV)	€100 000
Actual Cost (AC)	€110 000
Budget at Completion (BAC)	€299 577

From these values, the EVA indicators have been calculated as follows:

We can observe that the SPI is below 1, indicating that the project is behind schedule, while the CPI is also below 1, suggesting that the project is over budget. The negative CV and SV confirm these findings.

Indicator	Calculation
SPI	$\frac{100000}{120000} = 0.83$
CPI	$\frac{100000}{110000} = 0.91$
CV	$100000 - 110000 = -10000$
SV	$100000 - 120000 = -20000$
EAC	$\frac{299577}{0.91} \sim 329215$
ETC	$329215 - 110000 = 219215$
TCPI	$\frac{299577-100000}{299577-110000} \sim 1.05$

Table 1: EVA indicators at Day 100

10 CLOSE-OUT

The project close-out phase is structured to ensure a controlled and verifiable conclusion of all planned activities. It includes both technical and administrative procedures required to formally complete the project, deliver final outputs, and transfer responsibility to the client or end-user.

Close-out begins with a comprehensive review of completed deliverables against the original scope, using predefined acceptance criteria. This ensures that all outputs conform to expected quality levels and contractual obligations. Special attention is given to testing-related activities such as Factory Acceptance Tests (FATs), dimensional checks, and non-destructive testing (NDT), which serve as key verification milestones for both structural and process components.

Documentation is a critical part of the close-out phase. A complete Documentation Pack is prepared, including design files, test reports, certificates, and any as-built documentation. This package supports future maintenance, regulatory compliance, and operational readiness.

From a managerial perspective, the close-out process includes:

- Final resource and cost alignment.
- Compilation and archiving of lessons learned documentation, including questionnaires, etc.
- Formal closure of procurement contracts and outstanding obligations.
- Internal reviews with all functional units to capture feedback and improvement opportunities.
- Preparation and handover of the complete project documentation pack to the client.
- Administrative closure and release of project resources.

Only after formal acceptance and administrative closure will the project be considered fully concluded. This approach ensures transparency, traceability, and organizational learning for future projects.

11 CONCLUSIONS

The project underscored the value of traditional project management methods, particularly the importance of a well-defined Work Breakdown Structure (WBS) before scheduling and cost estimation. Different WBS perspectives enhanced clarity and revealed errors, while accurate assumptions were vital for effective planning. The project demonstrated the application of traditional techniques in a semi-real industrial scenario, resulting in a coherent and executable plan. Using multiple WBS structures and detailed breakdowns provided a comprehensive project view, improving control and traceability.

11.1 Agile methodology in PW development

Although the overall organization of the project itself followed a traditional Waterfall approach, appropriate for representing the complete lifecycle of an industrial system, Agile working methods were adopted within the students' team during the development phase. With fixed delivery deadlines and clearly defined resources (e.g., our personal effort, availability and time), Agile principles were applied by adapting the scope and content of the deliverables to fit these constraints. Key Agile practices included frequent team meetings that served as iterative checkpoints, allowing to incrementally build the final report. At each stage, progress was reviewed, errors were identified and corrected, and the approach was adjusted accordingly. Moreover, a Kanban Board was used to identify, assign, plan and monitor the different tasks to complete. The software "YouTrack" served as support. This incremental and adaptive process enhanced both the quality of our deliverables and our ability to collaborate effectively under time constraints, closely mirroring the behavior of Agile frameworks.

REFERENCES

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[3] Group3, *Wbs alternative 2*, 02 - WBS$_{A}lternative_{2}.png$, 2025.
[4] Group3, *Obs*, 04a - OBS.png, 2025.
[5] Group3, *Obs cross wbs*, 04b - OBS cross WBS.xlsx, 2025.
[6] Group3, *Cost estimation*, 03a - Cost Estimation.xlsx, 2025.
[7] Group3, *Network diagram*, 05 - Network Diagram.png, 2025.
[8] Group3, *Gantt*, 05E - Gantt.png, 2025.
[9] Group3, *Gantt*, 05L - Gantt.png, 2025.
[10] Group3, *Resource profile*, 06E - Resource Profile.png, 2025.
[11] Group3, *Resource profile*, 06L - Resource Profile.png, 2025.
[12] Group3, *S-curve*, 08E - S-Curve.png, 2025.
[13] Group3, *S-curve*, 08L - S-Curve.png, 2025.
[14] Group3, *Cash flow*, 07E - Cash Flow.png, 2025.
[15] Group3, *Cash flow*, 07L - Cash Flow.png, 2025.
[16] Group3, *Risk register*, 09 - Risk Register.xlsx, 2025.

LIST OF FIGURES

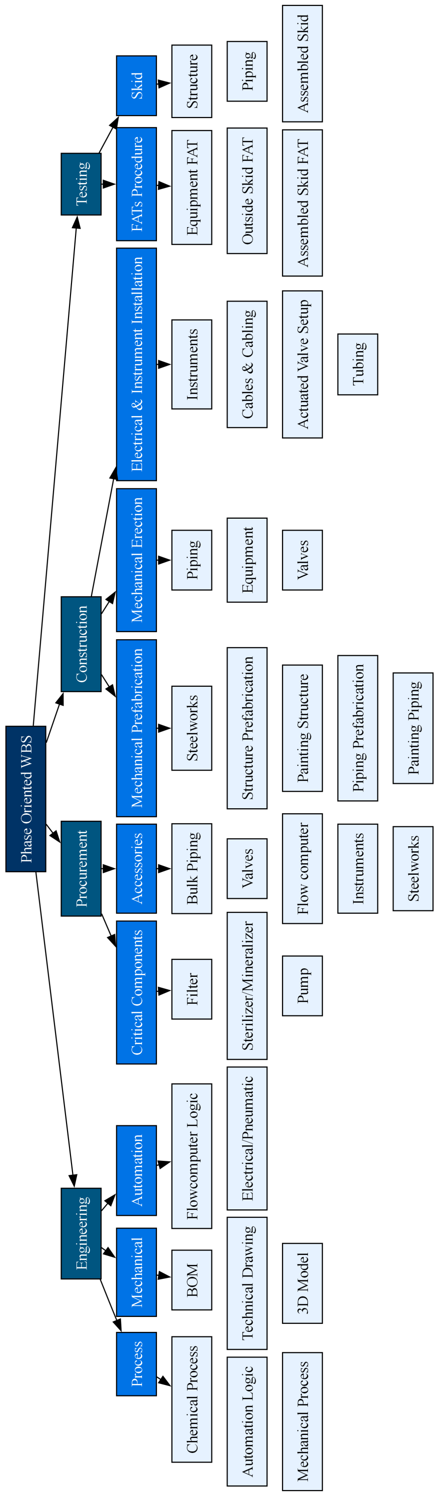

Figure 1: Phase-Oriented Work Breakdown Structure (WBS1) for the project.

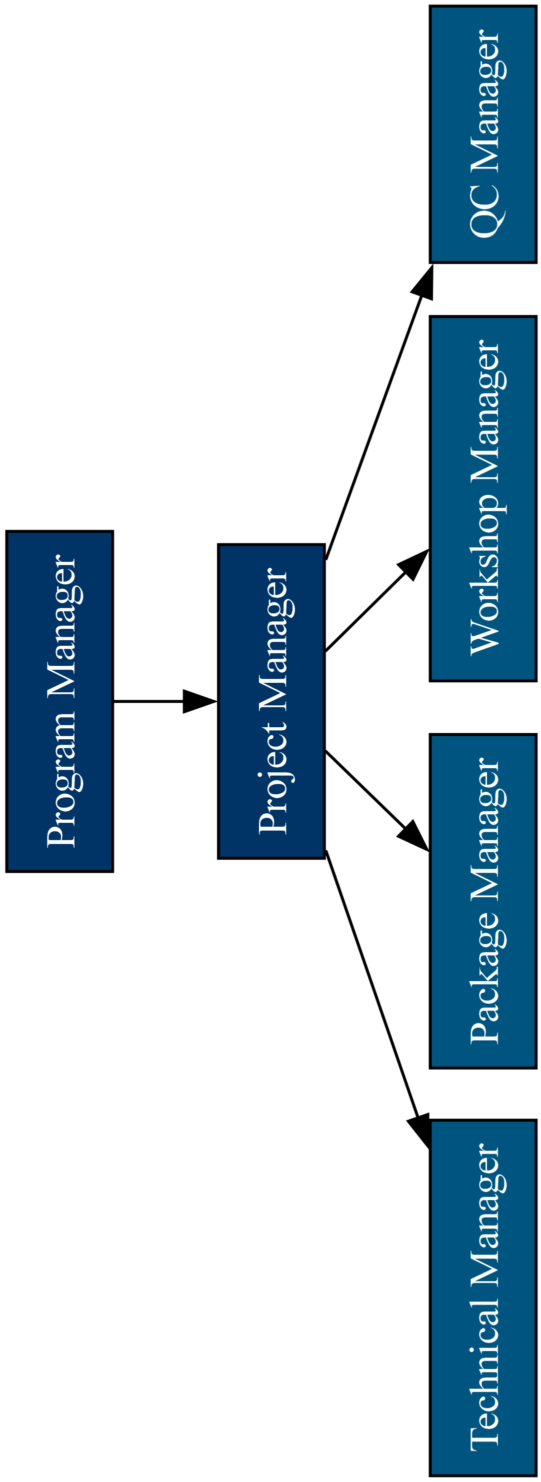

Figure 2: Organizational Breakdown Structure (OBS) for the project.

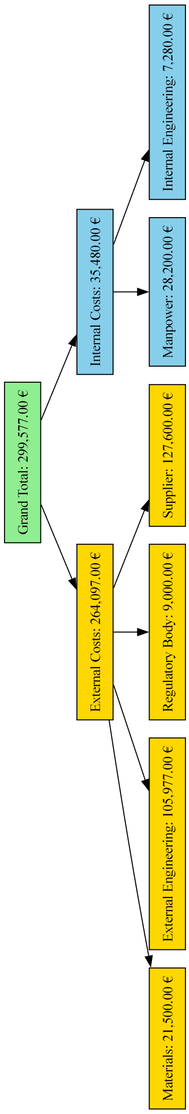

Figure 3: Cost Structure of the project.

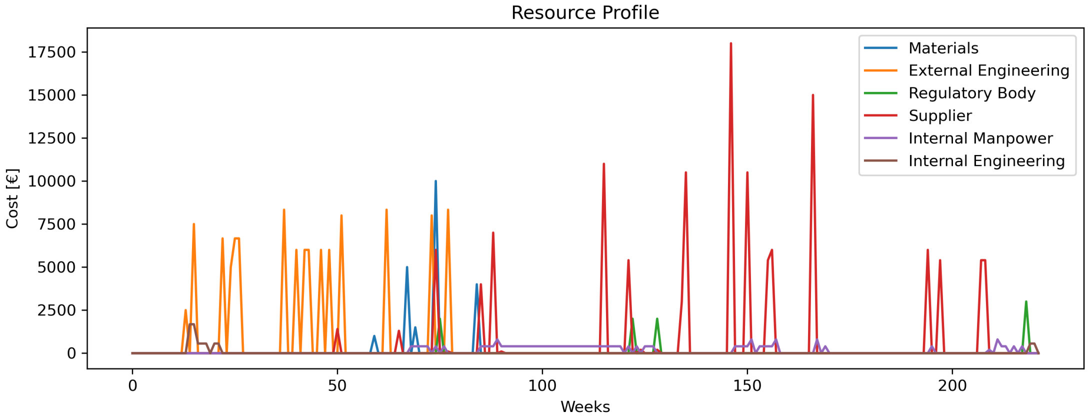

Figure 4: Resource Profile - Early Start Scenario

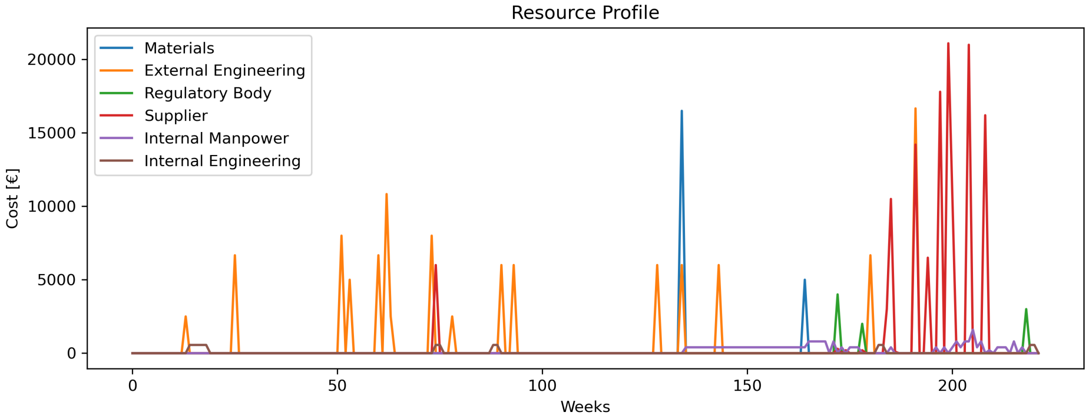

Figure 5: Resource Profile - Late Start Scenario

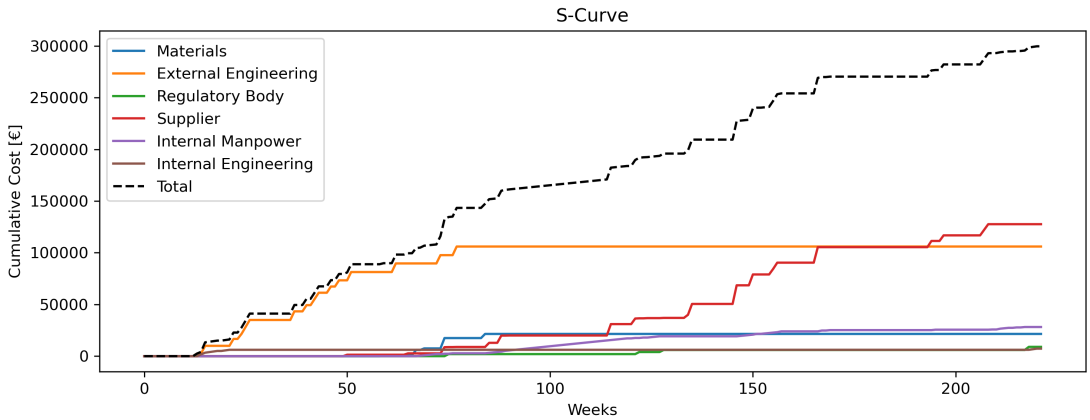

Figure 6: S-curve - Early Start Scenario

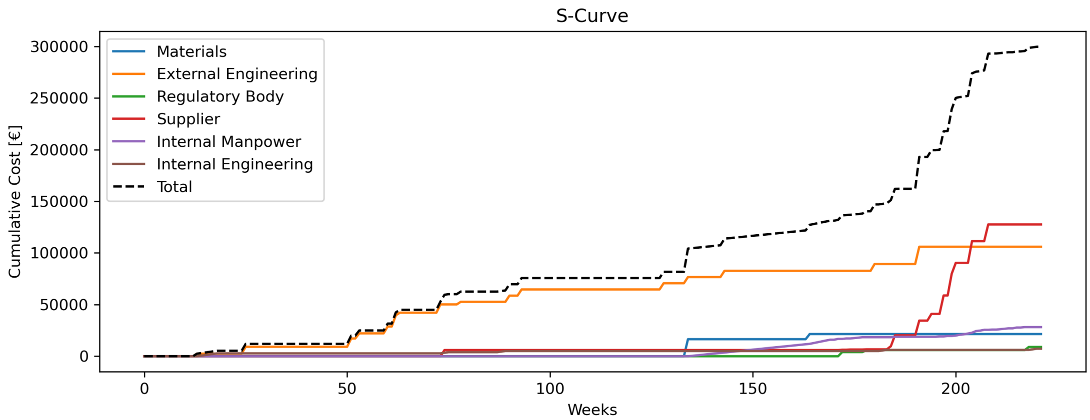

Figure 7: S-curve - Late Start Scenario

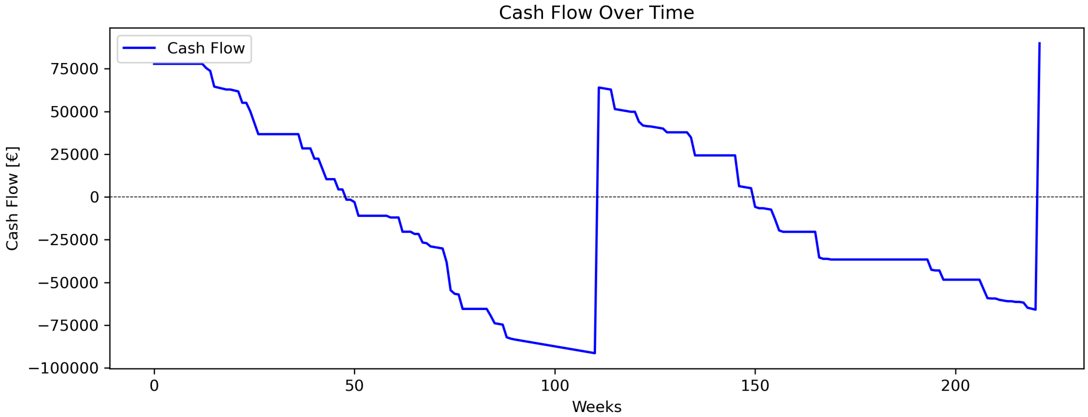

Figure 8: Cash Flow - Early Start Scenario

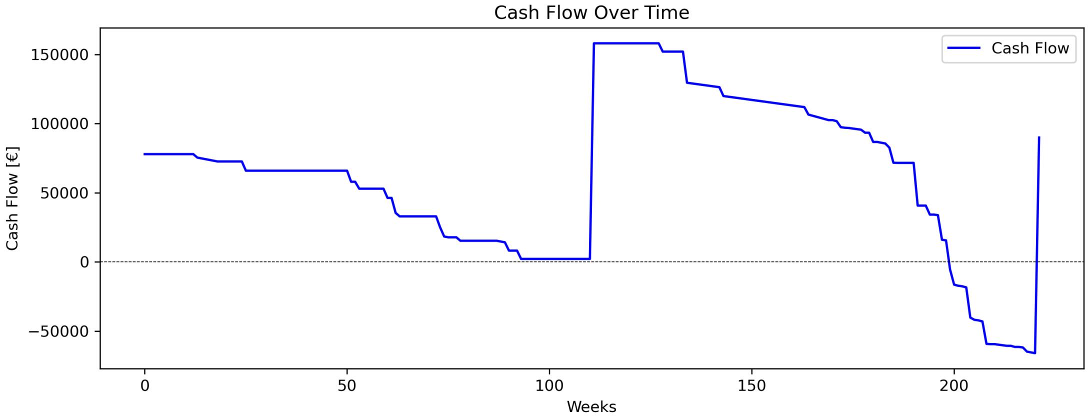

Figure 9: Cash Flow - Late Start Scenario