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Optimize replanning process to improve project planning quality

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Resumo

A Vestas, empresa líder global no setor de energia eólica, enfrenta desafios na gestão de projetos, particularmente na criação, priorização e replaneamento, que, geralmente, são processos complexos, de longa duração e suscetíveis a erros. Esta dissertação concentrou-se nestes desafios, procurando melhorar a sua eficiência e reduzir o desperdício de recursos nestas etapas críticas dos projetos na Vestas.

Estes desafios são importantes devido à grande escala das operações da Vestas. Por exemplo, a priorização ineficaz de um projeto e o replaneamento demorado podem resultar numa incorreta alocação de recursos e perdas significativas de produtividade. Quando analisadas de forma global, essas ineficiências podem ter implicações financeiras significativas. Da mesma forma, erros de previsão na fase inicial de planeamento de um projeto geralmente levam a replaneamentos e ajustes futuros, exigindo investimentos adicionais. Assim, melhorar estes processos garante a saúde financeira da empresa e garante a continuidade da sua liderança no mercado.

Este trabalho propõe e implementa três ferramentas inovadoras: a *Portfolio Prioritization Tool* (PPT), a *Replanning Tool*, e o *Work Package Catalog*. Cada ferramenta visa explicitamente um desafio no ciclo de vida dos projetos da Vestas. A primeira, PPT, utiliza um modelo de pontuação ponderada para priorizar projetos, garantindo a alocação estratégica de recursos. A ferramenta de replaneamento oferece uma *interface* amigável e integração com o *software* de gestão de projetos para um replaneamento eficiente. O *Work Package Catalog* dá uso aos dados históricos de projetos para um planeamento inicial mais preciso. Coletivamente, estas ferramentas aumentam a eficiência do processo, reduzem o tempo necessário para cada fase e diminuem significativamente o risco de erros.

O potencial impacto destas ferramentas é significativo para a Vestas. Elas prometem uma poupança considerável de tempo e reduzem o desperdício de recursos, permitindo assim que a empresa aloque recursos de forma mais estratégica. A PPT já foi aprovada pelo vice-presidente da área de planeamento estratégico da Vestas e as outras ferramentas mostraram resultados promissores nos testes realizados, indicando potencial para implementação em toda a empresa. No geral, os resultados indicam um futuro promissor para as ferramentas no aperfeiçoamento da gestão de projetos na Vestas, economizando tempo, reduzindo o desperdício de recursos e resultando em poupanças financeiras significativas.

Palavras-chave: gestão de portfólio de projetos, gestão de projecto, planeamento estratégico, processo de planeamento

Abstract

Vestas, a global leader in the wind energy industry, grapples with challenges in project management, particularly in project creation, prioritization, and replanning, which are often complex, time-consuming, and susceptible to errors. This dissertation focused on these challenges, seeking to introduce efficiencies and reduce resource wastage in these critical stages of project management at Vestas.

These issues are critical due to the sheer scale of operations at Vestas. For instance, ineffective project prioritization and time-consuming replanning can result in significant resource misallocation and productivity losses. When considered at the company-wide level, such inefficiencies could translate into substantial financial implications. Similarly, inaccuracies in the initial planning phase often lead to future replanning and adjustments, costing additional resources. Thus, enhancing these processes safeguards the company's financial health and ensures its continued market leadership.

This work proposes and implements three innovative tools: the Portfolio Prioritization Tool (PPT), the Replanning Tool, and the Work Package Catalog. Each tool explicitly targets a challenge in Vestas projects' life cycle. The PPT uses a weighted scoring model to prioritize projects, ensuring strategic resource allocation. The Replanning Tool offers a user-friendly interface and seamless integration with the project management software for efficient replanning. The Work Package Catalog leverages historical project data for more accurate initial planning. Collectively, these tools enhance process efficiency, reduce the time required for each phase, and significantly decrease the risk of errors.

The potential impact of these tools is significant for Vestas. They promise considerable time savings and reduce resource wastage, thus, enabling the company to allocate resources more strategically. The PPT has already gained approval from Vestas' vice president of strategic planning, and the other tools have shown promising results in testing, indicating potential for company-wide implementation. Overall, the results indicate a promising future for these tools in enhancing Vestas' project management, saving time, reducing resource wastage, and resulting in significant financial savings.

Keywords: project portfolio management, project management, strategic planning, planning process

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Pedro Seixas / PEFOX

*“Don’t stop when you’re tired.
Stop when you’re done.”*

David Goggins

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Symbols and Abbreviations

AHP	Analytical Hierarchy Process
ANP	Analytical Network Process
API	Application Programming Interface
CM	Contribution Margin
DSS	Decision Support System
GW	Gigawatt
HTTP	Hypertext Transfer Protocol
KPI	Key Performance Indicator
MW	Megawatt
PCR	Project Change Request
PM	Project Management
PMI	Project Management Institute
PPM	Project Portfolio Management
PPS	Project Portfolio Selection
PPT	Portfolio Prioritization Tool
P&L	Profit / Loss
R&D	Research & Development
SDK	Software Development Kit
UML	Unified Modeling Language
VTaC	Vestas Task Creator

Chapter 1

Introduction

This chapter aims to provide a comprehensive overview of the context (Section 1.1), motivation (Section 1.2), and objectives (Section 1.3) behind optimizing the planning process in Vestas, as well as give an outline of the dissertation structure (Section 1.4). The chapter focuses on the challenges companies face in managing projects and aligning their efforts with strategic goals. The need to evaluate and allocate resources in an uncertain environment makes portfolio and project management complex, often leading to delays, cost overruns, and misalignment with goals. This work addresses this issue by exploring how the planning process can be optimized to reduce the resources used in replanning activities. The chapter sets the stage for the research and provides a clear understanding of the importance of optimizing the planning process for the success of companies like Vestas.

1.1 Context

On a daily basis, companies face the task of carefully managing their efforts and resources to make the most out of the opportunities, ensure the projects are both profitable and delivered on time while also having the quality expected by the stakeholders, and keep their strategic goals aligned [58]. This process is often referred to as Portfolio Management, and it becomes a challenge for a portfolio manager to properly evaluate where to allocate the resources when there is so much uncertainty and variance in internal and external factors to the company [24].

The planning process involves multiple activities that go from setting goals and objectives for the company to identifying the resources needed to achieve them and creating a plan for allocating those resources. Due to the uncertainty of the environment surrounding a company or project, *e.g.* unexpected delays in tasks or unavailability of resources, the project portfolio is characterized by having a *"continuous life cycle"* that is *"ongoing and not necessarily sequential"* [24, p. 20]. This uncertainty leads to constantly re-evaluating the company's strategy to ensure a continuous realignment to the previously defined strategic goals.

This dissertation focuses on optimizing the replanning process in Vestas, the largest wind energy producer globally [53]. Vestas recognizes that the replanning procedures provoke significant

time and resource costs, primarily due to the reliance on human decision-making and acting. To address this challenge, the company aims to enhance the process and minimize unforeseen losses arising from such situations, improving the overall quality of project planning.

1.2 Motivation

Many efforts have been made in the past 40 years to optimize individual tasks and get the results that lead to the best possible scenarios, resulting in increasing portfolio management tools and methodologies to help in the process [23].

The current tools and literature on project planning primarily focus on optimizing project schedules. Less attention has been given to the overall quality and integration of the planning process [58]. As a result, many projects end up with delays, cost overruns, and misaligned with the goals and objectives due to the unpredictability of future events and the difficulty to replan. Besides those repercussions, poor planning can result in low project outcomes and stakeholder dissatisfaction. Therefore, it is essential to understand how to increase the quality of project planning and appropriately adapt the portfolio management tools output to the needs of the companies.

Still, there is little to no capability to handle the iterative trait of a project portfolio [58], which requires constant analysis and replanning. In Vestas, the replanning and rescheduling activities are done based on agreements that later on require extra manual effort to make decisions and changes visible in the internal project planning tool. From an operational perspective, this requires additional use of resources that can be avoided by automating these operational activities, allowing resource and time-saving and improving the replanning process.

1.3 Objectives

This research aims to fill the gap in the existing literature by studying how to optimize the planning process and project execution, helping Vestas to better manage its resources and get the most value out of them. Optimizing and emphasizing automation makes the planning process more efficient and streamlined, reducing inevitable errors when large tasks are done manually, thus leading to a higher-quality plan that brings a competitive advantage to the company. The main goal is to decrease resource usage in time and cost across three key activities:

Portfolio Prioritization Prioritizing the project portfolio and simulating different scenarios is a complex task that often requires a significant investment of time by Portfolio Managers. This dissertation will tackle this challenge by developing a dedicated tool to assist in portfolio prioritization, aiming to reduce the time and resources required for this task.

Replanning Process The replanning procedure can be both complex and time-consuming, especially when relying on the available tools or manual approaches. The first option involves

a steep learning curve, while the latter is prone to human errors. The objective of this research is to automate the replanning process using a simple and efficient method, which would increase team productivity and reduce errors during project updates.

Initial Project Plan Given Vestas' emphasis on modularity, many projects share similar structures. However, creating these structures from scratch can be unproductive. Thus, automating this process not only saves time but also allows for the leveraging of historical data to improve time estimations and overall project planning.

1.4 Document Structure

This dissertation presents a comprehensive analysis of the planning process and optimization techniques. The document is organized into eight chapters, each addressing a specific aspect of the topic.

Introduction (Chapter 1) Introduces the context for the topic of this dissertation, as well as its motivation and goals.

Background (Chapter 2) Provides an overview of the portfolio/project management process, the company (Vestas), and the tools used in this study.

State of The Art (Chapter 3) Presents a comprehensive review of the current state of knowledge in project planning and portfolio management.

Problem Statement (Chapter 4) Identifies the problem, and its impacts, being addressed in this study and describes the proposed solution used to solve that problem, which focuses on three main areas: portfolio prioritization, project replanning, and setting up the initial project plan.

Portfolio Prioritization Tool (Chapter 5) Presents the first out of three tools developed to address the problem, focused on optimizing the portfolio prioritization process.

Replanning Tool (Chapter 6) Presents the second tool, focused on optimizing the replanning procedures.

WorkPackage Catalog (Chapter 7) Presents the third and last tool, assisting in the creation of the initial project plan.

Conclusions and Future Work (Chapter 8) Summarizes the findings of the study, presents the impact on project planning and replanning in Vestas, and proposes topics for further improvements.

Chapter 2

Background

This chapter introduces the most important concepts and contextualizes this dissertation. The different topics are defined, and the relations among themselves are described to better understand the subject.

2.1 Vestas

Vestas is a Danish company founded in 1945 that specializes in manufacturing, selling, and maintaining wind turbines. It is currently the world leader in sustainable energy, operating in 88 countries [53]. The company focuses on developing and implementing wind energy solutions that help reduce carbon emissions and promote sustainable energy use.

Over the years, Vestas has constantly been innovating and improving its products, allowing it to be the first wind turbine manufacturer to exceed 100 GW of installed capacity and supply turbines for some of the world's largest wind farms. In addition to its wind turbine products, Vestas also offers a wide range of services and solutions, including project development, financing, construction, and maintenance, to ensure that its customers receive the full benefits of wind energy. Vestas products have already prevented 1.5 billion tonnes of CO₂ from being emitted to the atmosphere, and the company plans to continue to do so [53].

Project Structure

Vestas comprises several initiatives, which are the building blocks of its overall strategy and operations. Each initiative is designed to achieve specific goals and objectives and comprises several elements that work together to support its success.

The bottom layer of an initiative is the task, the most basic unit of work. Tasks represent work that needs to be done with a short and simplified description. An Epic is a group of tasks that brings value to the business, including changes or additions to existing functionality. There are multiple aggregation levels, and each has its role in the initiative. On the top level are the milestones, representing significant stages in the project development. They help to ensure that all the necessary steps are taken and that the initiative is on track with its objectives. A work package

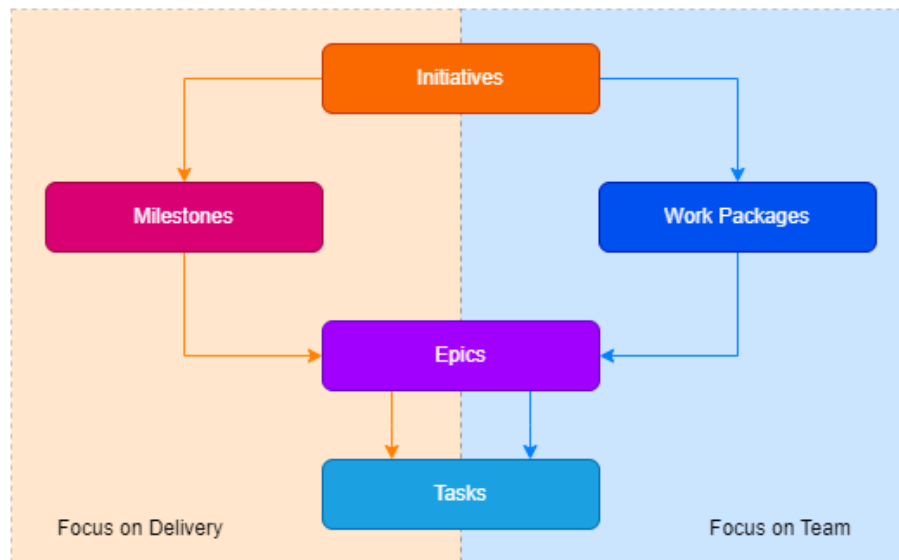


Figure 2.1: Vestas' Project Structure.

is another essential building block of initiatives. It is usually seen from another perspective, as it couples tasks together in a defined delivery, with budget and resources allocated.

While milestones focus more on simple steps that the team must do to work together with other teams with the final goal in mind, the definition of work packages gives each team a more detailed view of what needs to be done as a whole. The first perspective focuses on the final product, while this second focus on the work that has to be done by each individual.

The company's initiative structure can be seen in Figure 2.1. This structure is integral to Vestas' overall strategy and operations, where each element works together to support the initiative's success, thus leading to the company's success.

2.2 Project Portfolio Management

Project Portfolio Management (PPM) involves overseeing one or more projects to attain specific goals. It employs portfolio management techniques to reconcile the portfolio and its components with the organization's plan. Additionally, it can also be seen as a constantly evolving process where an organization allocates its resources to accomplish its strategic objectives by "*identifying, categorizing, monitoring, evaluating, integrating, selecting, prioritizing, optimizing, balancing, authorizing, transitioning, controlling, and terminating portfolio components*" [24, p. 5].

El Hannach *et al.* [13] mentions some challenges that arise when trying to manage the portfolio in a company:

Uncertainty It is complicated for managers to accurately predict future market trends and make informed decisions about allocating resources.

Changing Environment The company's strategy must be flexible and responsive to environmental changes to maintain competitiveness.

Portfolio Heterogeneity Different projects with different types of information available, either in quality or quantity, make it hard to assess the risk and returns of each project, directly affecting the quality of the strategy.

Resource Availability Resources are limited and scarce, so it becomes very difficult to balance the efforts made to maintain stability and growth properly and, at the same time, make strategic investments thinking about the company's future.

Balance Maintaining the portfolio aligned with the company's strategic goals can be challenging due to the risky nature of some projects that may disconnect from the company's tolerance to risk.

2.3 Project Management

Following the definition given by the Project Management Institute (PMI), a project is:

"A temporary endeavor undertaken to create a unique product, service, or result. The temporary nature of projects indicates a beginning and an end to the project work or a phase of the project work." [25, p. STD4]

Project Management (PM) is about guiding the different components of a project to meet the requirements and achieve its goals. It involves planning, managing, and monitoring different aspects of the project in order to reduce risks. Although unexpected events are inevitable, good project management techniques allow for better handling of those events, reducing the adverse outcomes resulting from them [54]. The six main aspects mentioned by Watt [54] that need to be taken into account are:

Time Deliverables and the time needed for them should be correctly estimated and planned.

Cost A good balance between what can and needs to be spent on the project should be achieved.

Scope The goals and objectives of the project should be ruled out.

Quality The performance should be constantly analyzed to ensure the project meets the desired quality requirements.

Risk Risks should be assessed as soon as possible to reduce their impact on the project.

Resources The employees, working space, and equipment needed for the project completion should be determined.

Project management is a critical function in a company that helps it to achieve its goals. With an exemplary implementation of project management techniques, organizations can increase the likelihood of project success and ensure that projects are delivered on time, within budget, and to the required quality standards.

2.4 Planning Process

The planning process is a crucial step in portfolio management whose purpose is to optimize the benefits, taking into account the risks and the available resources. As the company has multiple projects either running or being prepared to run, there is a need to properly plan the allocation of resources to save time and money [24]. The resource allocation plan is achieved with a meticulous analysis that consists of three activities: *Portfolio Prioritization*, *Project Selection*, and *Resource Allocation*.

2.4.1 Portfolio Prioritization

In an ever-changing environment, the projects must generate financial value for the company and provide a strategic advantage. Since the resources are limited, some projects must be sidelined to give others more attention, as the latter brings more value to the company. It becomes imperative to establish a prioritization system to identify which projects align with the company's plan and is worth allocating resources to maximize revenue while reducing risks arising from environmental instability. Additionally, the prioritization process needs to balance the demands of the organization's short-term and long-term goals and ensure that efforts are directed towards projects that align with its objectives [13, 24].

Project prioritization is a complex decision problem characterized by "*multiple goals which are conflicting and difficult to measure*" [12, p. 1042]. The complexity also arises due to the process's natural uncertainty, generated from either incomplete information or the inaccuracy of the data used [12, 13].

Different criteria are used when evaluating the portfolio that goes from financial, technical, or related to the risks, the resources, or the contractual conditions. After establishing the criteria, a score is calculated for each project. This score allows the projects to be ranked by their priority, giving the portfolio manager a good overview of the most promising ones [44].

2.4.2 Project Selection

Project Selection is the most important step in Portfolio Management [27, 17] because it analyses the portfolio and selects the projects that enable the company to grow, be profitable, and achieve its strategic goals [21, 1, 28]. As stated by Abbassi *et al.* [1], Project Selection is not about executing the project correctly but instead executing the correct projects. It immediately follows the prioritization step, but it considers multiple factors that go from the ranking assigned in the prioritization and the individual characteristics of each project to the relations that exist between them [1, 17].

2.4.3 Resource Allocation

Resource Allocation is a difficult task that occurs as the last step of the Planning Process. Its difficulty comes from sharing resources between the different projects, which makes them have

dependencies that would not exist otherwise [43].

When allocating resources, it is significant to consider the expected value and strategic importance of the portfolio components being funded. Those with higher expected benefits and stronger strategic alignment should be prioritized and assigned resources accordingly. It is also important to consider the organization's risk tolerance to balance opportunities and threats [24].

The resources allocated to the portfolio should be evaluated continuously during the portfolio execution. This way, it is possible to balance supply and demand and align with the company's strategy, which maximizes the portfolio's value [24].

2.5 Existing Tools and Technologies

This section introduces the tools and technologies essential to this dissertation's scope. Vestas employs a variety of tools in its day-to-day operations, among which Microsoft's suite of applications, like PowerBI and PowerApps, play a central role. Another fundamental part of Vestas' technological toolkit is Jira, responsible for Vestas' project management processes, and the Vestas Task Creator (VTaC), an internally developed tool designed to optimize the task creation process within Jira. These tools are highlighted due to their relevancy to the objectives of this thesis. Furthermore, the Portfolio Prioritization Tool (PPT) is also introduced, a tool initially developed as part of a previous project that will serve as the foundation for the solution proposed in this dissertation. The upcoming subsections will provide a deeper understanding of these tools and their significance within the context of our study.

PowerBI

Microsoft PowerBI¹ is a powerful business analytics tool that offers interactive visualizations and business intelligence capabilities, where users can transform raw data into meaningful information using user-friendly dashboards, interactive reports, and clear visualizations. PowerBI offers the following components, among others, that will be mentioned throughout this document:

PowerBI Report This is a multi-perspective dataset view, with visuals representing different findings and insights. These highly interactive and configurable reports enable users to extract specific insights pertinent to their analysis.

PowerBI Tile A tile is a single visualization in a report or on a dashboard that can be materialized into a table, a chart, a key performance indicator (KPI), or any other form of data representation available in the tool. Tiles offer an interactive data snapshot, leading to more detailed reports or insights when clicked.

PowerBI Dataset A dataset in PowerBI is a collection of data that PowerBI uses to create its visuals. A dataset could be a simple collection of data from a single source or a more

¹<https://powerbi.microsoft.com/>

complex data model imported from multiple sources, shaped and transformed to support more sophisticated reporting.

PowerApps

PowerApps², also a Microsoft product, is a suite designed to create custom business applications with access to data stored in the underlying data platform, Microsoft Dataverse, or in various online and on-premises data sources such as SharePoint, Excel, PowerBI, and others. PowerApps can help streamline business operations by creating custom applications without needing extensive coding knowledge allowing users from various roles to create or customize applications according to their needs.

One of PowerApps' strengths explored in this dissertation is its ability to connect to other Microsoft apps, including PowerBI. Through PowerBI integration, PowerApps can access PowerBI Datasets and utilize the data to build applications, as well as embed PowerBI Tiles within PowerApps to introduce visualization charts, thereby enriching the functionality and user experience of the applications.

Jira

Jira is a project management tool developed by Atlassian that is "used by teams to plan, track, release, and support world-class software." [4]. Its core functionalities evolve around issues, the building blocks of every project, that are of a wide range of types, including tasks, sub-tasks, epics, bugs, or milestones.

The software provides teams with an updated overview of their work and the consequent project's progress and provides a user-friendly and all-in-one platform to plan sprints and manage backlogs and tasks. Other software tools and plugins can also be developed and integrated into Jira Software, allowing for the extension of its functionality and making it compatible with almost any type of project. This ability is one of the main reasons for making it Vestas' primary project management tool.

Vestas Task Creator

Vestas Task Creator (VTaC) is an internal tool developed by Vestas, designed to streamline the process of cloning task structures within Atlassian Jira. With its frontend developed using Angular³ and the backend managed using C#⁴, VTaC exhibits a robust and efficient architecture. The tool connects to Jira through the Atlassian .NET SDK⁵, providing a seamless bridge between the two systems.

The functionality of VTaC allows users to select a specific Jira issue, choose the child issues they intend to clone within its structure and determine a destination issue for the cloned structure.

²<https://powerapps.microsoft.com/>

³<https://angular.io/>

⁴<https://learn.microsoft.com/en-us/dotnet/csharp/>

⁵<https://bitbucket.org/farmas/atlassian.net-sdk/src/master/>

This cloning process significantly enhances project management efficiency by facilitating the rapid replication of task structures across different issues.

Within the context of this work, VTaC served as a foundational tool for the developed solution, as the solution leveraged the already established connection with Jira and the familiar user interface to significantly reduce the learning curve and streamline the workflow for users.

Portfolio Prioritization Tool

The Portfolio Prioritization Tool (PPT) was developed as a project in the first year of the Master's Degree in Informatics and Computing Engineering in the "Project Management Laboratory" course. The team worked collaboratively on creating PPT to aid in project prioritization within Vestas. PPT aimed to offer insightful information about the project portfolio, thus facilitating more informed and effective decision-making regarding its prioritization.

The PPT operates on a scoring model provided by the stakeholders at Vestas. This model ranks projects based on their value by considering key project characteristics, such as *Effort*, *Value*, *Gate*, *P&L Period*, and *Strategic Relevance*. These characteristics are integrated into the following score function that determines each project's ranking, enabling an objective, quantitative evaluation of the projects:

$$score = x * \left(\frac{Value}{Effort} \right) + y * Gate + z * Period$$

where x , y , and z are the weights of the value effort ratio, the gate rating, and the P&L period rating. These weights are adjustable so that the portfolio manager can fine-tune the importance given to each aspect of the project. The following sections describe how each one of these factors is calculated to rank the projects. All tables and formulas have been agreed upon and handed out by the stakeholders at Vestas.

Another important aspect when ranking the projects is the ability to know whether each project has *Strategic Relevance*.

Strategic Relevance A project that is essential from a strategic rather than a value standpoint. It indicates that even if the project has a low score, it shouldn't be overlooked to strengthen the company and give it a competitive advantage.

This tool incorporates multiple functionalities allowing better visualization of the portfolio and its metrics. Its structure is divided into six different tabs, and they can be seen in Appendix A:

1. **Home** — *Figure A.1*

Application landing tab.

2. **Input** — *Figures A.2 and A.3*

This tab is responsible for the input and handling of data. The user can upload data files, manually edit or restore to the defaults of each data row, and delete individual entries.

Table 2.1: Effort Mapping

Rating	Hours (k)	Cost (mEUR)
1	0-50	0-5
2	50-100	5-10
3	100-250	10-25
4	250-500	25-50
5	500-1000	50-100
6	1000-2000	100-200
7	> 2000	> 200

3. Program Ranking — *Figure A.4*

The primary tab of the application, where the user can see the program ranking by their scores and some analytics.

4. Program Matrix — *Figure A.5*

In this tab, there is an Effort / Value matrix, where the user can visually see the positioning of each program.

5. Program Status — *Figures A.6 and A.7*

This tab's purpose is to show some in-depth information about each program. The user can see the cost and capacity breakdowns, as well as a timeline, with the possibility to select multiple programs for comparison purposes.

6. Settings — *Figure A.8*

The application variables can be managed and adjusted to the user's preferences in this tab.

The development of the PPT was a successful project, with the tool achieving the expected functionality. However, despite the functionality and potential of the tool, it could not be integrated into Vestas' systems during its initial development phase. This limitation posed a challenge and an area of focus for this thesis.

In the context of this research, the PPT was rebuilt using alternative technologies, and the newly developed version of PPT not only inherited the robust project prioritization capabilities of the original but also advanced them by ensuring its seamless integration within Vestas' workflow. This approach significantly enhanced the tool's utility, effectiveness, and contribution to efficient portfolio prioritization within Vestas.

Effort

The *Effort* is calculated based on the working hours spent on the project and the total R&D cost. These values are categorized following Table 2.1. It is the weighted average of the two mapped values, with the weights adjustable by the portfolio manager.

Table 2.2: Value Mapping

Rating	Yearly Volume (MW)	CM New (%)	CM Upside (%)
1	< 500	< 15	< 0.5
2	500-1000	15-18	0.5-1
3	1000-2000	18-20	1-2.5
4	2000-3500	20-22	2.5-5
5	> 3500	> 22	> 5

Value

The *Value* is calculated based on the yearly volume and the new and the upside contribution margin (existing volume). The three values are categorized following Table 2.2.

The *Value* is calculated through the following formula:

$$Value = volume * (x * (cmNew + cmUpside))$$

where x is the weight for the contribution margin and is adjustable by the portfolio manager.

Gate

The Gate is the representative value given to a project following a Phase-Gate Process. It represents the current decision point of the project and is a direct indicator of which phase of development the project is currently in. It is a categorized value that follows the mapping of Table 2.3

P&L Period

The P&L Period represents the years necessary for the project to become profitable. This value is categorized according to the mapping in Table 2.4.

Table 2.3: Gate Mapping

Rating	Gate
1	Appraisal
1.5	Mandate
2	G1
5	G2
6	G3
7	G4
10	>= G5

Table 2.4: P&L Period Mapping

Rating	P&L Period
10	N+1
8	N+2
6	N+3
4	N+4
2	N+5
1	N+6

Chapter 3

State of The Art

This chapter presents the current state of knowledge on the topics of this dissertation. The first section, Section 3.1, demonstrates the methodology used to perform the search. This section is followed by one section for each of the relevant topics in this dissertation: the different steps in the Planning Process and the current tools that exist to help in that process. For this purpose, Portfolio Prioritization and Project Selection are merged in Section 3.2 as they are directly related to each other, and they are usually studied as one big step. Then, Section 3.3 presents a summary of the existing tools and their capabilities.

3.1 Methodology

A systematic review of the current literature on planning/project optimization was performed to understand this topic's state of the art. This systematic approach was based on the guidelines proposed by Peterson *et al.* [41] and by Kitchenham [29].

The review was performed following six steps, each of which will be described in detail in its subsection:

1. Research Questions
2. Search
3. Study Selection and Quality Assessment
4. Data extraction
5. Analysis and Classification
6. Validity Evaluation

The first step is associated with *Planning the Review*, the following three steps are associated with the *Conducting the Review*, and the last two with the *Reporting the Review*, as stated in [29]. The flowchart associated with the process is presented in Figure 3.1, as well as the number of articles in the collection at the time of each step.

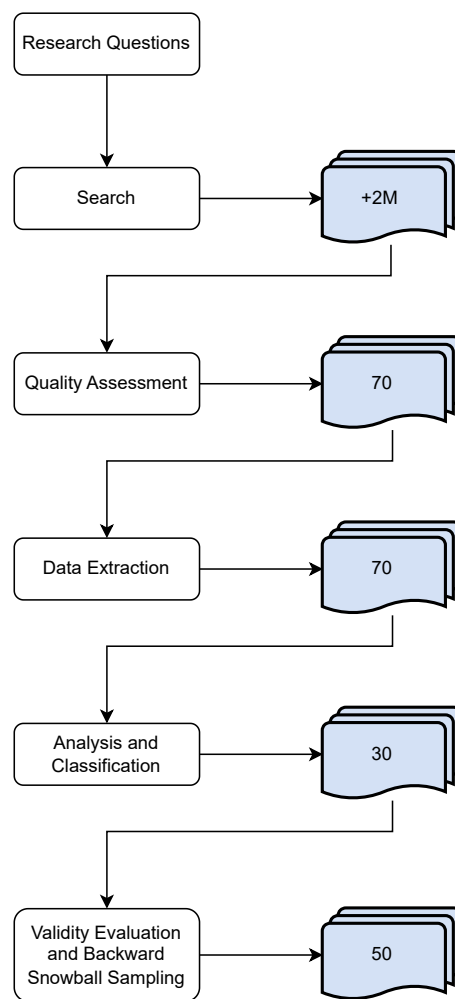


Figure 3.1: Systematic literature review process.

Research Questions

Two research questions were used to guide this literature review, relating to each of the relevant topics to explore: optimizing the planning process, responsible for connecting high-level portfolio planning with lower-level project task outline and assignment, and determining the best project management practices and tools that companies should use and adopt.

RQ1 How can the planning process be optimized in terms of resources?

RQ2 What are the existing tools and practices that help with the portfolio management task?

Search

The literature search was mainly conducted using the Google Scholar¹ search engine, but there were some cross references from other search tools like IEEE Explore² and Scopus³. The relevant keywords were extracted from the research questions previously presented to perform the search. For each question, the keywords were the following:

RQ1 *optimize, planning process, resources*

RQ2 *portfolio management, tools, practices*

Study Selection and Quality Assessment

From the large number of documents available after the search, there was a need to filter and select the most relevant ones. This task was done iteratively based on the titles, abstract, and year of publication on the most pertinent results retrieved.

Data Extraction

After selecting around 70 documents, it was necessary to reduce this list and work on the most relevant ones. For that, a cursory reading of the text was made to understand the study's key findings and get a general idea of the topic of discussion.

Analysis and Classification

After the data extraction, the documents were grouped based on the topic and classified as either *Important*, *Somewhat Important*, or *Irrelevant*. The studies classified with the first class were used in this literature analysis as they were the most relevant and up-to-date literature.

Validity Evaluation

At last, a complete detailed reading of each of those selected texts demonstrated to be a critical task to properly understand the state of the art of the topics aborded in this dissertation. This reading led to adding more relevant studies through backward snowball sampling, which is the process of adding articles from the references and citations present in other relevant articles [57].

3.2 Project Portfolio Selection

According to Mohagheghi *et al.* [38], the Project Selection problem has existed for more than four decades, and in the past twenty years, it has been studied more and more by scholars. The main

¹<https://scholar.google.com/>

²<https://ieeexplore.ieee.org/Xplore/home.jsp>

³<https://www.scopus.com/search/form.uri?display=basic#basic>

goal for this task is to choose the combination of projects that bring the most value to the company while following its strategy and controlling the risks.

Mohagheghi *et al.* [38] performed a literature review on the Project Portfolio Selection (PPS) approaches, discussing five topics: (1) Selection and Evaluation Criteria; (2) Uncertainty; (3) Modeling and (4) Solution approach, and (5) Applications in real-life case studies in the different areas. The solution approach is a characteristic of mathematical models whose solution can be exact or approximated. In the scope of this dissertation, it does not make sense to explore the other areas in which these solutions can be applied. Following this line of thought, the strategies can be outlined by the first three topics, each discussed in more detail in the following sections.

3.2.1 Selection and Evaluation Criteria

Selection and evaluation criteria are vital in determining the project's alignment with the company's goals. The variety of criteria allows decision-makers to assess projects from different perspectives, ensuring a robust and well-balanced project portfolio. This section delves into various types of criteria and their applications.

Financial

Different types of criteria can be used depending on the situation and environment. As stated by Dutra *et al.* [12], the financial aspect is one of the first and most widely used among portfolio managers. The main objective of a company is to maximize the potential return on the portfolio. Thus profitability criteria should be broadly used [14].

Different financial measurements have been used over the years. One of the first papers published by Lal in 1974 [31] selects projects based on metrics like internal rate of return (IRR) or marginal social cost/value. In 2008, Hu *et al.* [22] proposed a multi-objective model that used a project cost-to-benefit ratio. Later, in 2014, Khalili-Damghani and Tavana [26] proposed a different model that used capital investment as a criterion. More recently, many studies have been published using the net present value (NPV), making this one of the most prevalent measures in this process [49, 32].

Risk

Companies often use risk-related criteria as taking risks has upsides and downsides. Risks can be divided into multiple categories, from the component risks related to the project itself to overall risks associated with the dependencies and relations between projects [38]. They can be seen as something to avoid, associating risk with loss, and, at the same time, something to look forward to, associating risk with opportunities.

For example, in 2003, Ghaeli *et al.* [15] used the risk of public acceptance to model an Analytical Hierarchy Process (AHP), while in 2013, the model proposed by Gutjahr and Froeschl [18] takes into account the risks related to preferences of the decision-makers.

Strategic

Another important topic to properly evaluate and select projects is the strategic alignment with the company's goals and objectives.

In 2002, Cooper *et al.* [11] proposed two approaches to incorporate the strategy as a criterion in a portfolio selection model. The first, Bottom-up, by creating criteria that could represent and answer questions related to the strategic alignment of a project. And the second, Top-Down, also called as Strategic Buckets Model, which Cooper *et al.* claim "*is the only method designed to ensure that the eventual portfolio of projects truly reflects the stated strategy for the business*" [11, p. 17]. In this method, the manager organizes the projects into different groups according to the company's strategy. Then, each group is prioritized, and projects are selected from within to ensure the company follows its objectives.

Other Criteria

Besides the mentioned criteria, others can be used, such as social, environmental, or technological, as mentioned in [38]. Since this problem affects almost every part of a company and is directly related to the surrounding environment, the number of possible criteria is immense.

Different criteria are usually combined to evaluate the projects as much as possible. An excellent example of this combination was presented by Tavana *et al.* in 2015 [50], where multiple criteria from different types were used. The criteria, shown in Figure 3.2, were grouped into five categories: (1) Opportunity, representing the sustainability and ability to provide partnerships; (2) Potential Risks, representing the threats that can affect the project; (3) Technology, to evaluate the capability of the project to improve technological advancements within the company; (4) Finance, to measure the expected financial benefit and (5) Employment, to assess the number of personnel necessary to execute the project.

Summary

Different types of criteria exist to measure and evaluate particular parts of a project or a portfolio. Multi-criteria analysis has been demonstrated to give substantially better results than single-criteria models. As stated by Thakkar [51], multi-criteria decision-making approaches are valuable for portfolio managers facing the challenge of prioritizing conflicting objectives. These approaches don't focus on finding a single optimal solution but provide multiple options for "what-if" analysis, considering various internal and external factors. It enables decision-makers to thoroughly evaluate different scenarios and assess the practicality of proposed solutions across multiple axes.

3.2.2 Uncertainty

Uncertainty is an intrinsic aspect of the selection problem and requires careful consideration during decision-making. Scholars have explored different approaches to address uncertainty, with

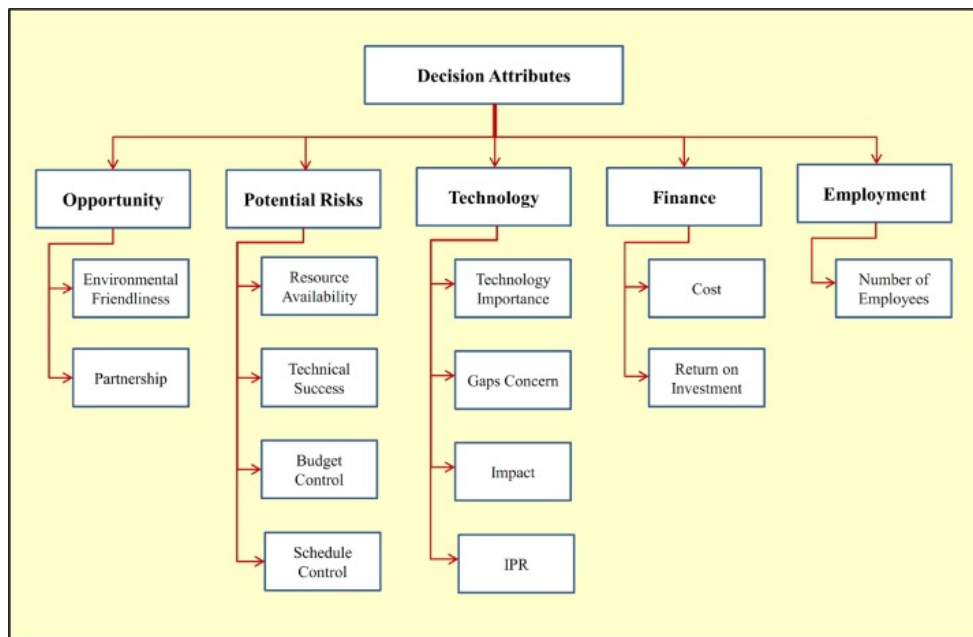


Figure 3.2: Criteria used by Tavana *et al.* in the project selection process [50].

stochastic theory and fuzzy logic being prominent contenders. This section explores these approaches in detail, highlighting their significance in dealing with uncertainty and enhancing the decision-making process in PPS.

Stochastic

In the reviewed literature, different approaches to solving the project selection problem also use distinctive notions to deal with uncertainty. Although widely used in various research areas, the stochastic theory is not so popular in portfolio management due to the uniqueness of the projects [38]. The stochastic approach tries to deal with uncertainty based on information from the past and previous experiences. Still, as the company and the environment evolve continuously, projects adapt to the surrounding conditions, giving them a unique trait. Budgets, resources, and even strategic goals differ from project to project, although they might seem similar at first sight.

Even with this characteristic, some research has been conducted on this topic. For example, Tofighian *et al.* [52] proposes a mathematical model to solve the problem considering multiple criteria such as risks, incomes (based on the historical data), and the possibility of reinvestment resources. He considers incomes as “*independent normally distributed stochastic variables*” [52, p. 573] due to the difficulty in finding their deterministic value. In 90% of the tests performed, the model originated better results than the counterparts, but even with those results, Tofighian *et al.* expect their model to be extended using fuzzy logic to achieve even better ones.

Fuzzy Logic

Fuzzy logic has been increasingly utilized over the years [38], and it first appeared due to the vagueness and imprecision of specific criteria used to evaluate the projects [47]. This concept was introduced in 1965 by Zadeh [59]:

"A fuzzy set is a class of objects with a continuum of grades of membership. Such a set is characterized by a membership (characteristic) function which assigns to each object a grade of membership ranging between zero and one." [59, p. 338]

In 2004, Lin and Hsieh [33] used fuzzy sets to represent the relevance of each evaluation metric perceived by the decision-makers. The relevance is a linguistic variable transformed into fuzzy numbers to perform arithmetic operations. Then, a fuzzy weighted average is used in the calculations. The process consisted of three main phases described in Figure 3.3: (1) Pre-evaluation, (2) Preference elicitation, and (3) Data analysis and reporting [33]. The system was tested in a company located in Taiwan and demonstrated to be very helpful due to its flexibility and adaptability. It incorporated fuzzy logic to handle the uncertainty and diversity in decision-makers' confidence levels for different criteria, which reduced the time spent on the strategic plan process, which went from two months to only two or three weeks [33].

3.2.3 Modeling Approach

The modeling approach is the most differentiating factor between different ways to address the project portfolio selection problem. A wide range of possibilities exists when trying to choose how to approach the problem, with multiple levels of complexity and each with its strengths and weaknesses [37]. A combination of different methods has been demonstrated to achieve better results than singular applications as it makes better use of each method's strengths. The techniques are divided into three categories, explained in detail in the next sections: (1) Optimization Models, (2) Scoring Methods, and (3) Decision Support Systems.

Optimization Models

The first type of models are the optimization models which mostly include probabilistic, real options, and combinatorial approaches. **Probabilistic Models** are usually shaped to handle uncertainty by making predictions based on probability distributions and include methods such as Bayesian theory or Monte Carlo simulation. Due to their ability to handle uncertainty, they are often combined with other methods [47].

In 2009, Chin *et al.* [10] designed a model based on a Bayesian network to evaluate and compare projects by their risk of not being executed within their scheduled dates. The network is built on eight root nodes that describe the risks associated with four primary risk categories: R&D (RADR), production (PROR), supply (SUPR), and product reliability (PRRR). The root nodes description is presented in Table 3.1, and the network is presented in Figure 3.4. The expert

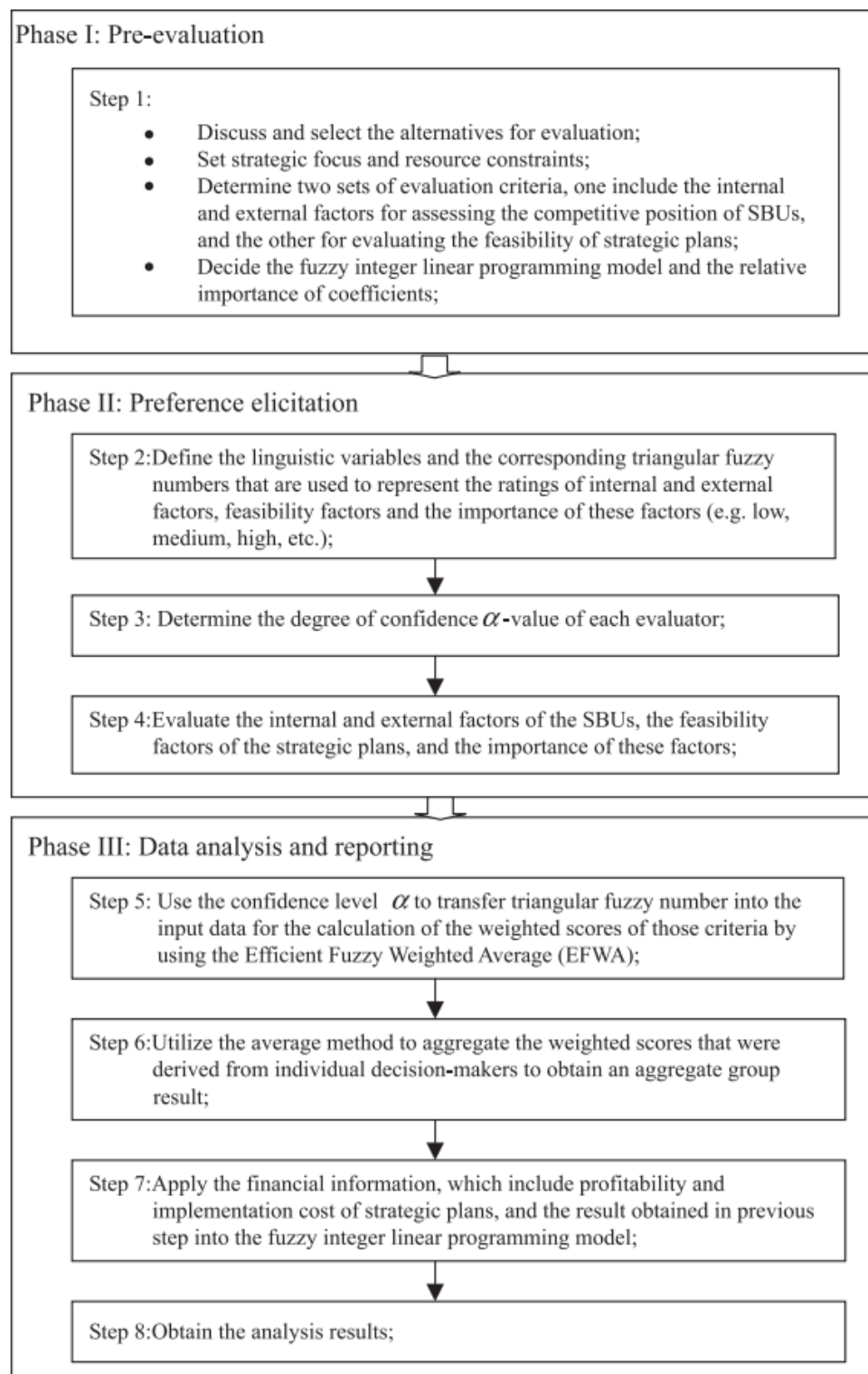


Figure 3.3: Flow chart proposed by Lin and Hsieh [33].

Table 3.1: Bayesian network nodes description [10].

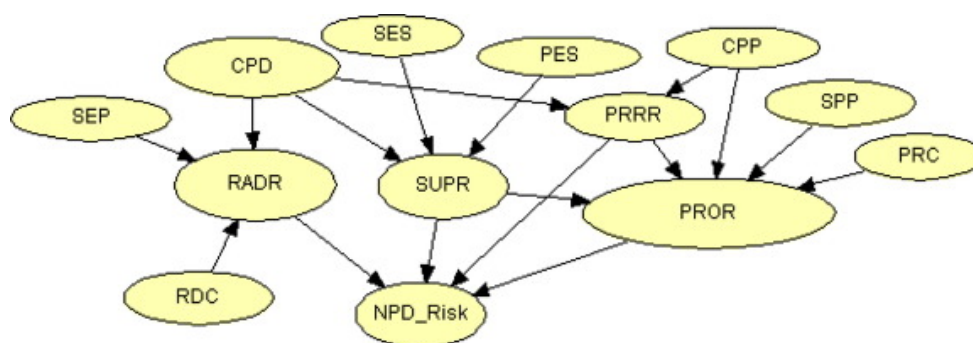
Node	Name
CPD	Complexity of the product design
SEP	Similarity of the existing product
RDC	R&D capability
SES	Similarity of the existing supply
PES	Supplier performance
CPP	Complexity of the production process
SPP	Similarity of the production process
PRC	Production capability

judgments estimate the root node probabilities with multiple levels of risk, which are then translated into the other nodes through pair-wise comparisons and conditional probabilities. Applying this network to the project portfolio selection problem, a manager would assess the risk for each project and allocate the resources to the ones with the lowest risk.

Real Options approaches are analysis techniques used to evaluate the value of flexible investment opportunities, and they frequently integrate learning models to handle uncertainty. They refer to real investment opportunities. Thus, exercising an option involves making investment adjustments on a project [40].

Montajabiha *et al.* [40] designed a model in 2017 capable of handling and helping with the decision-making process in portfolios of projects with multiple phases. They employed a robust combinatorial optimization algorithm that maximized the n-fold sequential compound options value. The n-fold sequential compound option concept was introduced in 2004 by Cassimon *et al.* [9]. In this model, the value of future options is contingent on the success of those that came before it in the sequence. The model led to excellent results, as the only measurements necessary for its execution were financial ones.

Combinatorial Methods are all techniques to solve problems that involve combinations of objects [14]. They are usually combined with other methods due to their complexity and difficulty in efficiently solving problems as they scale in size. They include methods like linear programming or evolutionary algorithms.

Figure 3.4: Bayesian risk network proposed by Chin *et al.* [10].

In 2018, Pérez *et al.* [45] built a mathematical model using triangular fuzzy numbers to represent the uncertainty. The main goal was to achieve the best portfolio selection in various confidence levels, and it was achieved through an objective function put together to maximize the expected projects' financial value and their relations. The final solution resulting from this model consists of the optimal portfolio for each confidence level, thus removing any uncertainty from the problem. It achieved impressive test results, returning the optimal portfolio selection for small to medium-sized problems.

Although optimization models that use mathematical programming are the most researched in the area [23], with the most papers and literature associated with them, due to their nature, they are not the most suited for the problem in question. The problem becomes an NP-hard combinatorial optimization problem in a real-world scenario with many projects. There are currently no efficient algorithms to solve that kind of problem, as finding the **exact optimal solution** becomes more complex as the model grows in size [38, 47, 1].

One way to approach this problem is to use linearization methods to attain solvable problems, as Liu and Liu did in 2017 [34]. They built a parametric credibilistic optimization model based on optimistic value optimization criteria. The goal was to "*maximize the optimistic value of the total portfolio returns under a prescribed credibility level instead of maximizing the expected total project portfolio return*" [34, p. 656]. The original problem was transformed into its mixed-integer programming model equivalent, which can be solved by deriving the analytical expressions of credibility constraints [34]. Although giving good results, these methods sustain limitations that prevent them from being used efficiently in real-case scenarios.

Those limitations are usually addressed through **heuristics or meta-heuristics**. They are intended to find close approximations to the optimal solution while being significantly more efficient [47, 23, 1], thus being used in NP-hard problems, where exact solutions are tough to find.

An example is the model proposed by Ghodoosi *et al.* [16], where the Shuffled Frog Leaping Algorithm (SFLA) is used as meta-heuristics. This algorithm merges the Memetic algorithm and the Particle Swarm Optimization. In their implementation, the model is composed of three phases: in the first, the parameters for the algorithm are predicted through a Neural Network; then, the SFLA algorithm is used to search for the optimal portfolio options. The results from this step are clustered using K-Means to identify the best choice and return. From the measurements made in the study, both error rate and CPU time remained low as the number of projects increased, contrary to the exact methods that can not maintain acceptable CPU times with the growing problem size [16].

In the past few years, authors frequently turned to meta-heuristics for handling multiobjective optimization problems, particularly in scenarios that involve complex constraints, such as the project portfolio selection problem. This is because meta-heuristics offer versatility in modeling and the ability to efficiently tackle large-scale and realistic project portfolio problems [47].

Scoring Methods

Scoring methods are used to evaluate projects based on different requirements and criteria, similar to a checklist, but instead of simply showing whether a project meets a condition, they provide a quantified value for it [14]. Qualitative information is transformed into quantitative measures through subjective decisions and opinions of decision-makers. Thus, scoring models aim to rank projects to the greatest extent to the decision-makers' view [47]. The simplicity and ease of execution of scoring models make them popular in this problem, often combined with optimization models to produce the most effective results. The two most common techniques used in scoring models are the Analytic Hierarchy Process (AHP) [56] and the Analytical Network Process (ANP) [46], the second being more suited for very complex scenarios [38, 23], although simpler comparative models are also used.

Comparative models apply the scoring methodology to make pair-wise and group-wise comparison rankings of projects and select the portfolio according to that information [23]. In 1999, Henriksen and Traynor [20] created a tool to help portfolio managers based on a comparative model. The tool produced a score for each project, considering its value and cost. It was calculated through a combined additive/multiplicative function with the values from a questionnaire handed to the managers mapped to a scale of 1 to 5. The questionnaire was composed of six questions based on four criteria: the relevance of the project, the risk related to it, the reasonableness, and the expected return. Then, projects were ranked according to their score, giving the managers an excellent baseline to make decisions and allowing them to test different scenarios by changing weights and values.

Another approach where researchers use scoring methods is the AHP, introduced in the 1970s by Thomas L. Saaty and has been studied and improved by other scholars [56, 23]. It is a structured method for comparing the relative importance of different criteria in complex situations. AHP breaks down the problem into a more straightforward hierarchy which is then used to assess the relative importance of each component in the final decision. The process is presented in Figure 3.5, and its vital step involves making pairwise comparisons between the components, rating the importance of each pair on a scale from 1 to 9, where one means *equal importance*, and nine means *absolutely more important*. The resulting data is then processed mathematically to determine the overall priorities of the components in the hierarchy. This approach provides a quantitative framework for considering multiple criteria in the project portfolio selection process [51]. Some implementations of this methodology can be seen in the model proposed in 2010 by Koppinen *et al.* [30], which combines AHP and real options ideology mentioned previously, or in 2014, by Aragonés-Beltrán *et al.* [2], which used both AHP and ANP to select the project portfolio.

Decision Support Systems

Decision Support Systems (DSS) are computer-based systems intended to simulate the decision-making process and integrate multiple activities smoothly in the project portfolio selection process

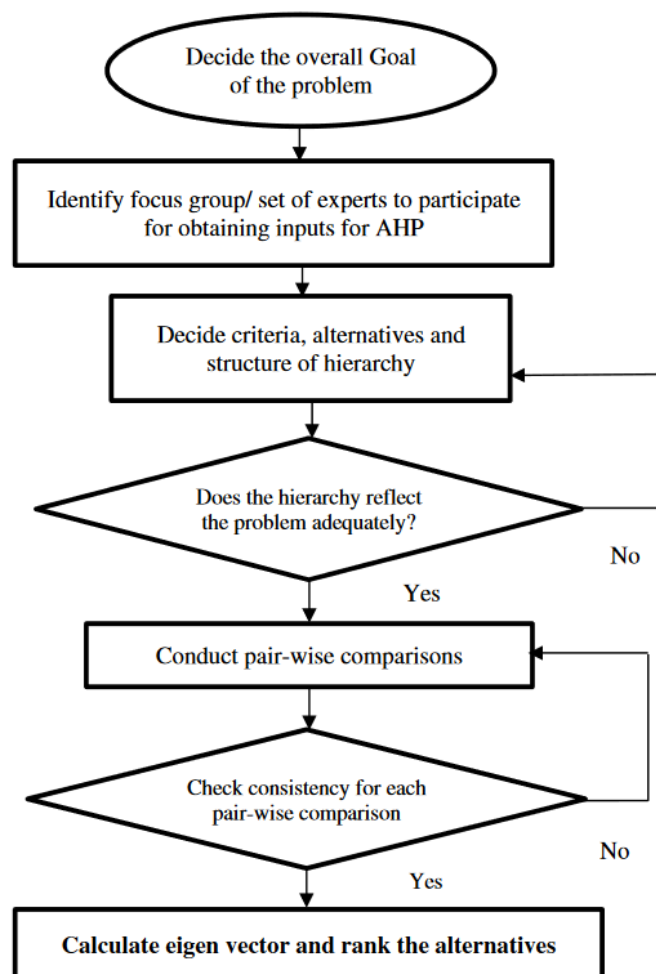


Figure 3.5: AHP Process diagram presented by Thakkar [51].

[23, 37]. The efficiency of the selection process can be significantly improved by using these systems, which automate the tasks involved in the process allowing for the execution of the necessary computations while simultaneously giving the ability to display information and interact with decision-makers [38, 47]. DSS usually combines multiple methodologies and provides a platform for evaluating and prioritizing projects based on the chosen criteria. One of the critical advantages of DSS is its ease of use, which allows decision-makers to quickly and easily access the information they need to make informed decisions [38].

Some simpler systems avoid the computational complexity by just allowing the plot of graphs or tables to show the relevant information and allow the decision-makers to make decisions based on that [14]. In 1992, Wheelwright and Clark [55] proposed a system that relied on a mapping strategy to divide the projects into five categories: *Breakthrough Projects* are the new projects that involve significant changes in the company's processes; *Derivative Projects* are the enhancements or sub-projects that originate from already executed ones, and *Platform Projects* represent the projects that are new but that do not introduce new changes in the processes. Besides the previous three, two more essential categories are *R&D* and *Partnerships*. This mapping was applied in a real scenario, which led to some changes in the strategy that have had an impressive impact on the profitability and efficiency of the company.

Martins *et al.* [35] built a more elaborate system in 2017. This web-based system offered a convenient platform for performing a multicriteria portfolio analysis. An additive aggregation method was used to score the projects, making it possible to consider multiple criteria in the portfolio selection process. A sensitivity analysis could also be performed through the Monte Carlo simulation allowing users to evaluate uncertainties in their portfolio. The simulation repeats the model multiple times, varying parameters within a selected range of values to comprehensively assess the portfolio. Additionally, the DSS allowed the user to adjust the scale and weights of the portfolio, making it possible to tailor the analysis to specific needs. The system was divided into multiple pages, providing information on the portfolio, displaying consequences matrices and parameters, and performing the sensitivity analysis.

Summary

As demonstrated in the previous sections, multiple ways exist to approach and model the problem. Optimization methods are highly effective for small problems but have limitations when the complexity grows. The use of meta-heuristics has been improving the optimization methods' results in the last year, but they could further be enhanced by combining them with scoring methods [47, 23, 1]. Although scoring methods are simple and easy to implement, their subjectiveness makes them unreliable to use as their own. Plus, a score can never be a sufficient measure when so many factors influence the execution and outcome of a project [14, 47, 20]. On the other end, DSS is highly interactive and allows for better alignment with the strategic goals. Still, it has limitations, such as the risk of ignoring feasible solutions or critical criteria [47]. Using a combination of modeling approaches is almost always beneficial, as it gives the ability to take advantage of each method's strengths [14, 38].

3.3 Planning Tools

Project Portfolio Selection takes great effort to achieve the desired solutions, but after a solution has been found and changes in the strategy are agreed upon, there is a need to reflect them in the Project Management Tool used by the company. These tools are critical in a company's success since the attitude towards a specific project is directly related to its performance and can make the difference between having many difficulties or completing on time, without extra costs and complications [19]. With this importance given to the tool, it is difficult for a company to decide which to use among all possibilities. There needs to be a trade-off between some features and usability. Otherwise, a tool that adds every feature would be too complex for the usual worker, directly impacting his efficiency.

Six tools are compared to understand better their features, usability, and how they are designed to solve different problems. These tools were selected among the most used and reviewed, which are the most relevant for this work. They are *Jira* [4], used by over 180 thousand customers in over 190 countries [7], *Monday.com* [39] and *Asana* [3], two other leading project management software together with *Jira*, and more robust and complete tools that incorporate portfolio planning like *Clarity* [8], *Planview* [42] and *SAP PPM* [48].

Jira [4], *Monday.com* [39] and *Asana* [3] try to address the duality of having a lot of functionality while maintaining a straightforward platform by allowing the users to extend the functionalities of the tool by creating extensions and providing integrations with other software tools. With this approach, they offer an intuitive and easy-to-use platform, and at the same time, they allow for customization and flexibility as each company chooses what features to add to the platform and how to use them.

Other tools like *Clarity* [8], *Planview* [42] and *SAP PPM* [48] have complete functionality and allow the users to have an all-in-one platform to facilitate the workflow. They provide features to allocate resources, forecast and prioritize the portfolio while allowing scheduling, assigning smaller tasks to teams or users, and getting an overview of each project. *Jira* [4] can also be included in this group, with the use of the *Jira Align* [5] software, which works as an extension to the original software to the portfolio selection that is already provided by the base software. This way, *Jira* could isolate different parts of the process and maintain the platform intuitive as well as functional and complete.

The tools offer the possibility of automation of processes, which is very important for reducing the cost of changing large volumes of data. *Jira* takes the lead here with its *ScriptRunner* extension that allows for far more complex automation than the ones permitted by the other four tools. This is very helpful in particular cases where no integrations are available (e.g. when the company uses customized software) and there is a need to automate the process with external information. Table 3.2 summarizes the features and utilities provided by the six tools.

Most portfolio management tools in the market offer the same key functionalities, like integrations with major applications, visualization tools to monitor projects and teams across the board, custom workflows, scheduling of tasks, and collaborative features. The differences among the

Table 3.2: Comparison of planning tools

	Management		Features			
	Portfolio	Project	Integrations	Automation	Extensions	Collaboration
Jira	*	*	*	*	*	*
Monday.com	E	*	*	L	*	*
Asana	L	*	*	L		*
Clarity	*	L	L	L	L	*
Planview	*	*	*	L	*	*
SAP PPM	L	L		L		*

* - Possible, L - Limited capability, E - Possible with extensions

primary tools are minimal and tailored to specific use cases [6], so the company can decide which ones better suit its objectives and needs.

3.4 Summary

In this chapter, a systematic review of the literature was performed on the topic of this dissertation. For this, two research questions were composed to align the literature with the problem. From the information retrieved from the various sources, we could understand how the Project Portfolio Selection problem can be addressed, dividing it into three main topics: the criteria used, how they handle uncertainty, and how they can be modeled and executed. Different solutions were studied, each with its strengths and weaknesses, and the trend was that most of the time, different solutions are combined to achieve a more robust and complete one that generates better results.

At last, a review of the current project management tools was done to understand how the portfolio selection problem integrates with the other components of a company. Although only a few tools were studied, there is a huge market in this area, and further research can be made to address more differences between the tools. From the analysis, most tools shared the same features, despite the different approaches. Some tools focus more on portfolio management, others on project management, but all offer possibilities and ways to address those two major tasks in a company. Currently, no tool is better than all others, as they all have positive and negative sides. Thus, each company must decide on the one that better fits its workflow and objectives.

Chapter 4

Problem Statement

This chapter aims to explain in more detail the problem addressed in this dissertation and how it can be solved. In Section 4.1, the problem is presented, and its impact in the workplace is described in Section 4.2. Then the solution and methodology are presented in Sections 4.3 and 4.4, respectively.

4.1 Problem

Vestas faces multiple challenges within the project life-cycle, mainly in three main stages: creation, prioritization, and replanning. In response to the previously presented research questions, it was discovered that while there are tools to assist with project management, the current systems and methodologies used in the company require significant improvement. The planning process, especially, is an area to gain from enhanced procedures and tooling.

In the project's first phase, during its initial planning, a common issue found in the company is the redundant nature of its structure creation. As many projects share a similar structure due to Vestas' commitment to modularity, creating new projects often involves unnecessary repetition and redundant tasks. This modularity, aiming to simplify project creation and improve efficiency, ends up not having its expected result, and the challenge here is to utilize the concept of modularity to reduce redundancy and improve the project initiation process.

Following creation, project prioritization poses another hurdle. Despite the existence of a portfolio governance tool to store information about initiatives, it lacks functionalities to prioritize projects effectively or simulate different scenarios. A Portfolio Prioritization Tool, presented in Section 2.5, was introduced to address these limitations, yet its lack of integration with Vestas' existing systems introduced additional challenges. Instead of improving the workflow, the tool's integration issues only added to the complexities, indicating a need for a solution with similar capabilities that better blends with Vestas' workflow.

Finally, the replanning phase of the project life-cycle also has its complications. The existing process is carried out by manually updating each issue (milestone, epic, or task) through complex interfaces. The absence of an efficient and straightforward solution to this process implies

time-consuming manual updates whenever changes occur, leading to decreased productivity and efficiency, underlining the need for a more streamlined replanning process.

4.2 Impact in Vestas

Vestas is a global leader in the wind energy industry, with operations on a colossal scale. The company has hundreds to thousands of projects, employs thousands of people worldwide, and the projects' monetary value often amounts to millions of dollars. The scale at which Vestas operates brings a series of challenges and potential risks. The inefficiencies in the project initiation, prioritization, and replanning processes not only lead to productivity loss but, considering the sheer scale of Vestas, can translate into considerable financial and resource implications.

Project prioritization, in particular, can have significant financial repercussions if mishandled. Given the extensive portfolio of projects and the significant investments associated with each, incorrect prioritization could result in substantial financial losses. The ineffective prioritization may result in resources being misallocated, critical projects being overlooked, or timelines being delayed. When the stakes are as high as they are in Vestas' context, these mistakes could cost the company an extraordinary amount of money.

Similarly, the replanning process, given the size and complexity of the projects, is both time-consuming and resource-intensive. It often takes weeks, if not months, to update and adjust project plans in response to changes, resulting in considerable resource wastage in money and hours. The inefficiencies in this process decrease productivity and increase the potential for errors, which could also have significant financial implications given the scale of the operations.

Though not as time-consuming as the replanning phase, the project creation process contributes to the inefficiencies. Even though initiating a project might take less time, the initial plan regarding tasks and estimates is rarely accurate. This lack of precision leads to future replanning and adjustments, costing additional resources. Therefore, quickly developing an accurate, reliable initial project plan can save significant money and time in the long run.

These problems collectively impact Vestas' operations, leading to inefficiencies, productivity losses, and significant financial implications. With the magnitude of Vestas' operations, even seemingly minor inefficiencies can translate into significant financial losses and delays. Thus, enhancing these processes is not just about improving productivity but also about safeguarding the company's financial health and maintaining its market leadership.

4.3 Proposed Solution

In response to these challenges, a three-tool solution was proposed, with each tool addressing a specific stage of the project life cycle. This includes the Work Package Catalog to enhance the efficiency of project creation, the Portfolio Prioritization Tool (PPT) for project prioritization, and a Replanning Tool to streamline the replanning process.

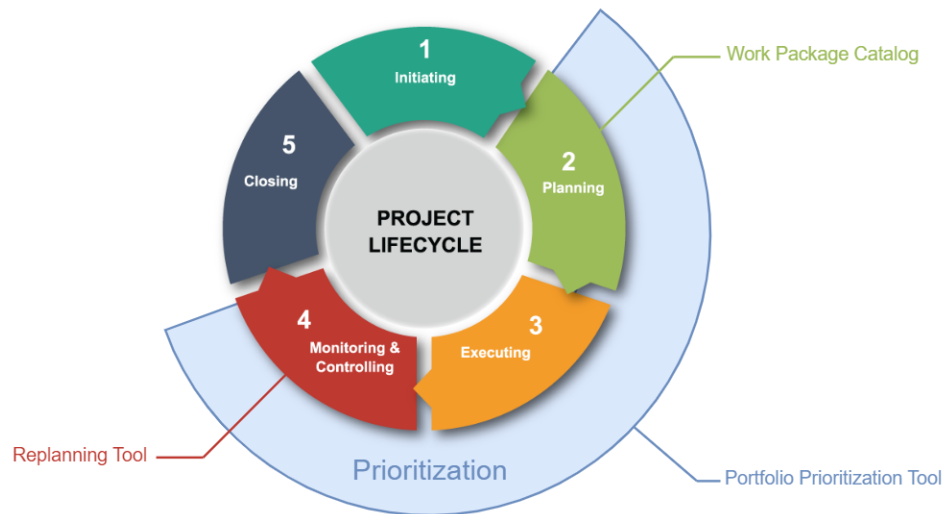


Figure 4.1: Project life cycle phases affected by the solution. Image adapted from [36].

The Catalog tool enhances the project creation phase. By leveraging the principles of modularity and standardization prevalent in Vestas, the Catalog aims to create a database of standard project components that can be reused across multiple projects. This reduces turbine development time to market and streamlines the process of initiating new projects. Furthermore, the Catalog can utilize historical data to provide more accurate project plans, budgets, and resource estimates, continuously improving the project initiation process.

The PPT provides a practical and well-integrated solution for project prioritization. Accurate prioritization of projects is essential to ensure that resources are allocated to the projects that bring the most value, following the company's current objectives and strategic goals. However, the importance of seamless integration into Vestas' systems must be recognized, given the previous complications experienced due to lack of integration. The new tool was designed to align with and complement Vestas' existing systems providing enhanced functionalities, such as scenario simulations and advanced prioritization features, and ensuring a smooth operation within the company's established framework, thus facilitating strategic and data-informed decision-making.

Finally, the Replanning Tool improves the process of project replanning. Efficient replanning processes are critical to ensure that projects can effectively adapt to changes and evolving circumstances. By minimizing manual work and reducing the probability of errors, the Replanning Tool enhances productivity and results in better project outcomes.

This suite of tools can considerably enhance Vestas' project management capabilities and boost efficiency across different project life-cycle phases, Figure 4.1, leading to improved productivity and greater business success.

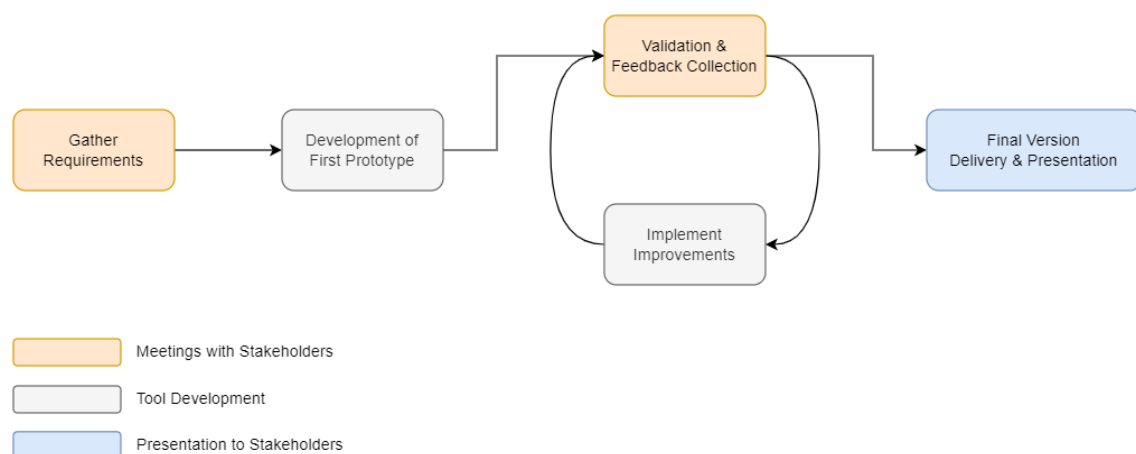


Figure 4.2: Procedure followed for each tool's development.

4.4 Methodology

To effectively address the challenges of project management in Vestas, a structured and phased methodology was employed to develop and implement the proposed tools. This process comprised two main stages: the procedure followed for each tool's development and the overall sequence in which the tools were developed.

Procedure

The methodology for each tool followed an iterative process. The first step was gathering requirements through stakeholder meetings, focusing on understanding their needs and expectations. These requirements were then transformed into a set of functional specifications to be worked on.

The development phase followed, creating a prototype for each tool. Feedback sessions with stakeholders were subsequently held to assess the prototype, and refinements and improvements were implemented based on their feedback. This development cycle, feedback, and improvements continued until the stakeholders were satisfied with the tool's performance and features.

Each tool was continuously validated and improved throughout this iterative process to ensure it effectively met Vestas' needs and was fully compatible with the company's existing systems and processes.

As shown in Figure 4.2, this methodology facilitated a high degree of collaboration with the stakeholders, fostering a mutual understanding and enabling solutions that effectively address Vestas' project management challenges. Furthermore, a complete list with all meetings and sessions with stakeholders can be seen in Appendix E.

Development Sequence

The development order was meticulously planned, considering the existing tools, their functionalities, and the most urgent needs.

Initially, this dissertation's scope only included the Portfolio Prioritization and Replanning tools. The development process started with the Portfolio Prioritization Tool, chosen as the starting point due to the existence of a baseline tool developed previously, which provided a foundation for improvement and integration. The objective was to enhance the PPT and ensure its seamless integration with Vestas' systems, thus aiding in efficient project prioritization.

The second tool developed was the Replanning Tool. This decision was motivated by the evident need for a robust solution to streamline the replanning process, given the current situation characterized by manual updates and complex interfaces that brought much friction. The development of the Replanning Tool focused on addressing these pain points and providing a tool that would enable quick, efficient, and accurate replanning of projects.

During the development of the Replanning Tool, the Project Planning & Execution team identified another pressing need: streamlining the project creation process. The company was exploring solutions to this problem, and our team recognized a unique opportunity to incorporate a solution into the ongoing work. The foundational aspects of the Replanning Tool, notably its connection to Jira and the enhanced planning features, could serve as the basis for a new tool to address this need — the Work Package Catalog.

The Catalog was designed to facilitate the efficient creation of new projects by using a repository of standard project components that can be reused and adapted as necessary. While this tool was not part of the initial project scope, its development became a natural extension of our work on the Replanning Tool, capitalizing on the tools and practices we were already employing.

Each tool was built upon the previous one to create a comprehensive solution to enhance the project life cycle. This phased and iterative methodology ensured that each tool was carefully crafted to meet the specific needs of Vestas while taking full advantage of existing tools and practices.

Chapter 5

Portfolio Prioritization Tool

Effective project planning and prioritization are crucial for companies to stay competitive and achieve their strategic objectives in today's dynamic business environment. With this in mind, Vestas has identified the opportunity to optimize the task of prioritizing initiatives through a Portfolio Prioritization Tool.

This chapter comprehensively explores the developed tool, detailing its requirements in Section 5.1, architecture in Section 5.2, relevant implementation aspects and user interface in Sections 5.3 and 5.4, respectively, its key features are presented in Section 5.5, and the validation process in Section 5.6. By the end of this chapter, readers will gain a detailed understanding of the PPT's role in enhancing the project planning process at Vestas.

5.1 Requirements

The requirements were initially set during the development of the previous tool, presented in Section 2.5. This initial set of requirements laid the foundation for developing the PPT. However, a subsequent meeting, Meeting E.1.1, was held with the stakeholders from the Strategic Planning & Portfolio Management team to ensure these requirements were still relevant and met the company's needs.

The PPT was developed to address the complex task of prioritizing Vestas' initiatives. This process involves considering multiple internal and external factors. The foremost include ensuring a realistic and skilled resource capacity and executing within the defined budget, for example, the cost and hours allocated to a project, retrieved from the database. The latter include new market possibilities, competitors' products and services, and value chain challenges. Examples of these factors are Contribution Margin and Yearly Volume, which are inputs from the Market/Sales team.

The tool was designed to meet the needs of two teams in Vestas' organization. The Strategic Planning & Portfolio Management team aims to develop Vestas' business plan and support the successful execution of the company's strategy and project portfolio by bridging the gap from strategy articulation to execution. This team needed a tool that allowed them to select relevant market variables, adapt the weights of each input for prioritization in accordance with the business

Table 5.1: Portfolio Prioritization Tool Requirements

Key	Name	Stakeholder	Priority	Description
PPT-1	Compatibility	All users	Critical	The tool must run with the current systems installed at Vestas.
PPT-2	Select Market Variables	St.Pl.&Port.Mgmt	High	The tool should allow the team to select relevant market variables for prioritization.
PPT-3	Adjust Weights	St.Pl.&Port.Mgmt	High	The tool should enable the team to adapt the weights of each input for prioritization.
PPT-4	View Results	St.Pl.&Port.Mgmt	High	The team needs to view the prioritization results on a Value / Effort matrix.
PPT-5	Recommend Plans	Project Excellence	Medium	The tool should easily recommend new plans to export.
PPT-6	Select Products	St.Pl.&Port.Mgmt	Medium	The tool should permit the team to select which products to consider for prioritization from the entire product portfolio.

strategy and needs, and select which products to consider for prioritization from the entire product portfolio. Viewing the prioritization results on a Value / Effort matrix and knowing the product delivery milestones was also essential to compare projects.

The Project Excellence team also had requirements for the tool. This team focuses on ensuring that the proper project management processes, tools, and training are given to the project managers and their teams. Thus, they needed this tool to easily recommend new plans in Jira to speed up the replanning process within the organization.

Finally, as the main requirement, running the tool with the current systems installed at Vestas was necessary to avoid adding complexity when new users needed to utilize the tool. These requirements can be seen in Table 5.1.

5.2 Architecture

The development of the PPT required careful consideration of various aspects, including data sources, connections, and integrations. The development process identified multiple vital requirements that must be present in the final solution.

The primary data source for PPT was a PowerBI dataset, which served as a repository for the information about Vestas' initiatives. Thus, a connection between the tool and PowerBI was required to enable real-time retrieval of the required data for prioritization and scoring calculations. With this connection, the PPT could use PowerBI visualization and business intelligence capabilities to further improve its user experience and features.

Table 5.2: Comparing different solutions for the prioritization tool.

	PowerApps	PowerApps w/ PowerBI Tiles	PowerBI Report	PBI Report w/ PowerApps
Access Dataset	No	No	Yes	Yes
Edit Data (db)	No	No	No	Yes
Edit Data (in-place)	Yes	Yes	No	Yes
Embed Graphs	No	Yes	Yes	No

With one of the main requirements being the program ranking, the application should effortlessly perform calculations through a customizable formula. That is easily performed in PowerApps, as opposed to PowerBI, which would require the addition of extra columns and fields in the dataset, which is not ideal for teams outside of this tool's scope. Besides that, the low-code trait of PowerApps would enable developers and even regular users to easily modify the calculation method without requiring significant programming skills. Furthermore, these calculations and modifications should not alter the underlying dataset in the database. The solution should ensure that any changes or calculations were applied only within the tool's scope, allowing the ability to simulate different scenarios while maintaining the integrity of the original dataset. PowerApps provides a user-friendly interface for data entry and editing, allowing users to easily add or modify data rows within the scope of the app.

A small comparison of these application types' most used architecture choices was performed and is presented in Table 5.2. None of the solutions was enough to fill in all the requirements because there was a need to take the most out of the two-way PowerApps / PowerBI connection. The only path to approach that situation, and consequently, the chosen architecture, was by combining two solutions.

The final solution consisted of a PowerBI Report with a PowerApps application integrated. This PowerApps app also used PowerBI tiles to improve its data visualizations. PowerApps provides the necessary user-friendly interface for data entry and editing, the ability to customize formulas and calculations, and a flexible platform for creating complex calculations and data manipulations. In contrast, PowerBI provides the ability to view, explore and analyze the data. The final architecture can be seen in Figure 5.1.

5.3 Implementation Aspects

In this section, the implementation aspects of the PPT are examined, exploring both the application workflow and the scoring calculations. Doing so offers a comprehensive overview of how this tool adds value to Vestas' project planning process.

Application Workflow

The Application Workflow of the Portfolio Prioritization Tool is presented in Figure 5.2 through an Activity Diagram, which visually represents the sequential steps involved in the tool's workflow,

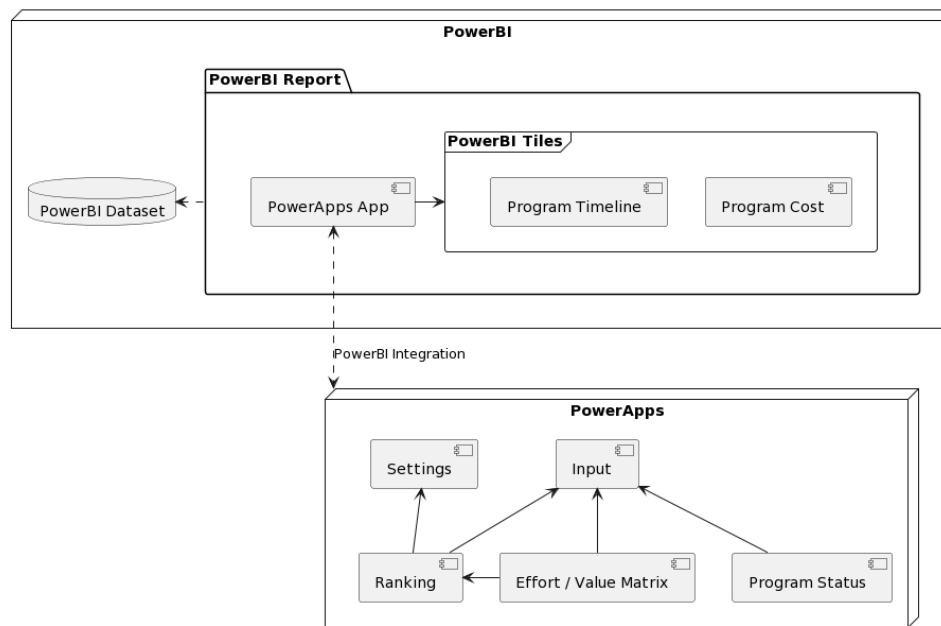


Figure 5.1: PPT Architecture.

aiding in comprehending its operational process.

Upon initiating the PowerBI report, the first phase the user engages in is the Data Loading phase. In this phase, users can import real-time data from PowerBI or load data from a previously saved scenario. This versatility allows users to choose their starting point based on the current requirements.

Following the data loading, the user transitions into the Scenario Testing phase. This phase offers an interactive platform where users can modify the scoring formula or edit the underlying data. Such editing could involve overriding internal factors or supplementing additional information through external factors. These alterations will automatically recalculate the program's score, allowing an instant review of the implemented changes.

With the programs now ranked in the new scenario, users are able to analyze the potential outcomes through various visualization options. These include the program ranking, a Value / Effort matrix, and timeline/resource comparisons, offering users a comprehensive, data-driven understanding of the projects.

Furthermore, users can export the scenario for future reference or to share it with other stakeholders. After exporting, the user can either create additional scenarios, further explore the possibilities, or exit the application and proceed with subsequent procedures based on the scenario analysis outcomes. Embedded in the Portfolio Prioritization Tool, this workflow structure ensures a user-friendly, flexible, and comprehensive platform for effective decision-making in the portfolio prioritization procedure.

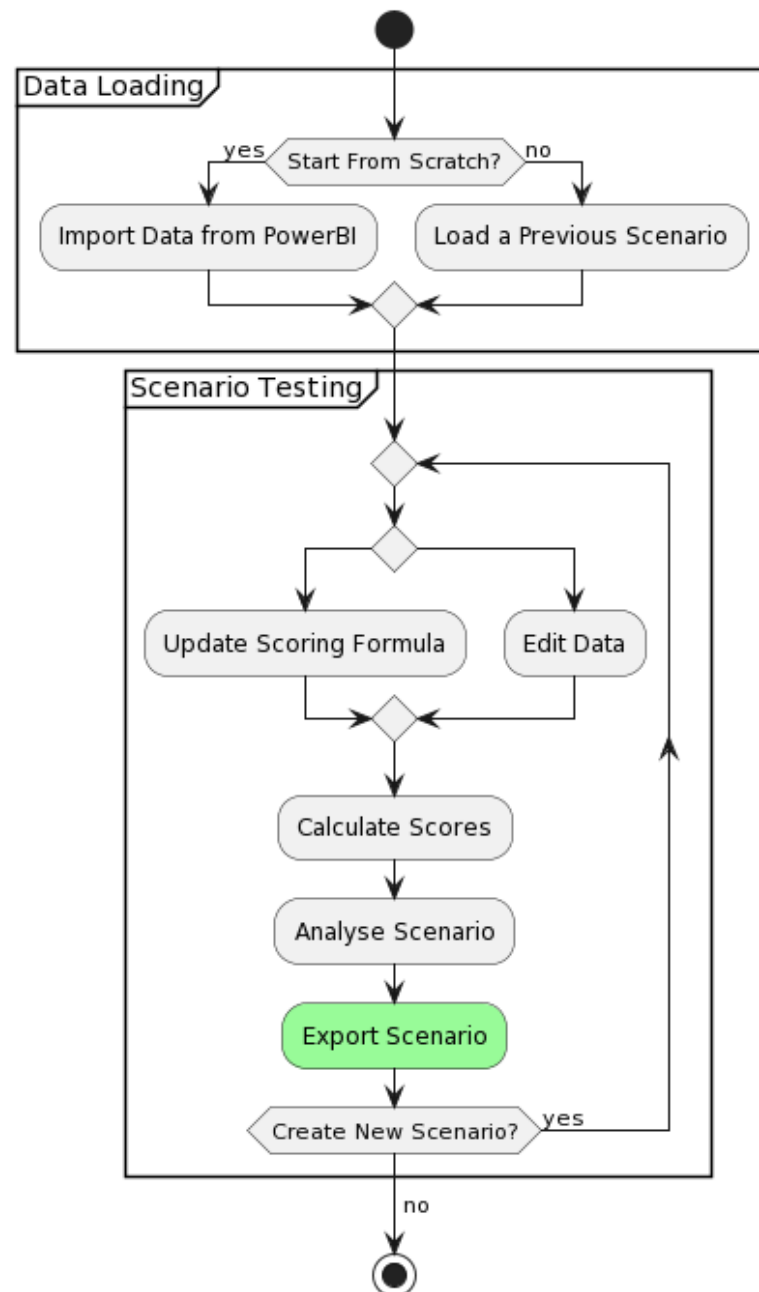


Figure 5.2: PPT Activity Diagram.

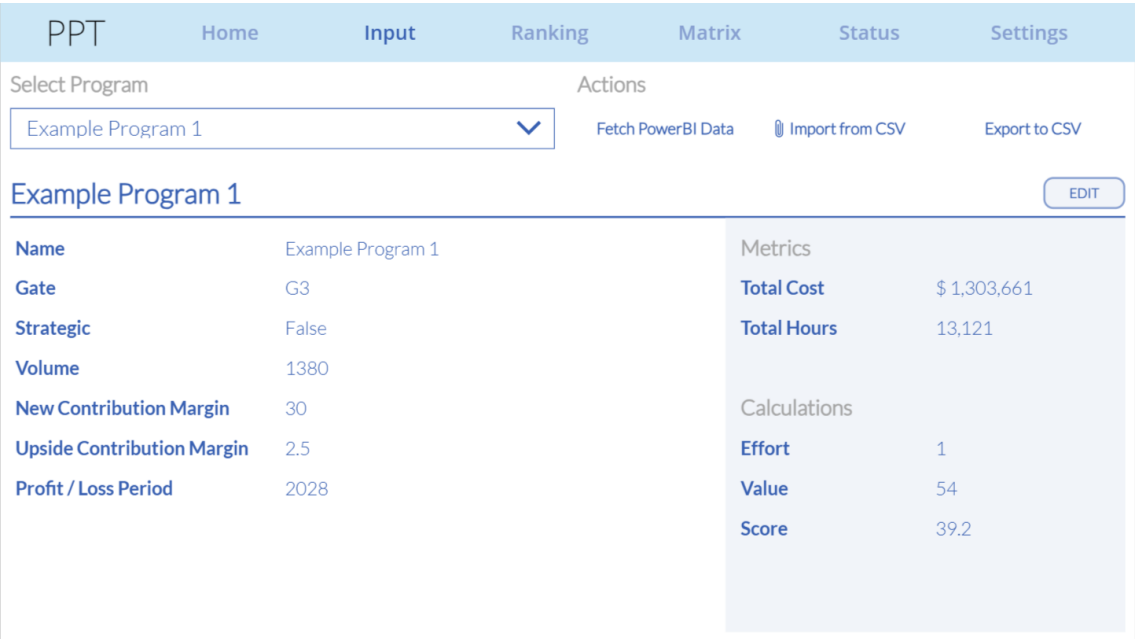


Figure 5.3: PPT User Interface.

Scoring Calculations

An essential aspect of the Portfolio Prioritization Tool’s implementation is the method used for calculating scores, as the programs’ ranking depends heavily on these calculations. It is important to note that the calculation methods employed in this tool are consistent with those outlined in the Background chapter, specifically in the section related to the initial version of the tool, Section 2.5.

5.4 User Interface

The user interface of the portfolio prioritization tool (PPT) was carefully designed to prioritize usability, intuitiveness, and a seamless user experience. It empowers stakeholders to interact efficiently with the system, enabling them to create custom scenarios and utilize a range of visualization charts to evaluate the performance of different projects considering internal and external factors. The primary objective was to provide users with a direct comparison between projects, offering a clear overview of resource allocation and facilitating informed decision-making based on these insights. It consists of five main pages, explained in more detail in the following subsections. These pages can be seen in Appendix B and Figure 5.3.

Input Page

The Input Page, Figure B.2, is a central hub for stakeholders to manage data and scenarios within the PPT. Here, users can easily import data (from PowerBI or a previously created scenario) or export scenarios, facilitating data exchange between stakeholders. Additionally, the Input Page

allows stakeholders to override internal factors, such as the project's allocated resources (cost and hours), and add external factors that may impact the project prioritization process. Taking into account all factors leads to more accurate and comprehensive decision-making. Each program's score is calculated from the information added by the user on this page.

Ranking Page

The Ranking Page, Figure B.3, gives stakeholders a clear view of how projects are ranked based on their scores. Using an intuitive and visually appealing interface, stakeholders can easily comprehend the relative prioritization of projects and have a visual sign of which projects have strategic relevance. The page also includes a graph that represents the allocation of costs across different projects, giving stakeholders valuable insights into the financial aspects of the portfolio.

Matrix Page

The Matrix Page, Figure B.4, presents stakeholders with a Value / Effort matrix, a graphical representation that allows for plotting projects based on their effort and value. This visual tool provides a comprehensive overview of project distribution and assists stakeholders in identifying projects that require a higher effort but offer substantial value. The Matrix Page helps stakeholders make informed decisions by considering the trade-offs between effort and value.

Status Page

The Status Page, Figure B.5, lets stakeholders compare programs based on cost, hours, and timelines. This page provides a comprehensive and concise summary of each program's performance, allowing stakeholders to assess the progress and status of individual projects. Through clear visualizations and critical metrics, stakeholders can quickly identify projects requiring additional resources or attention, ensuring timely adjustments and efficient project management.

Settings Page

The Settings Page, Figure B.6, enabled users to adjust the weights of the scoring formula based on their company's current strategy and needs, thus ensuring the dynamic adaptability of the tool. It also facilitates filtering programs based on pre-defined criteria, streamlining the decision-making process by focusing only on the relevant projects. The Settings Page enhances the tool's flexibility and alignment with evolving business strategies, supporting informed portfolio management.

5.5 Features and Benefits

The tool offers several key features that contribute to improving the planning process, whose primary goal is to guide stakeholders to make informed decisions, optimize resource allocation,

and enhance overall project planning quality. The following sub-sections outline them and discuss their corresponding benefits.

Scenario Testing

The tool enables stakeholders at Vestas to simulate different scenarios and assess their impact on milestone dates, resource allocation, and costs. By creating and analyzing custom scenarios, stakeholders gain valuable insights into the potential outcomes of different portfolio configurations, allowing them to explore various what-if scenarios and make informed decisions based on them. Scenario testing not only aids in identifying the most optimal project portfolio configurations but also ensures the establishment of realistic and achievable milestone dates, leading to improved project planning accuracy.

Data-driven Decision-making

Related to scenario testing, another one of the tool's key benefits is its ability to promote data-driven decision-making. The tool provides stakeholders with comprehensive data insights, allowing them to evaluate project performance and resource requirements while giving each one a quantitative value that helps compare it to others of the same kind. Incorporating clear visualizations, such as charts and a Value / Effort matrix, helps stakeholders visualize complex scenarios and identify patterns that may not be immediately noticeable in the raw data. With accurate scoring calculations and robust data analytics, stakeholders can make informed decisions, leveraging objective and quantitative information. Ultimately, this leads to more effective and efficient outcomes minimizing the dependence on subjective estimations and ensuring that decisions are based on concrete evidence.

Improved Resource Allocation

Efficient resource allocation is critical for a successful portfolio, and the tool supports its improvement by visually representing each program's value relative to its resource requirements in a Value/Effort matrix while considering multiple factors, including costs, hours, and timelines. It also helps ensure that higher-value programs are prioritized, enabling strategic decision-making that enhances overall project performance and leads to more efficiency and productivity, ultimately contributing to the success of Vestas' initiatives.

Transparency and Communication

Transparency and communication are critical aspects of effective project planning and decision-making. The portfolio prioritization tool enhances transparency by providing a clear, objective framework for evaluating programs. By assigning quantitative values to programs and comparing them on a standard scale, stakeholders have a standardized basis for assessing program value and making comparisons. This transparency fosters a shared understanding among stakeholders and

promotes collaborative decision-making. The visualizations and the Value/Effort matrix enable stakeholders to quickly grasp different programs' relative importance and potential value, facilitating discussions and negotiations about program priorities. With improved transparency and communication, Vestas can align stakeholders, ensure that decisions are made collectively, and increase the likelihood of successful project outcomes.

5.6 Testing and Validation

Throughout the development period, thorough testing and validation meetings were conducted to ensure the tool's functionality, usability, and efficiency aligned with its objectives and delivered the expected value to its intended users.

Testing

Various tests were performed using different scenarios to ensure the PPT worked as anticipated. These tests involved three similar initiatives with the same yearly volume, cost, and hours positioned at the same gate and with similar profit/loss periods. The tool correctly calculated the score for all three initiatives, plotted at the same position on the Value/Effort matrix, confirming the tool's consistency. The initiatives' attributes can be seen in Table 5.3 for reference.

Table 5.3: Prioritization Tool initial initiatives' attributes.

Program	Cost (mEUR)	Hours (k)	Volume (MW)	CMNew (%)	CMUpside (%)	P&L Period	Gate	Score
Initiative 1	40	300	1500	19.0	2.0	2030	G1	6.7
Initiative 2	40	300	1500	19.0	2.0	2030	G1	6.7
Initiative 3	40	300	1500	19.0	2.0	2030	G1	6.7

Next, the Initiative 1 gate was changed to a higher level, from Gate 1 to Gate 3, signifying greater maturity and advancement. This change led to an increase in the initiative's score, yet its effort and value, and hence its position on the Value/Effort matrix, remained unaltered, as seen in Figure 5.4.

Then, the profit/loss period of Initiative 2 decreased from 2030 to 2024, suggesting a shorter time frame for the initiative to generate profit. This resulted in a higher score but had no impact on its effort or value, and therefore, its matrix position was unchanged, as depicted in Figure 5.5.

Two additional tests were performed after resetting the initiatives to their original attributes. Initiative 3 was used as a reference to understand and visualize the impact of the specified changes. First, the Initiative 1 yearly volume was decreased to 750MW, reducing its value and, consequently, its score. This change led to a downward shift in its position on the matrix. Finally, the total cost of Initiative 2 was reduced by manually overriding it to 9 million, leading to a decrease in its effort and an increase in its score. The initiative consequently moved towards the left in the matrix, indicating reduced effort. The results can be visualized in Figure 5.6.

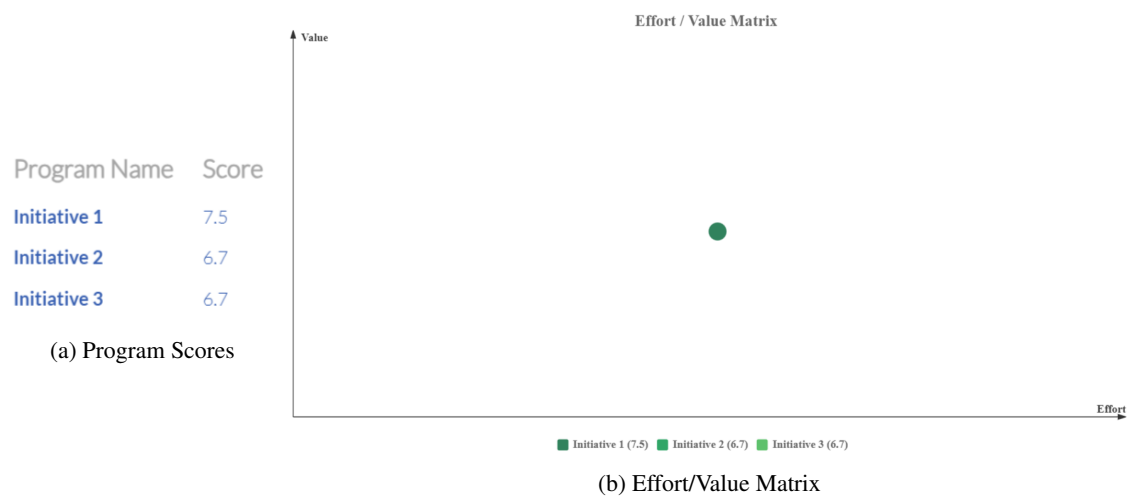


Figure 5.4: PPT Test 1 Results.

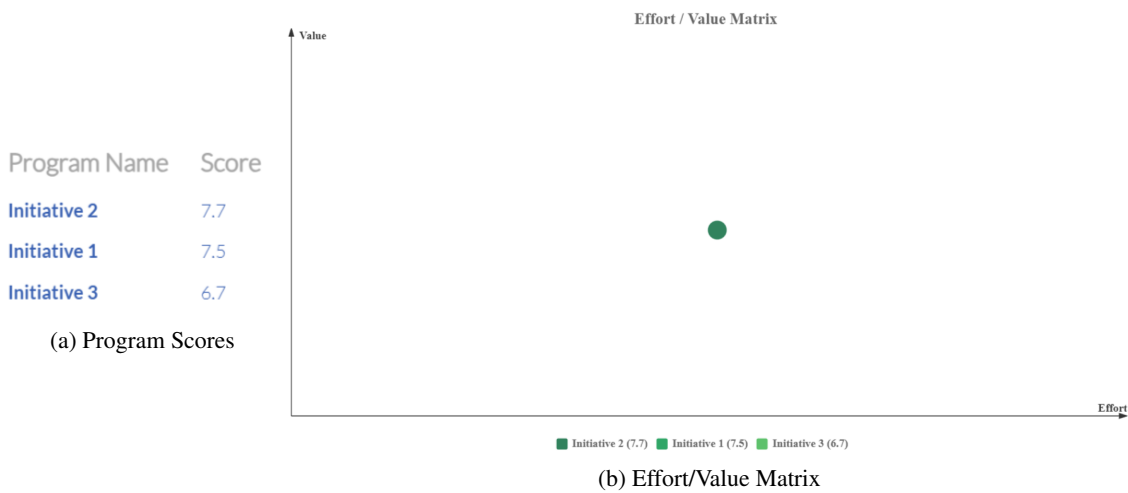


Figure 5.5: PPT Test 2 Results.

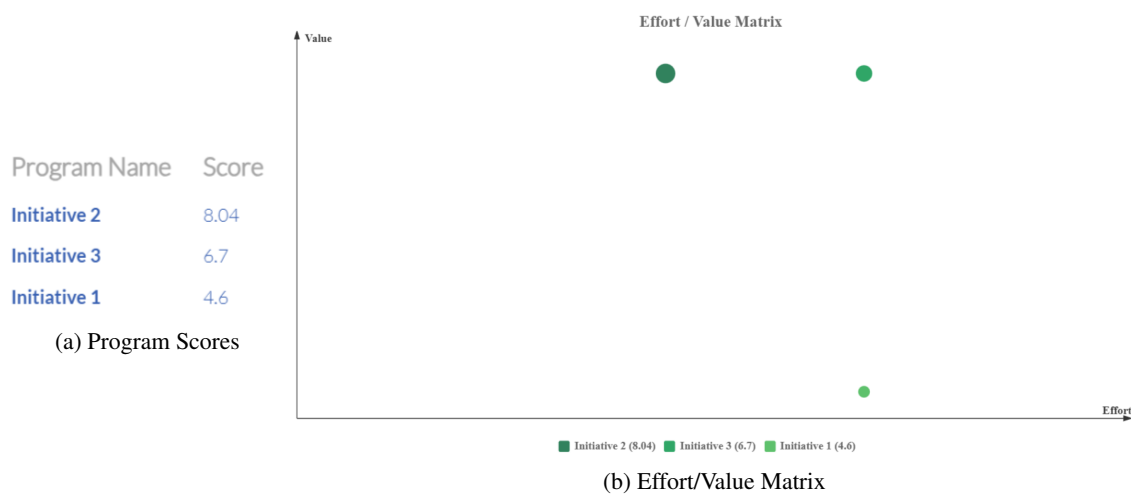


Figure 5.6: PPT Test 3 Results.

These tests confirmed the PPT's ability to accurately calculate scores and place initiatives based on their attributes on the Value/Effort matrix. The tool proved its adaptability and precision when handling changes in initiative attributes, validating its robustness and reliability for portfolio prioritization.

Validation

The PPT was validated through recurring meetings with Strategic Planning & Portfolio Management team stakeholders. These meetings served as a place to present and discuss the PPT's development stages or challenges.

The first significant meeting (Meeting E.1.2) allowed the presentation of the Portfolio Prioritization Tool's first draft. The stakeholders' feedback was incorporated into the tool's subsequent iterations, ensuring it met the team's needs and expectations.

The second meeting (Meeting E.1.3) was crucial in addressing technical issues, especially discussing potential solutions for the PowerBI integration data row limit, ensuring that the tool could handle the required data.

The third meeting (Meeting E.1.4) marked the presentation of the Portfolio Prioritization Tool's final version to the Stakeholder. This meeting aimed to collect the final feedback and fine-tune the tool to the team's requirements.

Finally, the tool was presented to the vice president of Strategic Planning at Vestas (Meeting E.1.5), marking the final validation stage. The final presentation ensured that the tool was fit for purpose and met the needs of the stakeholders. It represented a significant step forward in Vestas' portfolio planning process, offering a robust and efficient solution for initiative prioritization.

5.7 Summary

The Portfolio Prioritization Tool presented in this chapter is a powerful tool developed to assist Vestas in prioritizing initiatives. By integrating PowerApps and PowerBI, the tool offers a user-friendly interface, customizable formulas and calculations, and a flexible platform for data manipulation and project comparison. The architecture allows seamless integration into the currently used software while offering key features, including scenario testing, data-driven decision-making, improved resource allocation, and enhanced transparency and communication, improving Vestas' planning process and meeting the initial stakeholders' requirements. The tool was finally validated by the vice president of Strategic Planning, allowing its usage in production scenarios.

Chapter 6

Replanning Tool

Having a good project plan is essential for its successful execution and delivery on time. However, the constant changes in the surrounding environment caused by unexpected events or changes in priorities create a need for replanning. The replanning process is critical in ensuring project resilience, resource optimization, and timely delivery of outcomes, but this process is often subject to many challenges. Manual replanning methods are prone to errors and can be time-consuming, mainly when projects involve hundreds or thousands of tasks. On the other hand, although offering automated updates, existing tools often need more user-friendliness and personalized views to accommodate Vestas' needs.

The replanning tool described in this chapter was developed to overcome these challenges by providing automated replanning capabilities with a simple and intuitive user interface. The chapter is structured, similarly to the previous one, into six main sections: requirements and architecture in Sections 6.1 and 6.2, implementation aspects in Section 6.3, the user interface in Section 6.4, the tool's features and benefits are presented in Section 6.5 and finally, the testing and validation in Section 6.6. Each section delves into specific aspects of the replanning tool, providing a comprehensive understanding of its development process and functionality.

6.1 Requirements

The Replanning Tool was designed to meet the specific needs of Project Managers and Product Planners at Vestas. The tools' requirements were collected through four meetings with stakeholders from different areas, Meetings E.2.1, E.2.2, E.2.3, and E.2.4. Participants in these meetings included three Project Managers from three different areas and one Project Planner from the portfolio team. These requirements can be seen in Table 6.1

The primary requirement was to establish a standardized process for replanning. This standardization ensures that regardless of the individual or the level of replanning required, the process remains consistent, eliminating confusion and promoting efficiency. Three levels of replanning were identified and incorporated into the tool's design to cover all potential scenarios. These are often referred to in Vestas as A-level, B-level, and C-level replanning:

Table 6.1: Replanning Tool Requirements

Key	Name	Stakeholder	Priority	Description
REP-1	Standardized Process	All users	High	Establish a standardized process for replanning with support for all levels.
REP-2	Jira Integration	All users	High	Ensure seamless data exchange and real-time access to project data.
REP-3	Personalized Views	All users	High	Provide personalized views of the project timeline.
REP-4	Automatic Updates	All users	High	Automatically update dates for every issue affected by a change.
REP-5	Update Project	All users	High	Facilitate easy and quick transfer of the updated dates to the production server.

- A-level replanning concerns inputs from the portfolio or product side. This might involve changes in the company's objectives and targets. These updates typically have a wider impact on the project and can cause substantial shifts in the timeline.
- B-level replanning involves inputs from the project manager. This might involve delays from suppliers or critical delays reported by team members or other modules. These updates are usually more localized, affecting specific epics and smaller milestones within the project.
- C-level replanning involves inputs from the team, such as small delays and misestimations of certain tasks. These updates are even more specific, often affecting only individual tasks or small groups of tasks within the project.

Each type of replanning presents its challenges, and the tool should be designed to facilitate all of them smoothly and effectively.

The integration with Jira was needed to ensure seamless data exchange and real-time access to project data. This integration allows for the immediate reflection of changes made during the replanning process, ensuring all stakeholders can access the most current project information.

The tool was also required to provide personalized views of the project timeline. This feature allows users to focus on the relevant issues during the replanning process, promoting a clutter-free and streamlined user experience.

Another critical requirement was the automatic update of dates for every issue affected by a change. This feature ensures that any adjustments made to an issue are immediately reflected in its dependent tasks, maintaining the integrity of the project timeline and reducing the need for manual updates.

Finally, the tool needed to facilitate the easy and quick transfer of new dates to the Jira server. This feature ensures that the updated project timeline is immediately reflected in the production

An additional service, the *ReplanService*, was created for the replanning tool. This service contains all the logic related to the developed tool, providing a dedicated environment for implementing and managing replanning operations.

A dedicated module, the *ReplanService*, was developed for the processes specific to the replanning tool that encapsulates all the logic required for the tool's correct functioning. This service depends on the *IssueService* to fetch and update issues upon changes.

6.3 Implementation Aspects

The replanning tool was implemented by addressing several key aspects, including enhancing application modularity, defining specific use cases, designing an intuitive workflow, and establishing sophisticated update behaviors.

Application Modularity

Initially, the VTaC application served a more limited set of tasks and was relatively compact in structure. However, a significant transformation was needed to accommodate the replanning tool's wide-ranging demands. The application was restructured to be more modular in its components and services. This increased modularity greatly simplified the addition of new features and future-proofed the application, preparing it for additional enhancements and customizations that may be needed down the line.

Application Workflow

The workflow of the replanning tool was designed to be simple and intuitive. As illustrated in the UML activity diagram in Figure 6.2, users first log in and input the issue key to load the specific issue and its underlying structure from Jira. The timeline can then be personalized by adding or removing issues based on the necessities.

The next step involves updating the issues, which can be done manually or by moving or resizing them in the timeline as necessary, depending on the changes that need to be made. The tool automatically updates all affected issues and allows users to review and make extra adjustments.

Finally, the user can apply these changes to the Jira server, which immediately reflects them in the production software. This automated process dramatically reduces the time and effort required to update the project timeline, thereby increasing efficiency and productivity.

Application Behaviors

A critical aspect of the replanning tool is its sophisticated update behaviors. These behaviors ensure that when an issue is updated, all related issues are automatically adjusted to maintain the integrity of the project's structure and timeline.

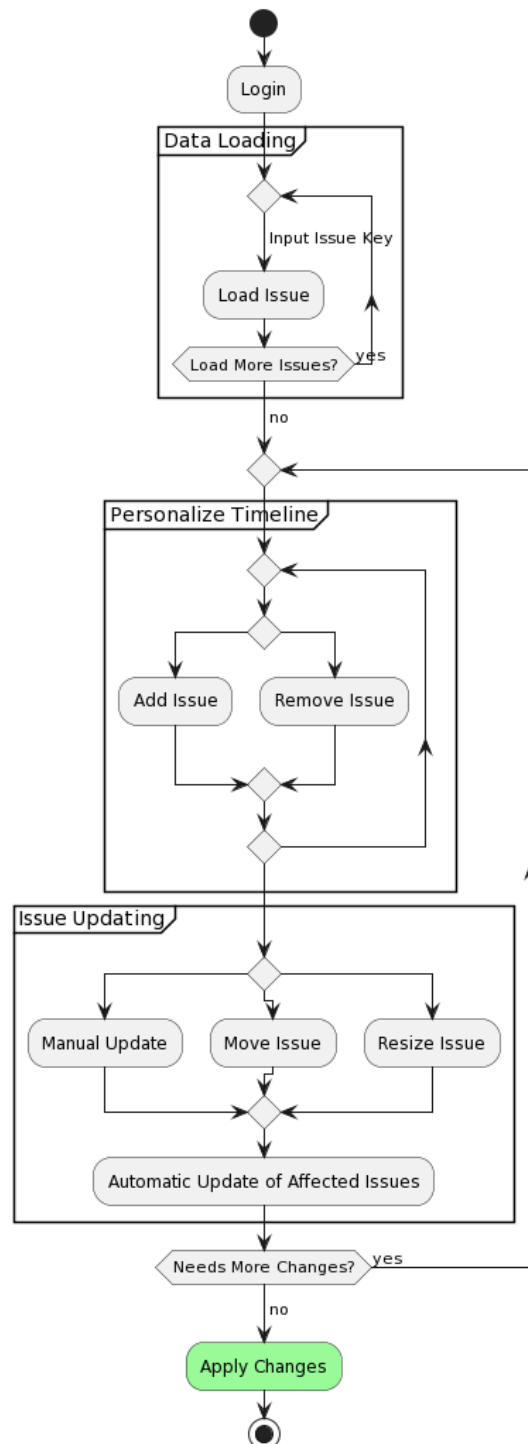


Figure 6.2: Replanning Tool Activity Diagram.

The tool keeps track of the hierarchical relationships of the issues — recognizing which issues are parent and child tasks — and automatically adjusts all related issues to preserve these relationships when any issue is updated.

To elaborate further, let us consider a few examples:

1. If a parent issue is moved, all child issues are automatically moved by the same amount, assuring that the tasks remain nested under their original objective or deliverable, maintaining the project's structure.
2. When a parent issue is resized, the child issues are resized proportionally, maintaining their original proportion within the parent issue's timeline.
3. Similarly, when a child issue is adjusted such that it expands beyond the timeline of its parent issue, the tool automatically adjusts the parent issue's timeline to accommodate this change, ensuring that the parent issue's timeline always encompasses all children.

These automatic adjustments ensure the project maintains its structure and coherence in the face of changes. Notably, these behaviors are not rigidly fixed. These update behaviors can be turned on or off on the fly to give users more control and flexibility. For example, a user might want to turn off the automatic adjustment of child issues when a parent issue is resized, as it may not always be desirable for all child issues to be proportionally resized.

Applying Changes

After the user completes their replanning tasks within the tool, the changes need to be applied to the actual project managed within the Jira platform. Applying changes is designed to be efficient, secure, and compliant with the company's standard practices.

Before the tool applies the changes, it presents the user with a consent form to ensure they agree with the following conditions:

Project Change Request (PCR) The user must agree that a PCR accompanies any changes to Initiatives or high-level Milestones. A PCR is a standard Vestas procedure that needs to take place every time big changes are needed in a project's timeline. This procedure confirms that all necessary approvals have been attained and that the changes align with project requirements

Manual Mode As the tool alters the dates of specific issues, the user should be aware that this can only be done if all issues are set to Manual update mode or, in case they are not already, they will be set to it.

Responsibility for Project Structure Lastly, the user must confirm their responsibility for maintaining the project structure. This ensures that users consider the broader implications of their changes and take responsibility for ensuring the overall project integrity.

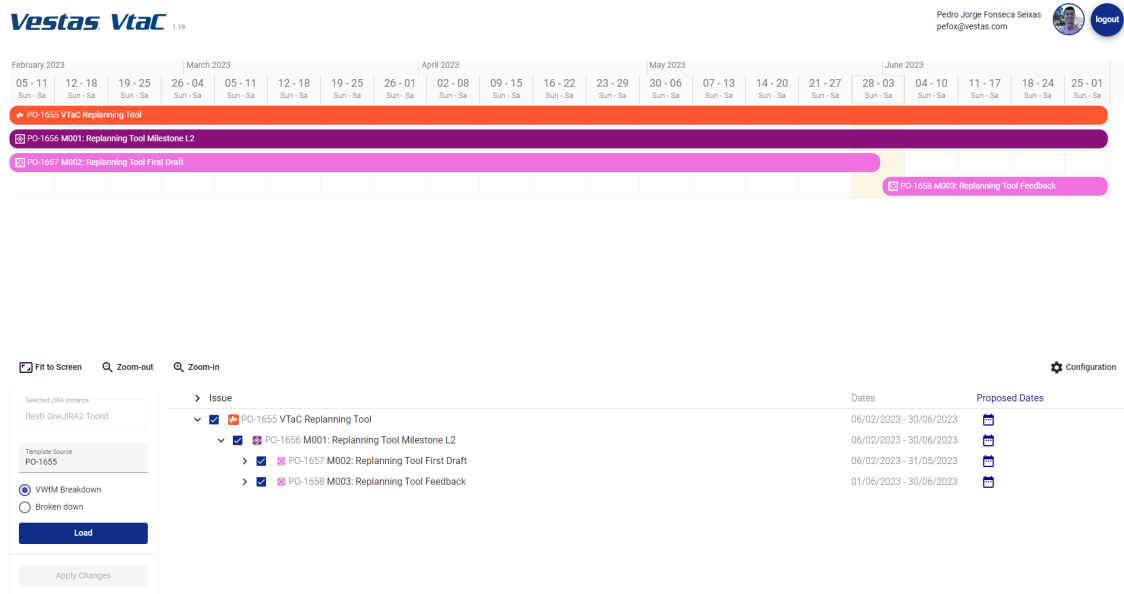


Figure 6.3: Replanning Tool User Interface.

Once the user agrees to these conditions, the tool applies the changes to the server through API calls, which update each altered task directly in Jira. The changes are reflected immediately, allowing team members to promptly view and react to the updated timeline.

This procedure for applying changes to Jira ensures that the new project timeline aligns with the company's project management procedures, respects the tool's limitations, and maintains the user's responsibility for the project's overall structure.

6.4 User Interface

The user interface of the replanning tool provides an intuitive and user-friendly experience, facilitating the project replanning process. Each process step corresponds to a specific interface section and can be seen in Appendix C and Figure 6.3.

Login

The login form (Figure C.1) is the first step in the replanning tool interface. Here, users select which Jira instance they want to login into — either the test or the production instance. Upon successful login, users gain access to the tool's features and can begin the replanning process.

Load Issues

Once logged in, the next step is to load the issues that need replanning through the form on the left sidebar (Figure C.2). Users can enter the unique Jira key of the issue they want to load on this form to load the underlying hierarchical structure of those issues from Jira into the tool. This

hierarchical structure is loaded following the issue links from one of the two linking structures presented in Figure 2.1 — *VWtM Breakdown* to follow the links focused on the delivery, and *Broken Down* to follow the links focused on the team.

Tree View

After loading the issues, users can visualize them in the tree view section (Figure C.3). This tree representation shows the issues' type, summary, and original and proposed/updated dates. Here, users have the option to manually update the dates if needed. This tree allows users to select which issues they want to display in the Timeline section.

Timeline

The timeline section (Figure C.4) provides a Gantt-like view of the selected issues. This feature allows users to personalize their view, only displaying relevant issues for more efficient replanning. Users can smoothly interact directly with the timeline by moving or resizing issues. Under the timeline, some configuration buttons are present to adjust the zoom and turn on/off the parent and children's behavior on an issue update.

Apply Changes

The final step in the replanning process involves applying the proposed changes to the Jira project. Users can commit the updates made in the tool to Jira by simply clicking on the *Apply Changes* button and accepting the consent conditions mentioned in section 6.3 (Figures C.5 and C.6).

With its intuitive and straightforward design, this user interface of the replanning tool ensures that users can effectively replan a project, making necessary adjustments and quickly reflecting them into their Jira projects.

6.5 Features and Benefits

The Replanning Tool is designed to address the complexities of project replanning, resulting in several distinct features that, in turn, bring many benefits to its users.

Standardized Process

One of the top features of the Replanning Tool is that it provides a standardized process for replanning, ensuring consistency across all levels of project management, whether it involves minor adjustments by a team member or significant directional shifts mandated by the company's top management.

This consistency helps to reduce confusion and ensures that every adjustment made within the project adheres to a common standard. Consequently, it aids in maintaining the integrity of the project's timeline and structure while improving efficiency in the replanning process.

Integration with Jira

The tool offers seamless integration with Jira, enabling it to pull real-time data for replanning and push updates directly to the Jira server. This feature allows stakeholders to access and update the most current project information at any given moment eliminating the need for manual data entry, thus reducing potential errors and saving considerable time.

Personalized Timeline View

Another key feature of the Replanning Tool is the personalized timeline view. Users can select the issues they want to focus on during replanning, creating a streamlined and tailored visual representation of the project timeline. This personalized view makes it easier to see the implications of changes on a specific subset of tasks, aiding in the formulation of effective replanning strategies. It also offers a clutter-free user experience promoting clarity in planning.

Automatic Update of Affected Issues

The Replanning Tool automatically proposes new dates for all issues affected by a change in another issue. Whether an issue has been moved or resized, the tool adjusts the timelines of related tasks to maintain the project's structure. This automation significantly reduces the manual labor involved in adjusting each related issue individually. It also helps to maintain the integrity and coherence of the project timeline, even when numerous changes are made.

These features collectively make the Replanning Tool a powerful aid in managing project timelines and coping with changes. It mainly enhances efficiency, maintains project coherence, and facilitates informed decision-making, all while offering a user-friendly interface that accommodates Vestas' specific needs. Mitigating the challenges associated with manual replanning ensures that projects stay resilient and adaptable in the face of shifting circumstances.

6.6 Testing and Validation

Extensive testing and validation exercises were carried out during the development period to ensure the Replanning Tool's functionality, usability, and efficiency met its objectives and provided value to its intended users.

The validation process was performed through periodic meetings with Project Managers and Product Planners (Appendix E.2). These stakeholders played an integral role in validating the tool's functionality and alignment with Vestas' project management processes. Besides collecting the tool's requirements from the stakeholder's inputs during these meetings, different scenarios were simulated, and the tool's behavior was observed so that the feedback could be incorporated into subsequent versions of the tool, making it more tailored to their needs.

User Feedback

The tool was distributed to various stakeholders within Vestas for hands-on testing after the first draft presentation in Meetings E.2.5 through E.2.10, and feedback was collected in Meetings E.2.11, E.2.12, and E.2.13. The feedback received from this user testing was extremely positive. Most users found the tool to be a significant improvement over manual updates, awarding its simplicity, user-friendly interface, and automated features.

However, the feedback was not only used for validation but also for improvement. Many users proposed enhancements that could make the tool even more beneficial. These suggestions were considered for future iterations of the Replanning Tool, ensuring that it continues to evolve according to users' needs and expectations.

Performance Evaluation

A series of performance evaluations were conducted to evaluate the effectiveness and efficiency of the Replanning Tool. These evaluations, presented in Meetings E.2.14, E.2.15, and E.2.16, were based on two exercises that simulated simplified real-world replanning scenarios that Project Managers and Product Planners at Vestas might encounter. The time to perform these tasks was measured for each of the three stakeholders with and without the Replanning Tool to evaluate the tool's effect on efficiency. In the following subsections, both exercises will be presented, each with the context and the task given to the stakeholders and its results.

The initial conditions under which the timers were started for both exercises are also worth noting. In the scenario without the tool, the timing started when the first issue was fully loaded on the browser within the Jira platform. On the other hand, with the tool, the timer started the moment the Replanning Tool was loaded, as it was essential to highlight that the time included the duration required to log into the application — an extra step that otherwise would not be necessary. These starting points were selected to give a comprehensive view of the time savings that can be achieved when using the Replanning Tool, as it includes the time taken to manipulate issues and the time to access the tool or platform.

Exercise 1

Context Your team has just finished the project's first milestone, Milestone 1, and you were about to start the second. However, due to some delay in a dependent delivery from another module, you must delay the next milestone, Milestone 2, for at least one month.

Tasks 1. Move Milestone 2, and consequently, the three epics inside it, for one month.

Illustration Figure 6.4.

The time to perform this task manually and with the Replanning Tool was measured and presented in Figure 6.5. The graph shows that the Replanning Tool significantly reduces the time

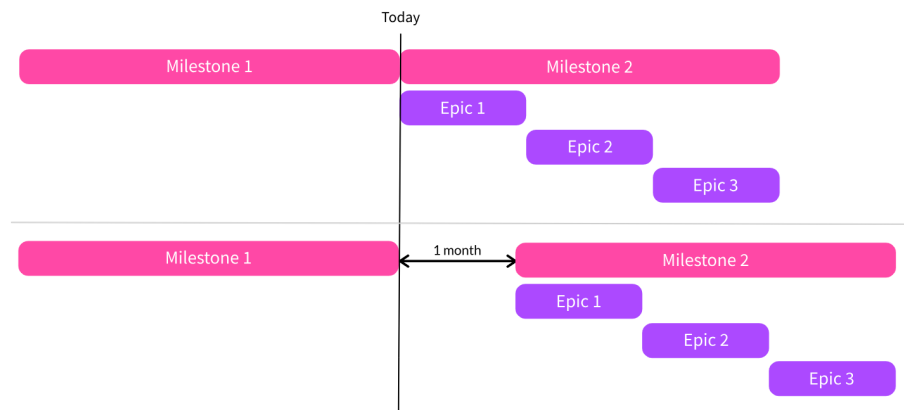


Figure 6.4: Exercise 1.

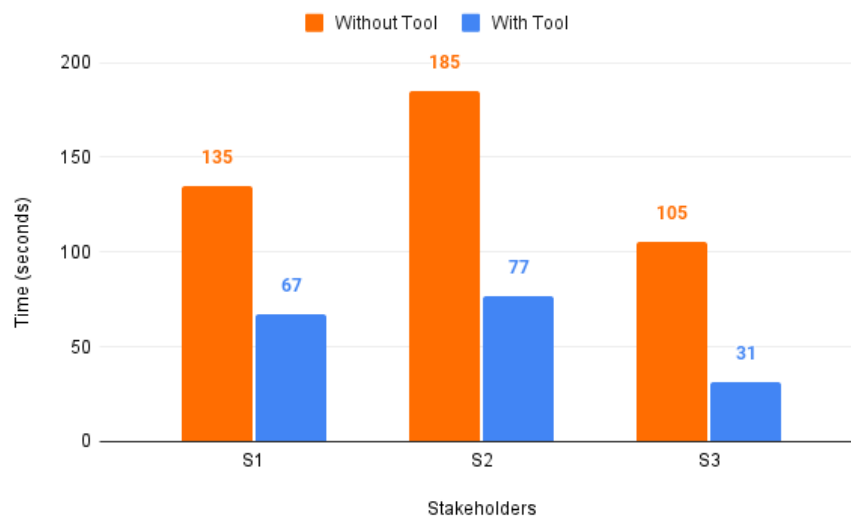


Figure 6.5: Exercise 1 Time Results.

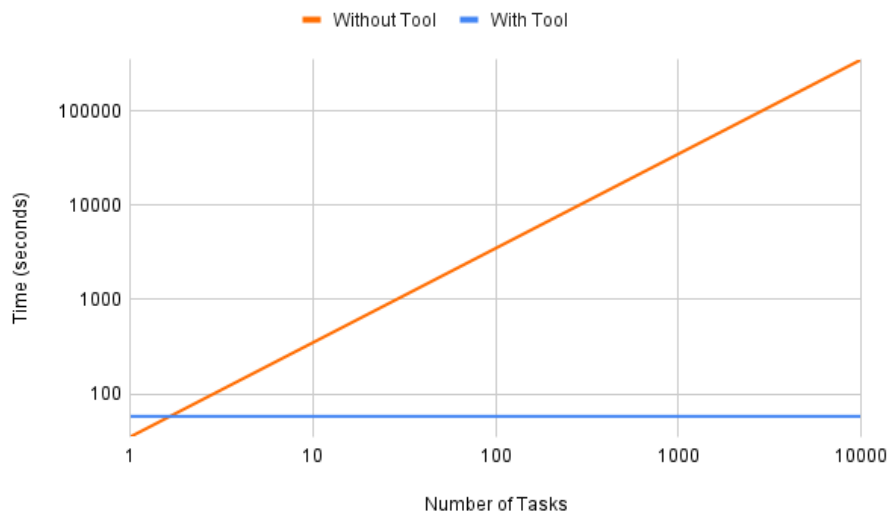


Figure 6.6: Moving Issues Trend Lines.

needed to perform this task. It does this by automating the updates of all associated issues when a milestone is moved, eliminating the need for manual adjustments.

In Exercise 1, the task involved moving a total of four issues. When performed manually without the Replanning Tool, this procedure required an average of 142 seconds, or approximately 2 minutes and 22 seconds, equating to an average time of around 35 seconds per issue.

On the other hand, when the Replanning Tool was employed for the same task, it took an average time of 58 seconds to move the issues, including the time taken to log into the application. This time was 2.4 times faster than the previous, resulting in 59% of time savings. If we consider only the time required for issue manipulation, discounting the login duration, the time taken is relatively similar to that of manual movement per issue.

The Replanning Tool truly shines in automatically updating the underlying issues. While this particular exercise involved only four issues and the time differences were not very significant, the tool's true potential becomes evident when we scale the task up to a typical project size, which often involves a series of milestones with thousands of issues each.

Following Figure 6.6, without the tool, the time required to update issues increases linearly with the number of issues involved. However, with the Replanning Tool, the time remains relatively constant for use cases that require only moving the issues. This demonstrates the time-saving efficiencies the tool can bring to larger-scale replanning procedures.

Exercise 2

Context You are planning a future project containing two milestones, Milestones 1 and 2. Each of those Milestones contains three epics, each lasting one month. Now you discovered that your team could deliver the epics from Milestone 1 in one sprint (two weeks) instead of the one month you have previously allocated.



Figure 6.7: Exercise 2.

- Tasks**
1. Update the duration of each epic inside Milestone 1 to two weeks.
 2. Update Milestone 1 start and end date to reflect the changes in the underlying epics, meaning, Milestone 1 start date is the start date of the first epic, and the end date is the end date of the last epic.
 3. Move Milestone 2 and the underlying epics dates to start when Milestone 1 ends.

Illustration Figure 6.7.

Again, the time taken to perform these tasks manually and with the Replanning Tool was compared. Figure 6.8 visually represents the time comparison. In this more complex scenario, the time-saving benefits of the Replanning Tool are even more pronounced. The tool drastically reduces the time and effort required to replan and update multiple associated issues by enabling automated updates of parent and child issues.

Exercise 2 was a more complex task, requiring the resizing of four issues and the movement of four additional issues. When performed manually without the aid of the Replanning Tool, this exercise took an average of 294 seconds, or approximately 4 minutes and 54 seconds, calculating an average time of around 37 seconds per issue, similar to the first exercise. However, it is worth noting that in this exercise, stakeholders typically spent less time physically updating the issues and more time calculating the specific dates to set for each issue due to the problem's increased complexity.

When using the Replanning Tool, the average time to complete the task was significantly reduced to just 71 seconds, or roughly 1 minute and 11 seconds, which is 4.1 times faster, resulting in 76% of time savings. With the tool, stakeholders were only required to update the two milestones to achieve the desired result, yielding similar time efficiency per issue as observed in Exercise 1.

In this type of exercise, where issues are resized, a crucial factor is the additional time needed to verify and adjust the timeline accordingly. This aspect of the task is more complex than simply

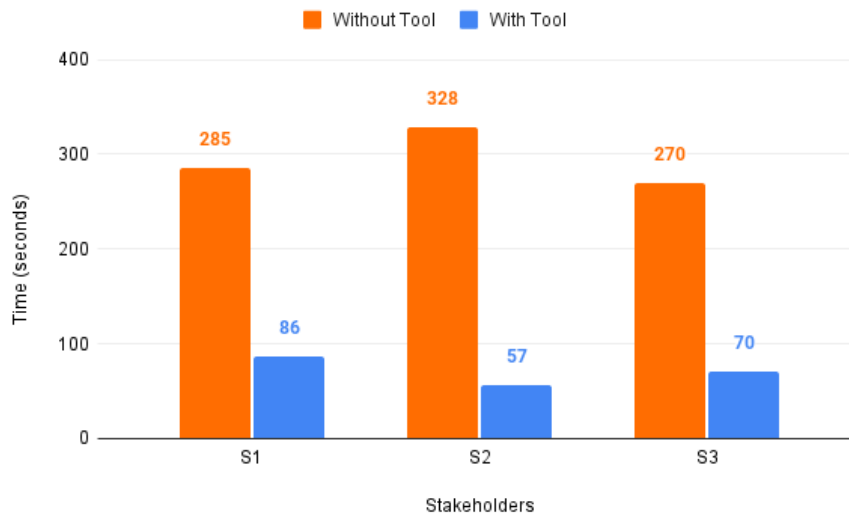


Figure 6.8: Exercise 2 Time Results.

moving an entire structure, as, in reality, proportional resizing does not always apply 100% of the time.

Let us estimate that we need an additional 4 seconds to verify each child issue in such instances. Even in such case, represented in Figure 6.9, the trend lines demonstrate the distinct time efficiency advantage offered by the Replanning Tool, resulting in one order of magnitude difference in times when comparing both situations. Despite the complexities of resizing and moving issues, the tool significantly reduces the time spent per issue when the tasks are scaled to the size of real-world project management challenges. This underlines the considerable potential and benefits that the tool brings to the project replanning process.

Through these exercises, it is evident that the Replanning Tool offers significant time-saving advantages, especially in scenarios with multiple interconnected issues that need to be updated. In the first exercise, the tool delivered an impressive time-saving benefit of 59%. This improved further in the second exercise, where the tool cut the time expenditure by 76%. Moreover, these savings increase with the size and complexity of the replanning situation, suggesting an even higher potential for efficiency in more demanding project scenarios.

The tool simplifies the replanning process and minimizes the risk of errors that could occur during manual updates. This substantial time reduction, coupled with the decreased error potential, dramatically enhances the efficiency and effectiveness of project management at Vestas, making the Replanning Tool a significant step forward in Vestas's project replanning strategy.

6.7 Summary

This chapter provided a comprehensive overview of the Replanning Tool, a solution designed to optimize and streamline the project replanning process at Vestas. It addressed the unique chal-

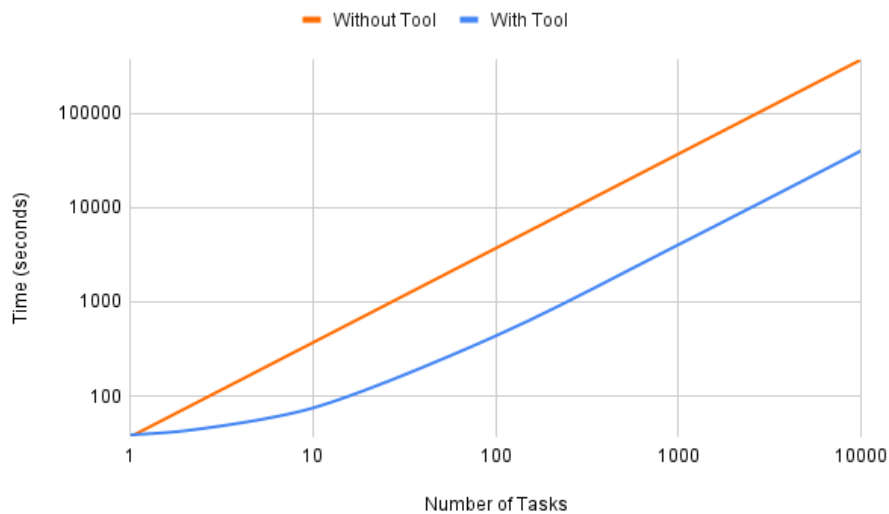


Figure 6.9: Resizing Issues Trend Lines.

allenges of replanning at different levels (A, B, and C) and introduced a standardized process for each, minimizing confusion and promoting efficiency.

Requirements were detailed, establishing the critical functionality needed for the tool to meet the needs of its users. Then, its architecture was described, demonstrating how it leverages the VTaC Tool's established connection with the Jira API to facilitate seamless data exchange and real-time access to project data. The user interface was discussed, emphasizing its user-friendly and clutter-free design that gives users a personalized view of the project timeline. Finally, Performance evaluations showed the tool's effectiveness in significantly reducing the time taken for replanning tasks, especially in scenarios involving thousands of issues.

Overall, the Replanning Tool is a powerful solution, bridging the gap between project managers and planners and promoting a more efficient, user-friendly replanning process.

Chapter 7

Work Package Catalog

At Vestas, project planning regularly involves creating entire structures from scratch — a time-consuming task that reduces productivity, mainly when similar structures have been used in the past. The Work Package Catalog was developed to address this issue by leveraging existing project structures and integrating them in a template repository, so they can easily be reused in new initiatives.

The following chapter comprehensively examines this Work Package Catalog tool, diving into its conception, design, functionality, and benefits. The tool's specific requirements are detailed in Section 7.1, its architecture is explained in Section 7.2, and the vital implementation aspects are presented in Section 7.3. The user interface is discussed in Section 7.4, and the tool's features and benefits are presented in Section 7.5. Lastly, the chapter concludes with the testing and validation process of the tool in Section 7.6.

7.1 Requirements

The source of the Work Package Catalog tool was an idea of the Project Planning & Execution team at Vestas. With a proactive approach, this team organized several meetings with various stakeholders, especially Project Managers, over a few weeks to determine the critical issues that required solutions. This information was acquired during Meeting E.3.1, gathered by a specialist dedicated to consolidating feedback from these stakeholders. These insights served as a foundation to define the requirements for the Catalog tool, which were then revisited in Meeting E.3.2 to ensure the developed tool would meet the users' actual needs. The final requirements can be seen in Table 7.1.

In this implementation, catalog maintenance was a relevant topic that needed attention. Each module/sub-module needed someone responsible for maintaining and overseeing the catalog, approving or removing new items based on their relevance to future projects. Catalog Owner is the name of the role attributed to this responsibility that will be used from now on.

Catalog Owners are charged with maintaining and updating the work package catalog. They needed a flexible and dynamic catalog that enabled them to modify existing templates, including

Table 7.1: Work Package Catalog Requirements

Key	Name	Stakeholder	Priority	Description
CAT-1	Catalog Maintenance	Catalog Owner	High	Catalog Owners should be able to add, edit, or remove templates as needed.
CAT-2	Catalog Visibility	Project Manager	High	Project Managers should have visibility of the catalog specific to their sub-modules.
CAT-3	Issue Selection	Project Manager	High	Project Managers should be able to include only relevant issues from the template.
CAT-4	Milestone Connection	Project Manager	High	Project Managers should be able to connect Epics to Milestones through their ID.
CAT-5	Project Estimates	Project Manager	High	Project Managers should be able to estimate projects in a bottom-up approach.
CAT-6	Timeline View	Project Manager	High	There should be a timeline view to visualize and make additional changes in the project plan.
CAT-7	Project Update	Project Manager	High	Project Managers should be able to update the Jira project based on the plan developed in the tool.
CAT-8	Catalog Adaptability	Catalog Owner	Medium	Catalog Owners should have the ability to approve or remove new items created by Project Managers.
CAT-9	Issue Addition	Project Manager	Medium	Project Managers should have the ability to add new issues on the fly.
CAT-10	Version Selection	Project Manager	Low	Project Managers should have the capability to select a specific template version.

adding, editing, or removing templates as needed, ensuring that the templates stay relevant and applicable to new project plans. One of the essential requirements from the Catalog Owners is the ability to manage issues added by project managers, as this will allow them to ensure these issues are correctly integrated into the templates.

On the other hand, Project Managers are catalog users, formulating new project plans based on the templates. They require visibility of the templates specific to their sub-modules, providing a baseline for their planning. They also request the capability to select a specific template version, allowing them to choose the most suitable for their unique use case. A significant need is the ability to add new issues on the fly, a feature that allows them to tailor the plan to the specific tasks of the current project. Furthermore, project managers seek to include only relevant issues from the template, ignore irrelevant ones, and have access to high-level and detailed estimates for their projects. The requirements also underline the necessity of a timeline view for final changes and the ability to update the Jira project based on the plan developed in the tool.

7.2 Architecture

The Work Package Catalog tool builds upon the architecture of the replanning tool, inheriting its fundamental structure. The architecture of the Work Package Catalog tool, presented in Figure 7.1, is well-integrated into the existing VTaC platform, which forms the backbone of this solution.

Much like the replanning tool, the Catalog tool architecture follows a similar scheme: the frontend, backend, and database components interact through HTTP requests, with the use of the Atlassian .NET SDK within the backend, serving as a bridge for the catalog's integration with Jira.

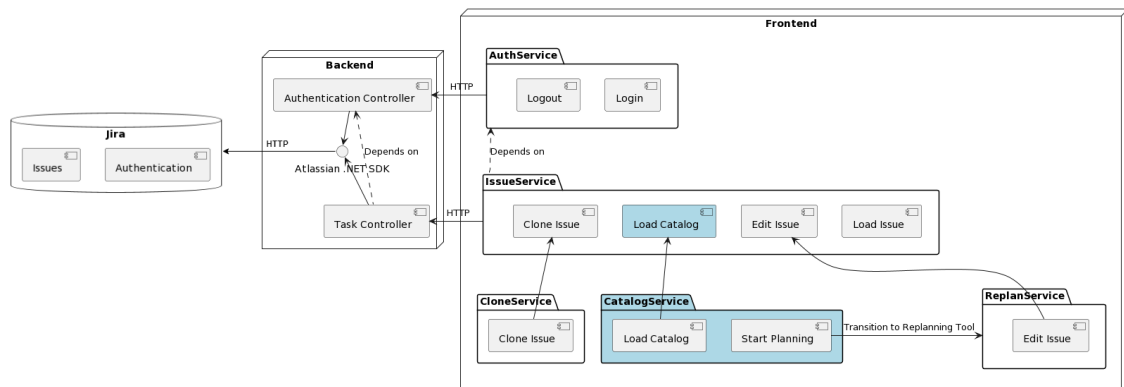


Figure 7.1: Work Package Catalog Architecture.

The architectural components highlighted in blue within the diagram represent the new modules integrated into the application for the tool's functionality. These components have been incorporated to fetch and manage the catalog data from Jira, making it an indispensable part of the tool's infrastructure.

By adopting a similar architectural approach as the replanning tool, the catalog tool leverages the benefits of a familiar structure while adding the necessary modules for its distinct functionality.

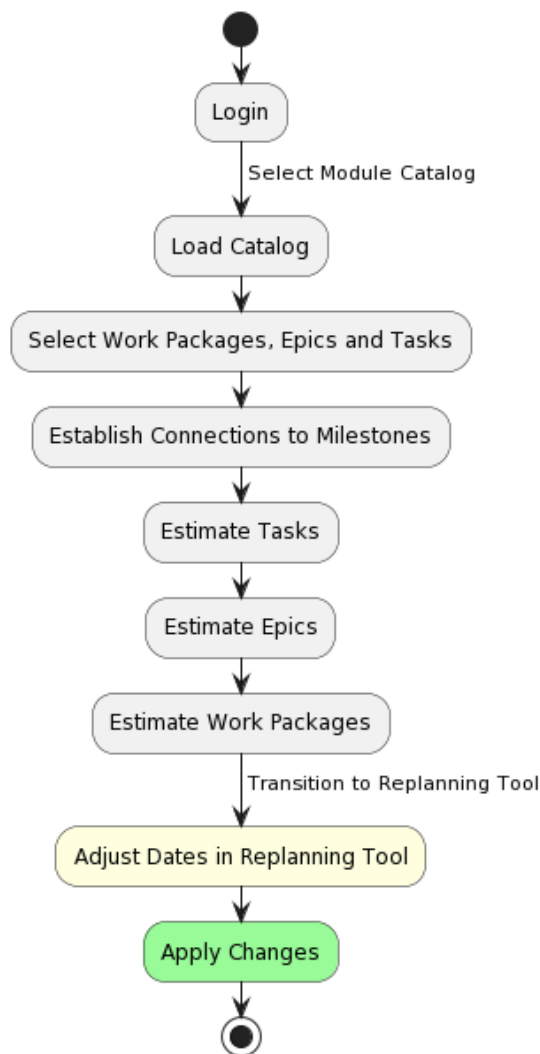


Figure 7.2: Work Package Catalog Activity Diagram.

This strategy ensures the smooth operation of the tool, providing users with an efficient and user-friendly platform for managing project structures.

7.3 Implementation Aspects

This section delves into the implementation aspects of the Work Package Catalog, exploring the application workflow and the utilization of historical data, providing a comprehensive overview of how the Work Package Catalog delivers value to Vestas' project planning process.

Application Workflow

The application workflow, presented in Figure 7.2, was designed with an intuitive user experience in mind, guiding the user through each step of the planning process.

1. **Login:** The user first logs into the system so the application can retrieve data from Jira.
2. **Select Module Catalog:** The user chooses the appropriate catalog based on their specific project needs. The catalogs are pre-loaded with templates for different types of projects.
3. **Load Catalog:** The selected catalog is loaded into the system, presenting the user with an array of work packages, epics, and tasks relevant to their chosen module.
4. **Select Issues:** The user then filters through these elements, selecting those relevant to the new project. The work packages, epics, and tasks are chosen/created on the fly to align with the project's objectives.
5. **Establish Connections to Milestones:** After selecting the necessary elements, the user must establish connections from each epic to the project's milestones. This step is crucial in tying together the two structural views: one focused on the delivery, and the other focused on the team (Figure 2.1).
6. **Estimate Tasks:** Using the pre-loaded and historical data, the user can estimate the hours required to complete each selected task, creating an initial rough estimate for the epics.
7. **Estimate Epics:** The user then estimates the epics based on the task estimates, creating a higher-level view of the project timeline.
8. **Estimate Work Packages:** The user estimates the work packages, encompassing multiple epics. This is the final step in creating the project's timeline and estimating the resources necessary for completion.
9. **Adjust Dates in Replanning Tool:** With all the estimates and structure ready, the user transitions to the Replanning Tool to adjust the plan dates, ensuring the project is realistic and achievable with the available resources.
10. **Apply Changes:** After final adjustments, the user applies the changes, and the updated project plan is ready to be executed.

The workflow ensures a structured, systematic approach to project planning, leveraging pre-existing templates and allowing users to adjust plans to their specific project needs.

Historical Data

This tool's integration of historical data offers a significant advantage in the project planning process by allowing the catalog to leverage data from previously completed projects to improve the accuracy of future estimates.

This data usage is achieved using a new Jira field to represent the catalog tag. Every task, epic or work package completed, can be associated with a catalog entry by its tag. Later, when a new

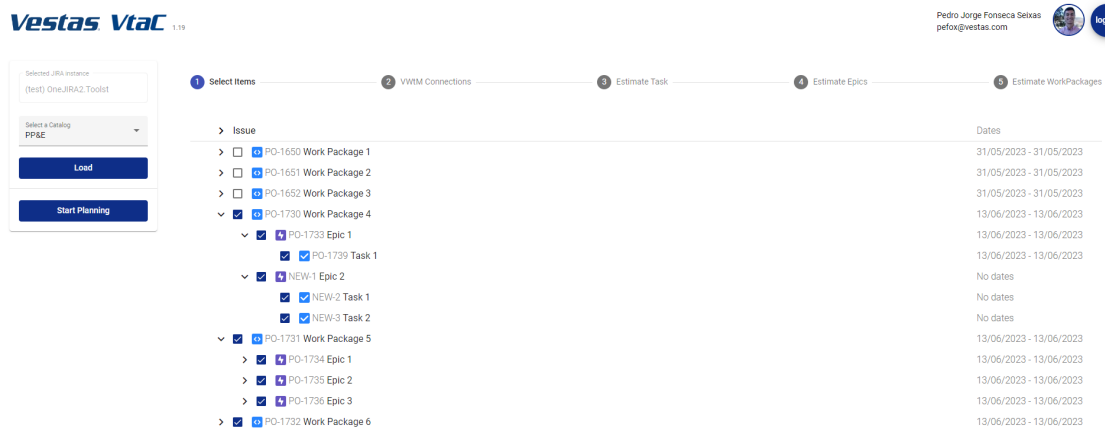


Figure 7.3: Work Package Catalog User Interface.

project is in the estimation phase, the user can quickly scan for every instance in which an issue has been completed in past projects, identified by searching for its corresponding tag.

This analysis exemplifies how similar tasks have been handled previously, including the time required to complete them and the resources consumed. Consequently, this allows the user to make more accurate and realistic estimates for the current project.

As more projects are completed and their data is added to the historical database, this feature's value will continue to grow, as the tool's ability to provide reliable estimates will improve, enhancing its effectiveness. Furthermore, this historical data analysis not only assists in setting accurate project estimates but also helps to identify frequently encountered issues. Such insights can lead to preemptive actions and smoother project executions in the future.

7.4 User Interface

The user interface of the Work Package Catalog tool is designed to be straightforward, guiding users through the project planning process step by step. Figure 7.3 and Appendix D contain screenshots from each of the steps.

Load Catalog

The first step is to load the catalog of the desired module/sub-module (Figure D.1). This is the initial step of the planning process, where the user fetches the relevant project structures from Jira to be reused for the new project.

Select Issues

The next step involves selecting issues through a tree view of the catalog (Figure D.2). The user can select which Work Packages, Epics, and Tasks to include in the new project. Moreover, the

tool allows users to add new items on the fly by hovering over any item and clicking the plus sign on the right.

Establish Connections

At this stage (Figure D.3), the epics are grouped by work package, and the user can introduce the milestone ID for each epic to connect it to a previously created milestone. This step ensures a comprehensive and well-structured project plan, following Vestas' way of structuring projects shown in Figure 2.1.

Estimate Tasks

In this step (Figure D.4), tasks are grouped by epic, and the user can estimate the number of hours each task needs to be completed. The user can also edit the start and end dates of the tasks at this stage. Although these dates will later be edited with more precision, this step provides a preliminary estimation of the duration of each task and an overall estimate of how many hours each epic will need.

Estimate Epics

This step is similar to the previous one but operates at the epic level (Figure D.5). Epics are grouped within work packages, and with the information from the previous step, users can estimate how long each epic will take. This step provides an overall estimation of the resources required for each work package.

Estimate Work Packages

The last step of the estimation process involves estimating work packages based on the information gathered in the previous steps (Figure D.6). It provides an overview of the resources needed for the entire project, ensuring that users comprehensively understand the project's scope and requirements before moving forward.

Start Planning

With the estimates complete, users can click the *Start Planning* button to transition to the Replanning Tool presented in Chapter 6. Here, users can finalize editing the start and end dates in a more user-friendly interface, ensuring the project plan is detailed and precise.

The user interface's step-by-step design significantly simplifies the project planning process, making it more accessible and less time-consuming for users. By leveraging existing project structures and providing easy customization options, the Work Package Catalog tool enhances the efficiency of project planning at Vestas.

7.5 Features and Benefits

The Work Package Catalog tool combines features designed to streamline and enhance project planning at Vestas. The capabilities of this tool result in several key benefits that align with the company's objectives. This section provides a detailed exploration of the critical features of the tool and the benefits they offer.

Catalog Repository

The central part of the Work Package Catalog tool is a repository of project templates. This feature offers users a catalog of existing project structures that can be reused when initiating new projects. The key benefit of such a repository is that it significantly reduces the effort and time to create project plans. Project managers no longer need to start from scratch because they can pull from previously successful project structures and tailor them to fit the current project's needs. This feature streamlines the planning process and fosters consistency in project planning across the organization.

Flexible Templates

In addition to storing templates, the Work Package Catalog tool facilitates their flexibility by allowing the catalog owners of each module to add and edit templates, ensuring it stays up-to-date with the organization's requirements. By allowing modules to update their templates, the tool promotes continuous improvement in project planning, making the process more efficient and aligned with project outcomes. Furthermore, it promotes the reuse of successful project structures, contributing to more effective and efficient project planning.

Historical Data

The Work Package Catalog tool is designed to use historical data when setting up new projects through a new tag field in Jira. With this field, the user can view every instance of a similar issue in other projects and estimate based on that information. The key benefit of this historical data is the estimates' increased accuracy as time passes and more projects are completed, improving the tool's planning capabilities and resulting in more efficient resource allocation and improved project timelines.

Transition to Replanning Tool

Once the initial project structure and estimates are in place, users can effortlessly transition data to the Replanning Tool to make final adjustments to the project plan. This feature ensures a complete project planning process. It bridges the gap between selecting the structure and estimating the necessary resources to plan its dates and create an accurate timeline, leading to an improved project plan and better project outcomes and deliveries.

In summary, the Work Package Catalog offers powerful features that collectively enhance the efficiency of the project planning process, reduce redundancy, and improve the accuracy of project estimates. Over time, it will result in improved project outcomes, higher productivity, and significant cost savings.

7.6 Testing and Validation

The Project Planning & Execution team initially validated the Work Package Catalog idea through stakeholder meetings (Appendix E.3). This initial concept was pivotal in identifying potential flaws and areas of improvement, giving the team a chance to refine the concept early in the development process. The feedback from these meetings was highly optimistic and demonstrated the tool's potential, thus providing the opportunity to continue with the development within the scope of the dissertation.

The development process was straightforward, with the requirements clearly defined and the concept approved. The knowledge from stakeholder meetings and the insights gained from the initial validation to guide the development of the tool helped to develop each feature to meet the needs of the stakeholders, ensuring that the final product would align with the expectations set during the validation process.

The validation phase concluded with a final presentation to the stakeholders, where they saw the tool's full potential and provided feedback based on their experience. Although some improvements were identified during this review, the general feedback was very optimistic. The stakeholders recognized the tool's ability to simplify the project planning process, highlighting its user-friendliness and efficiency. The constructive feedback received during this validation phase, including Meetings E.3.3, E.3.4, E.3.5, and E.3.6, was instrumental in further refining the tool, ensuring its readiness for full deployment, and maximizing its potential impact on the project planning process.

7.7 Summary

This chapter delved into the development of the Work Package Catalog tool, an innovative solution designed to optimize the project planning process within Vestas. The tool addresses a significant challenge project planners face: the need to regularly construct entire structures from scratch, despite the potential to reuse components from past projects. The Work Package Catalog tool was devised to simplify this process, promoting efficiency and effectiveness in project planning.

The critical aspects of the tool, including the requirements, architecture, implementation aspects, user interface, and features and benefits, were discussed in depth. The tool's architecture builds on the existing structure of the Replanning tool, incorporating additional components to facilitate fetching catalog data from Jira. Its user-friendly interface allows for the easy selection and estimation of tasks, epics, and work packages, leading to a more accurate view of project resources. The tool offers numerous features, such as template flexibility, historical data utilization,

and project structure reusability, which provide substantial benefits for both Catalog Owners and Project Managers.

The chapter culminated in validating the tool through stakeholder meetings, where it received positive feedback and suggestions for further improvement. In conclusion, the Work Package Catalog tool presents a promising solution for project planning at Vestas, promising a future of efficient and accurate project plans.

Chapter 8

Conclusions and Future Work

This final chapter reflects upon the challenges identified, the solutions designed and implemented, and the impacts and future implications of these solutions. The problem set out to solve applies to three critical stages in the project life cycle at Vestas: project creation, prioritization, and replanning. The solution was the development of three unique tools – the Portfolio Prioritization Tool, the Replanning Tool, and the Work Package Catalog – each designed to target specific challenges. These tools are revisited in Section 8.1, their impact on the company is discussed in Section 8.2, and some future improvements are also suggested in Section 8.3.

8.1 Conclusions

Addressing the critical issues in the Vestas' project life cycle required a multifaceted approach. The development of a set of innovative tools was initiated, with each one targeted at a specific stage of the life cycle, and combined, these tools offered a comprehensive solution.

The Portfolio Prioritization Tool (PPT) was designed to respond to the problems found in the prioritization process. This tool incorporates many different factors, such as project cost, potential revenue, alignment with strategic objectives, and risk level, to provide a robust ranking of projects using a weighted scoring model. Through this ranking, decision-makers at Vestas can now make informed and strategic choices regarding which projects to prioritize. This has made the prioritization process more transparent and facilitated an alignment of projects with strategic objectives, thus, enhancing the overall portfolio management process.

The Replanning Tool significantly enhances the replanning process at Vestas. It creates a standardized process applicable across all replanning levels, ensuring uniformity throughout the organization. A vital attribute of this tool is its ability to automatically update affected issues in response to any change, reducing manual intervention and ensuring timely adjustments, which are quickly reflected in the project management platform upon user approval. The tool is distinguished by its user-friendly and customizable interface, facilitating straightforward navigability and enabling users to make necessary adjustments in the timeline effortlessly. This, in turn, optimizes the user experience and promotes regular utilization, ultimately streamlining the project

replanning process. In essence, the Replanning Tool is an excellent addition to Vestas's project management process, contributing significantly to the efficiency and effectiveness of project replanning.

The Work Package Catalog was developed to ease the project initiation phase by offering a catalog of project templates. This repository reduces the need of constructing project plans from scratch each time, instead promoting the reuse of effective work packages, epics, and tasks based on historical data. This saves considerable time and ensures that project estimates are more accurate, as they are grounded in actual project experiences. By fostering consistency and reducing the time spent creating new structures, the Work Package Catalog allows project managers to focus on refining project-specific details, thus enabling a more efficient and reliable project initiation process.

In conclusion, the PPT provides a strategic solution to project prioritization; the Replanning Tool mitigates the challenges associated with project replanning and the Work Package Catalog streamlines project initiation. Each tool, in its own right, brings a degree of efficiency and effectiveness to the respective project stage it addresses. However, their collective implementation promises a profound improvement in Vestas's project management.

8.2 Impact on Project Planning and Replanning at Vestas

Introducing these tools in Vestas' project lifecycle substantially improves efficiency, accuracy, and consistency. They provide a precise solution to address the pain points of each phase, ensuring the project's alignment with the company's strategy, reducing the likelihood of errors, and providing a more accurate estimation of project duration, resources, and costs.

The Portfolio Prioritization Tool is set to bring meaningful change within Vestas. Beyond the support from the Vice President of Strategic Planning, who recognizes the potential to be widely used across the company, the PPT stands to enhance project prioritization. By systematically accounting for crucial project variables, the PPT offers an objective method for ranking, ensuring an informed, strategic selection of projects. It improves decision-making, enabling the alignment of projects with strategic objectives and, consequently, enriching the overall portfolio management process. The Vice President's intent to showcase this tool in an upcoming event, Vestas Tech Days — where the best practices and initiatives are presented company-wide, all around the world — further underlines its significance, potentially setting a new standard for project prioritization within Vestas.

The Replanning Tool offers a transformative change to the way Vestas undertakes project replanning. In the simplified analysis, the tool delivered significant time-saving benefits. More importantly, these time savings are expected to increase with the complexity of the problem. Given the scale of operations at Vestas and the labor cost, these time savings could be exceptional, potentially translating into millions of euros saved by the company.

As for the Work Package Catalog, the tool is expected to make the initiation stage of projects much smoother by allowing for a faster and more accurate initial project plan. This is of considerable importance because a more precise initial plan means fewer requirements for replanning, thus reducing the resources allocated to that process. The tool shortens the project initiation phase and reduces the overall time and resources spent on replanning, contributing to substantial resource optimization.

In conclusion, the tools developed — Portfolio Prioritization Tool, Replanning Tool, and Work Package Catalog — all cater to a particular aspect of the project life cycle. However, together, they streamline and standardize processes, enhance efficiency, and, more importantly, have the potential to bring about substantial financial savings. These tools hold immense potential to improve Vestas's operations and significantly impact the company's productivity and financial health.

8.3 Future Work

While significant improvements have been made to the planning quality at Vestas through the development of the tools mentioned above, there is always room for growth and enhancement. After establishing the stability of each tool by designing integration tests and encouraging users to use and examine these tools for potential flaws, many additional functionalities can be added to further meet the needs of the various stakeholders involved.

For the Portfolio Prioritization Tool, the following enhancements can be considered:

Include New Factors Future tool iterations could include additional factors to add more dimensions to the score function. These factors could reflect evolving business strategies or emerging industry trends, ensuring the tool stays relevant in prioritization.

Include New Visualizations Decision-makers could better interpret and analyze the prioritized project list by creating and combining new visualization options.

Regarding the Replanning Tool, potential improvements can be:

Include Resource Availability The tool could be improved by integrating information about the availability of team resources during the project planning stage. This enhancement would ensure that the replanning process considers the team's realistic capacity, leading to more achievable project plans.

Include Dependencies Considering dependencies between different projects and tasks during the replanning process, the tool could create a more coherent and integrated project plan, minimizing conflicts and enhancing efficiency.

Include Task Status Accounting for the current status of tasks during the replanning phase can add further refinement to the replanning process. This would allow the tool to provide updated project plans that are fully aware of ongoing progress. An example of where this

feature would be helpful would be when a project has to be resized, but some tasks have already been closed. These closed tasks should not be updated, as they have already been completed.

Potential improvements for the Work Package Catalog include:

Introduce Tag Field in Jira Adding a new field in Jira to use historical project data for better project estimation represents an important future step. This feature wasn't implemented within the scope of this dissertation due to the extensive procedures required to modify the project management software. However, its potential value for project initiation and planning makes it a promising future addition.

Include Dependencies Lastly, including dependencies within and between catalogs could offer project managers the ability to build more comprehensive project plans. Understanding these dependencies would allow for better sequencing of tasks and, thus, a more accurate and realistic project timeline.

In summary, while the tools developed as part of this work have significantly enhanced Vestas's planning quality, there are still several opportunities to further refine these tools and increase their value. This future work should not only focus on the continued enhancements and optimizations of these tools but also on establishing measures for their successful adoption within the company's workflow. It is essential to provide support and training, enabling the teams to integrate these tools effectively into their daily tasks and ensuring their potential is fully achieved, contributing significantly to Vestas's productivity and success.

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Appendix A

Initial PPT User Interface

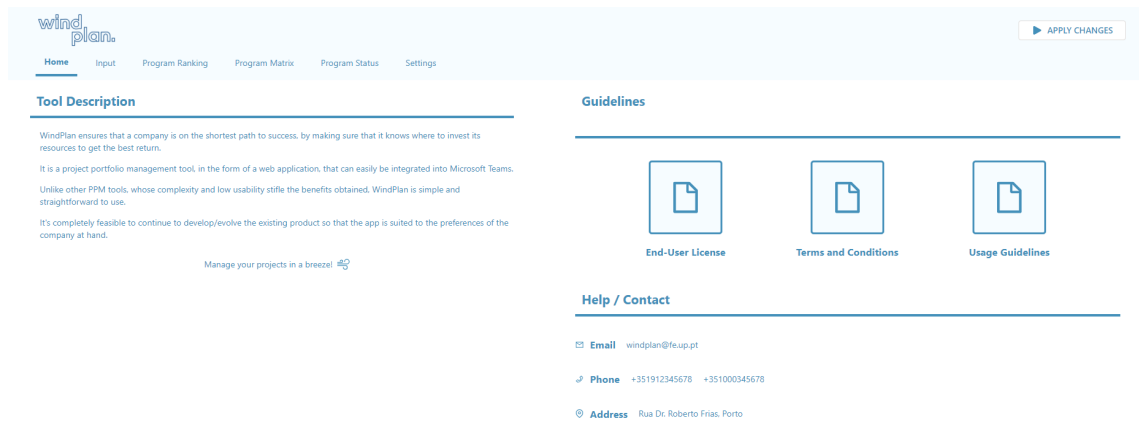


Figure A.1: Initial PPT Home tab.

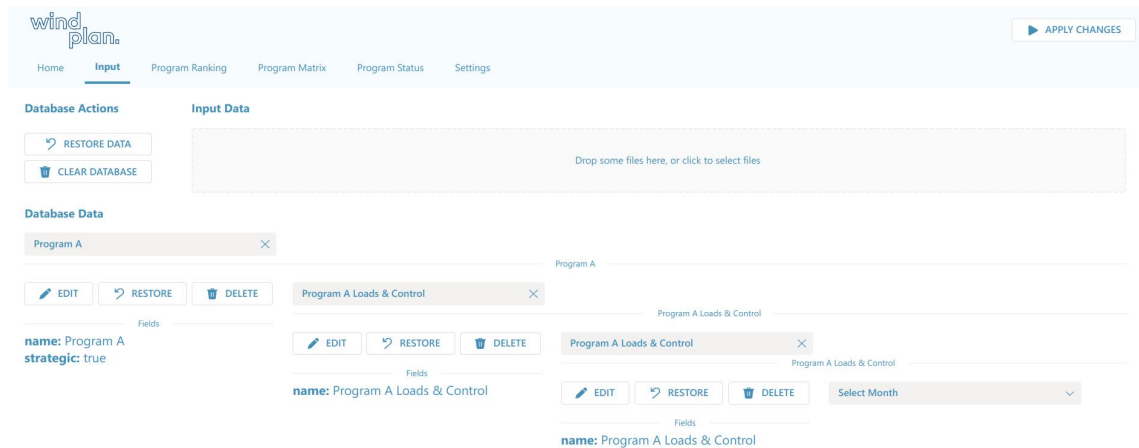


Figure A.2: Initial PPT Input tab showing the program hierarchy.

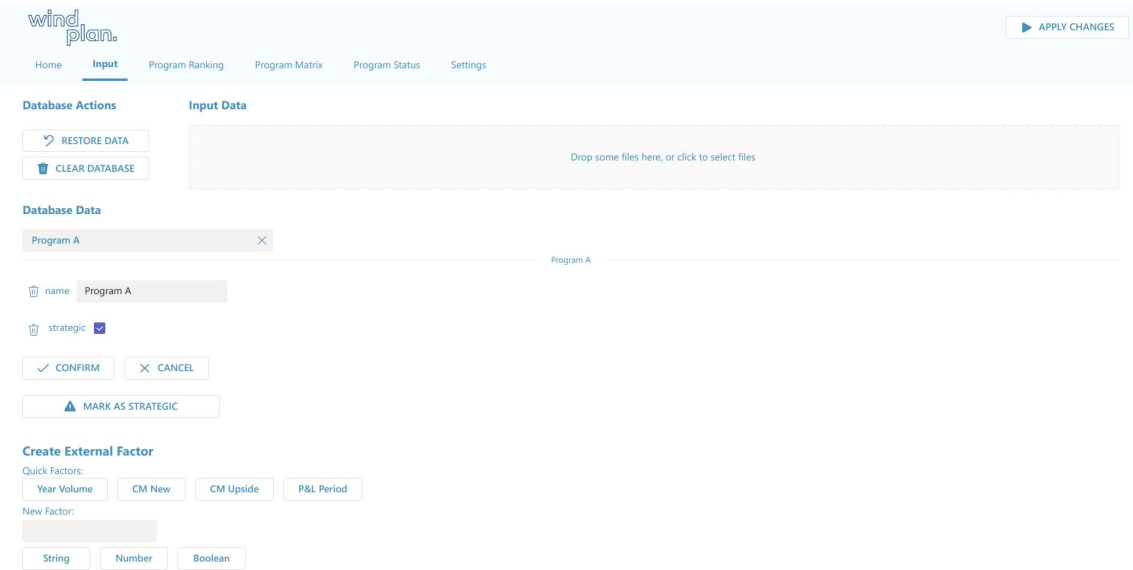


Figure A.3: Initial PPT Input tab editing a program.

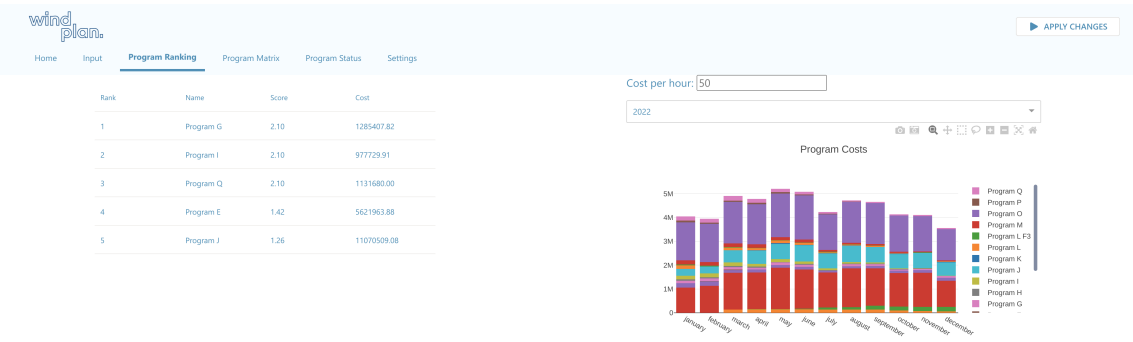


Figure A.4: Initial PPT Program Ranking tab.

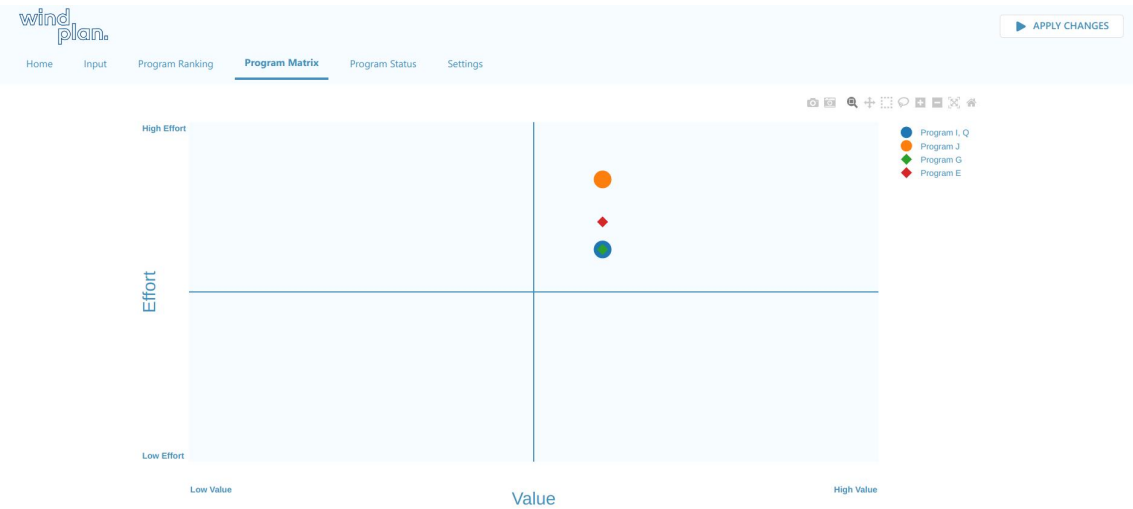


Figure A.5: Initial PPT Program Matrix tab.

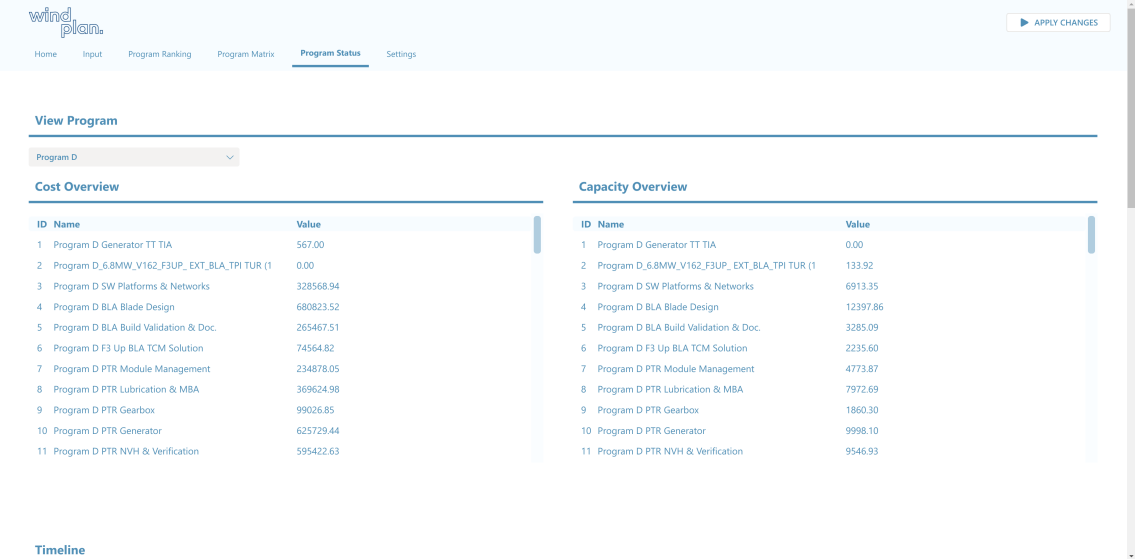


Figure A.6: Initial PPT Program Status tab comparing Cost and Capacity.

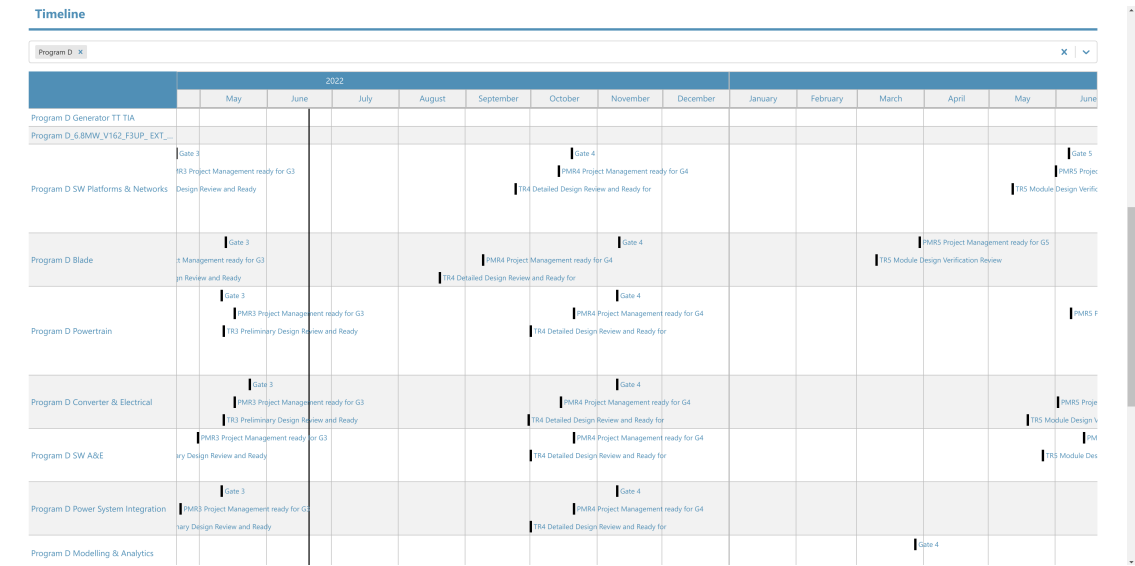


Figure A.7: Initial PPT Program Status tab comparing Timelines.

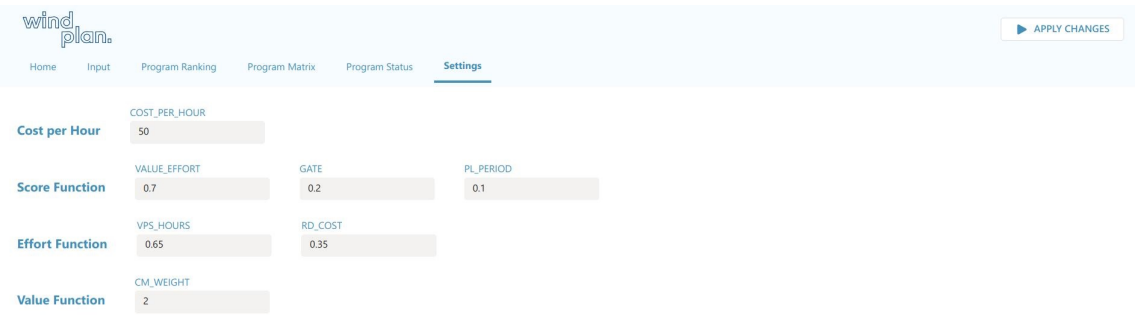


Figure A.8: Initial PPT Settings tab.

Appendix B

PPT User Interface

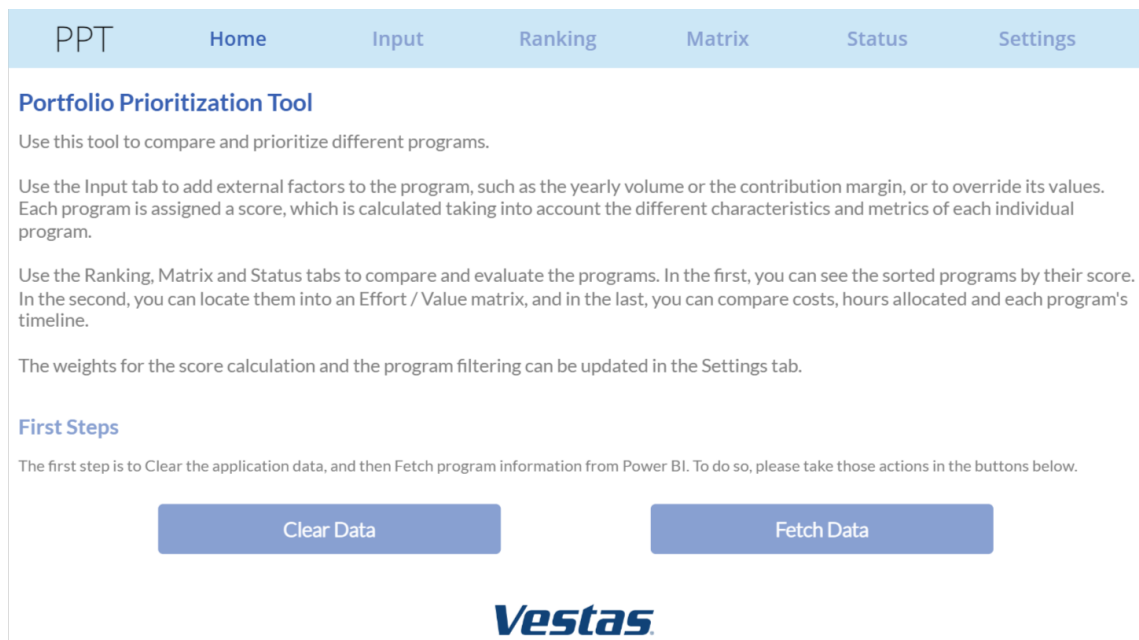


Figure B.1: PPT Home tab.

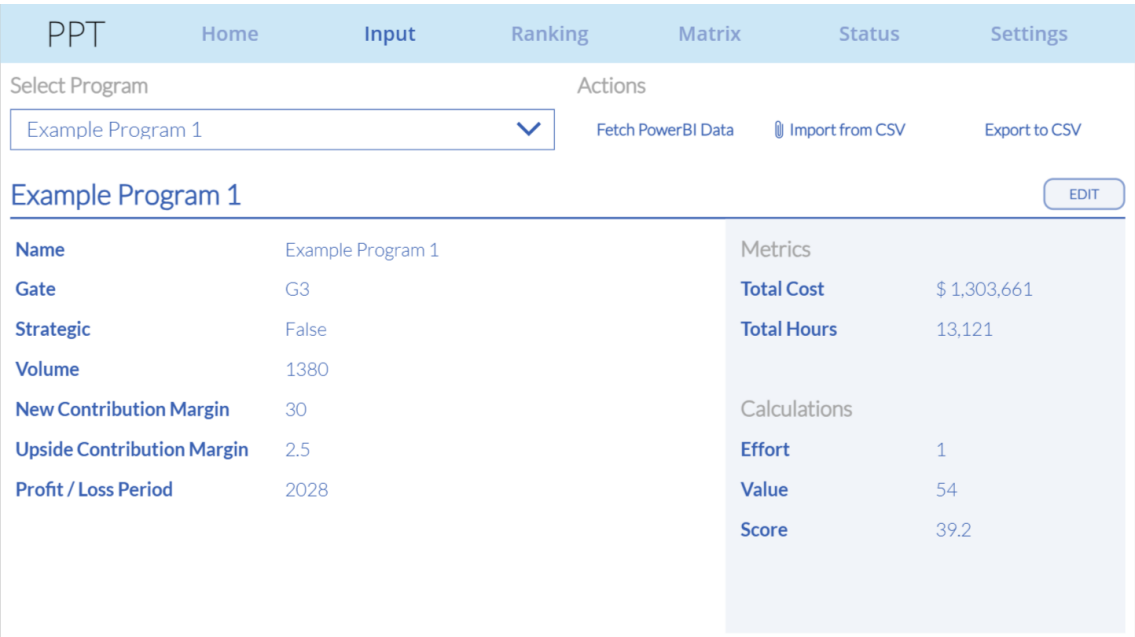


Figure B.2: PPT Input tab.

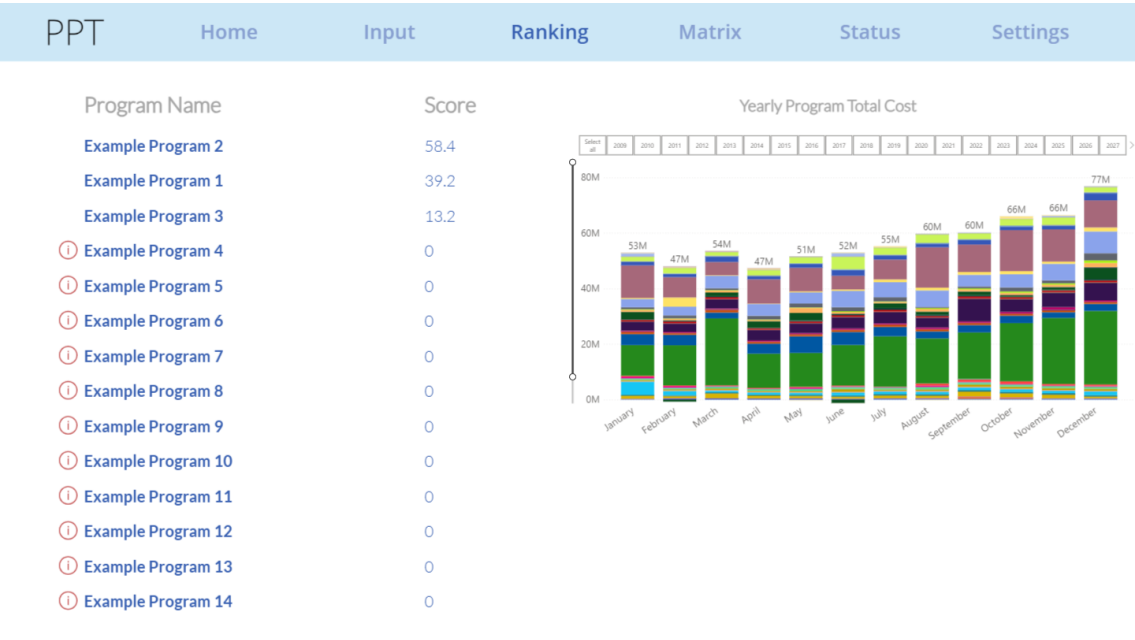


Figure B.3: PPT Program Ranking tab.

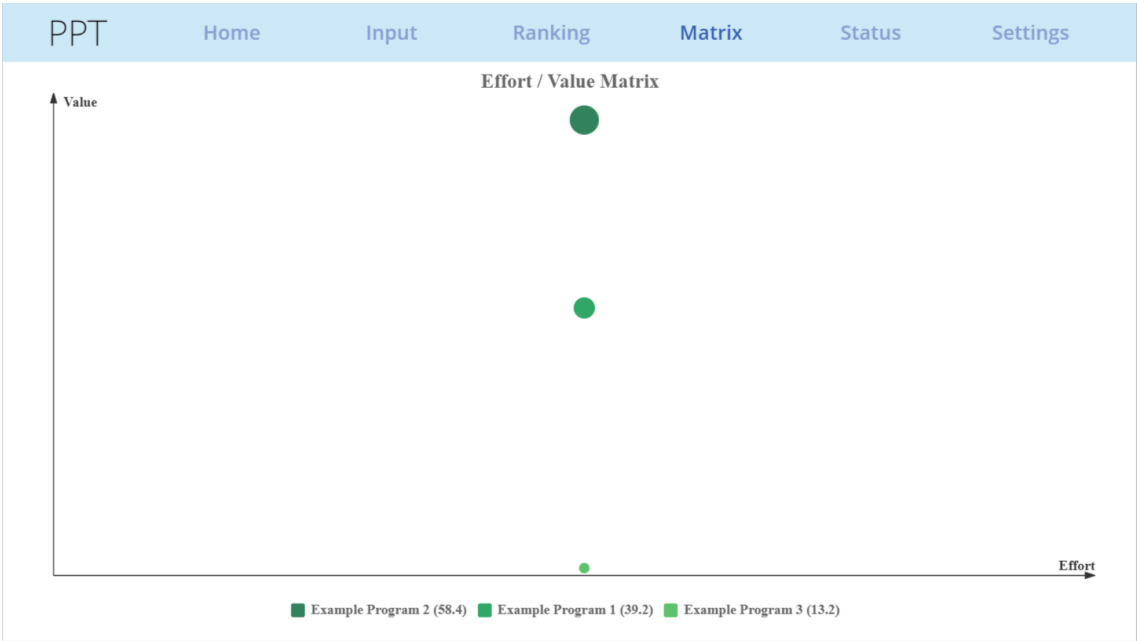


Figure B.4: PPT Program Matrix tab.

PPT			Home	Input	Ranking	Matrix	Status	Settings
Select Programs								
Example Program 1 Example Program 2 Example Program 3			View Timeline					
Project Name	↓ Cost		Hours					
Example Program 2	\$ 2,710,973		30,216					
Example Program 3	\$ 1,309,881		2,289					
Example Program 1	\$ 1,303,661		13,121					

Figure B.5: PPT Program Status tab.

PPT

Home

Input

Ranking

Matrix

Status

Settings

Filter Programs

Complete Info

▼

Weights

Score Function Weights

Value / Effort

0.7

Gate

0.2

P&L Period

0.1

Effort Function Weights

VPS Hours

0.65

R&D Cost

0.35

Value Function Weights

CM

2

Reset

Save

Figure B.6: PPT Settings tab.

Appendix C

Replanning Tool User Interface

Vestas VtaC 1.19

Select JIRA Instance
OneJIRA

User

Password

login

May 2023

23 Tuesday

24 Wednesday

25 Thursday

26 Friday

27 Saturday

28 Sunday

29 Monday

30 Tuesday

31 Wednesday

June 2023

01 Thursday

02 Friday

03 Saturday

04 Sunday

05 Monday

06 Tuesday

Fit to Screen

Zoom-out

Zoom-in

Configuration

Selected JIRA instance

Template Source

☒ VWIM Breakdown

☐ Broken down

Load

Figure C.1: Replanning Tool login form.

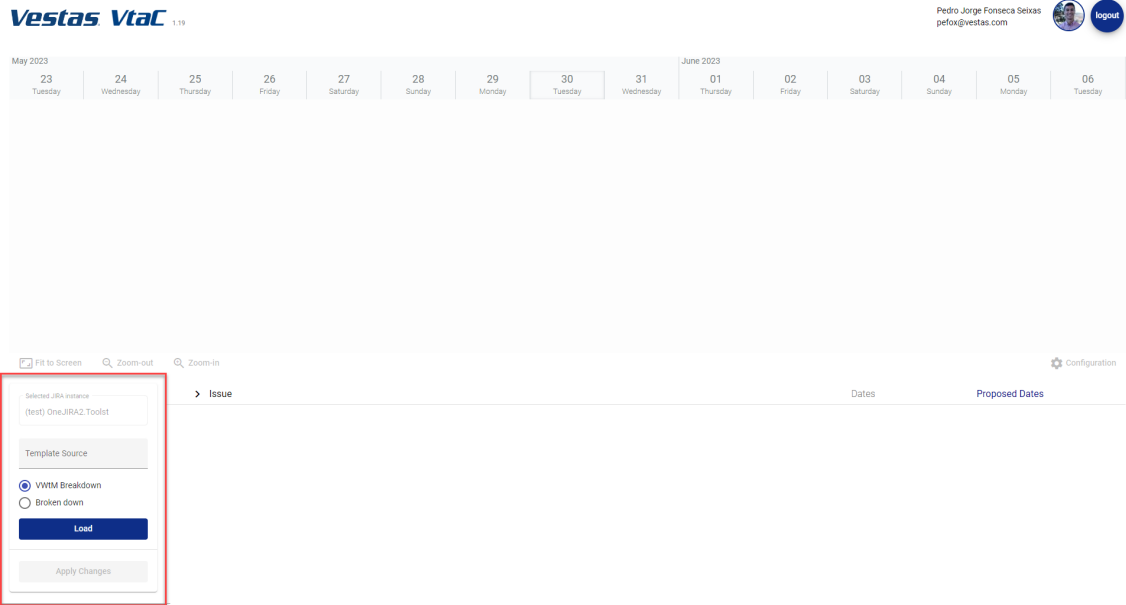


Figure C.2: Replanning Tool data loading form.

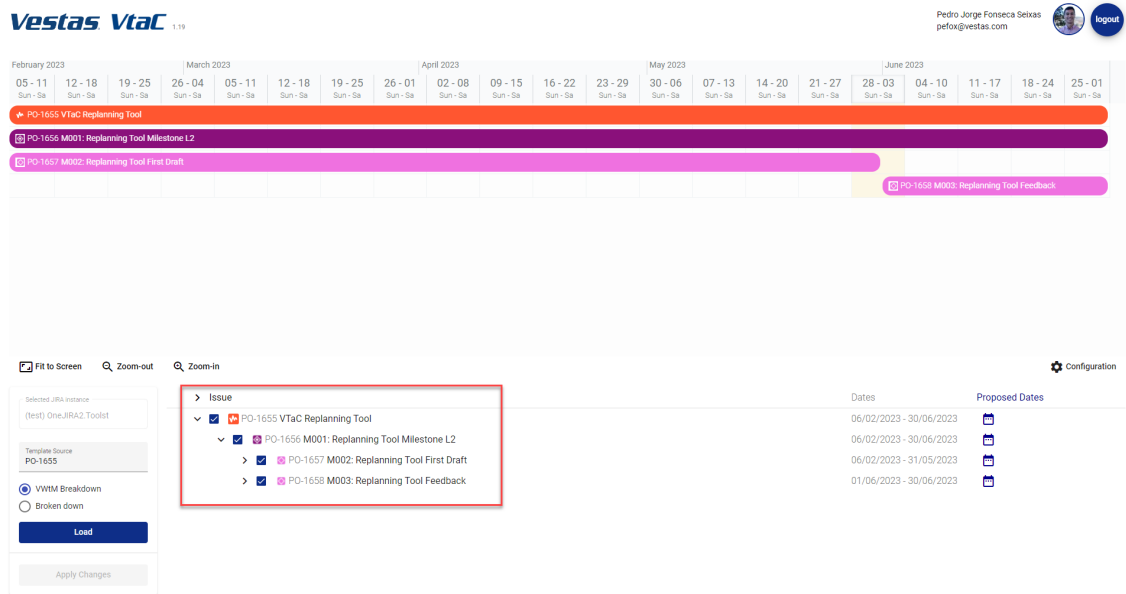


Figure C.3: Replanning Tool issue tree view.

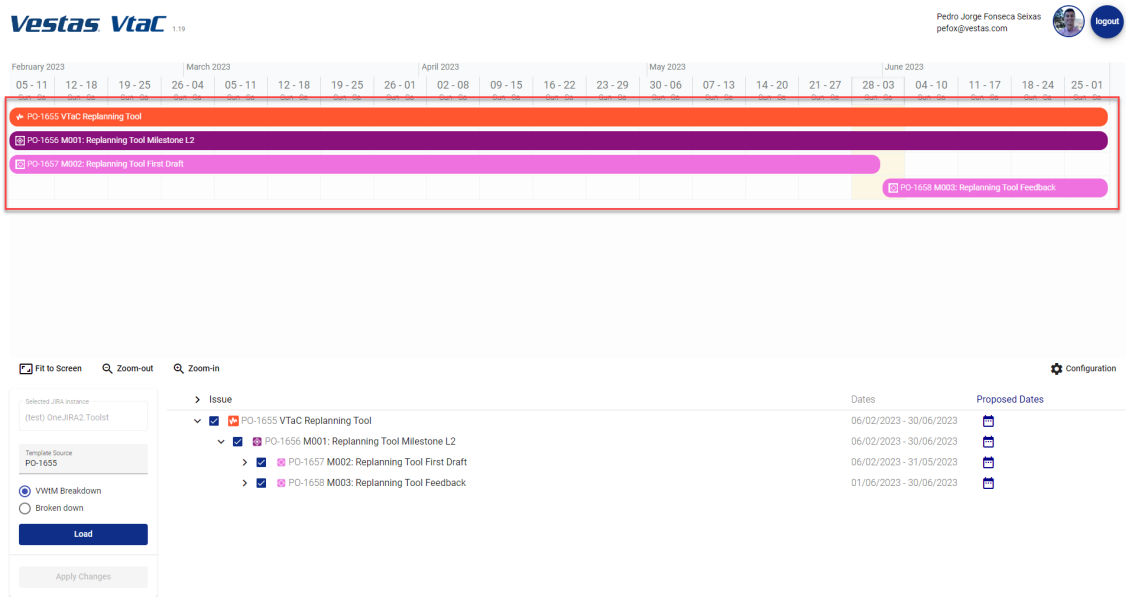


Figure C.4: Replanning Tool timeline view.

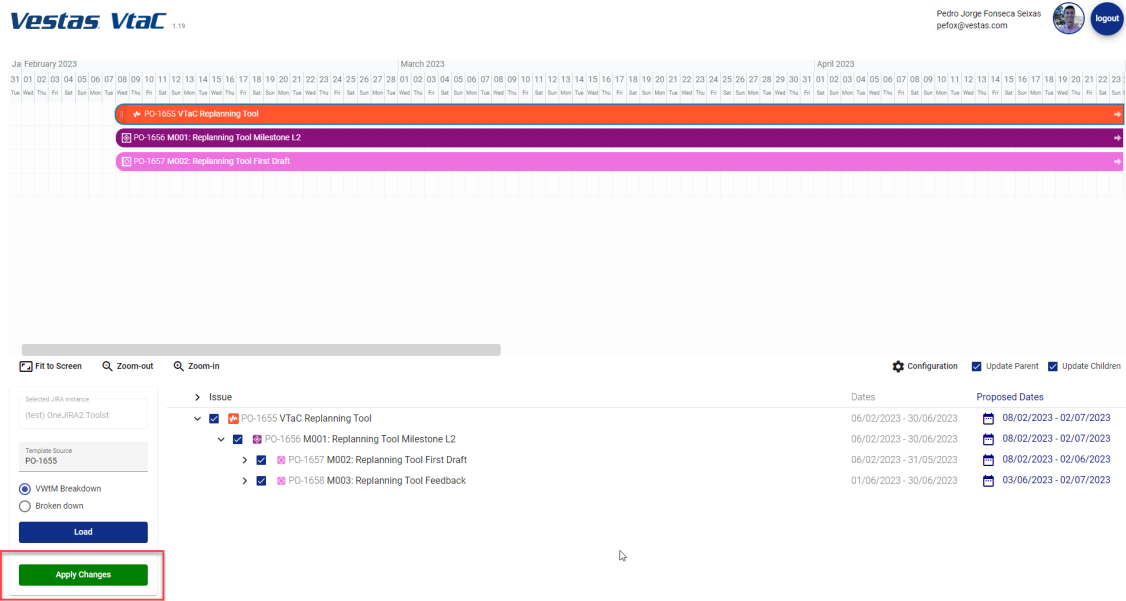


Figure C.5: Replanning Tool apply changes button.

You are about to update 21 issues.

Before you proceed with updating the dates, we kindly ask for your attention to a few important considerations. To ensure a smooth and controlled process, please carefully review and provide your consent by checking the corresponding checkboxes below.

☐ **Change Approval**
I confirm that any changes made to issues of type Initiative or Milestone L2 are accompanied by an approved Project Change Request.

☐ **BigPicture Task Mode**
I acknowledge that every updated issue's task mode in BigPicture must be switched to "Manual" in order for the updates to take place correctly.

☐ **Responsibility Acknowledgement**
I understand that if the project structure is not correct, I take full responsibility for any impact these changes may have on other issues. The tool only guarantees error-free updates when the project structure is correct.

Close

Apply Changes

Figure C.6: Replanning Tool consent message.

Appendix D

Work Package Catalog User Interface



Figure D.1: Work Package Catalog loading form.

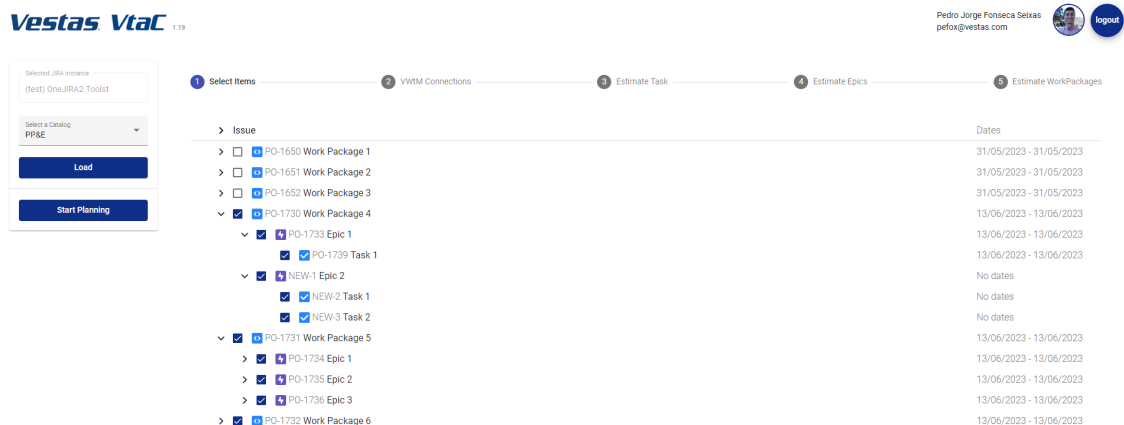


Figure D.2: Work Package Catalog select issues.

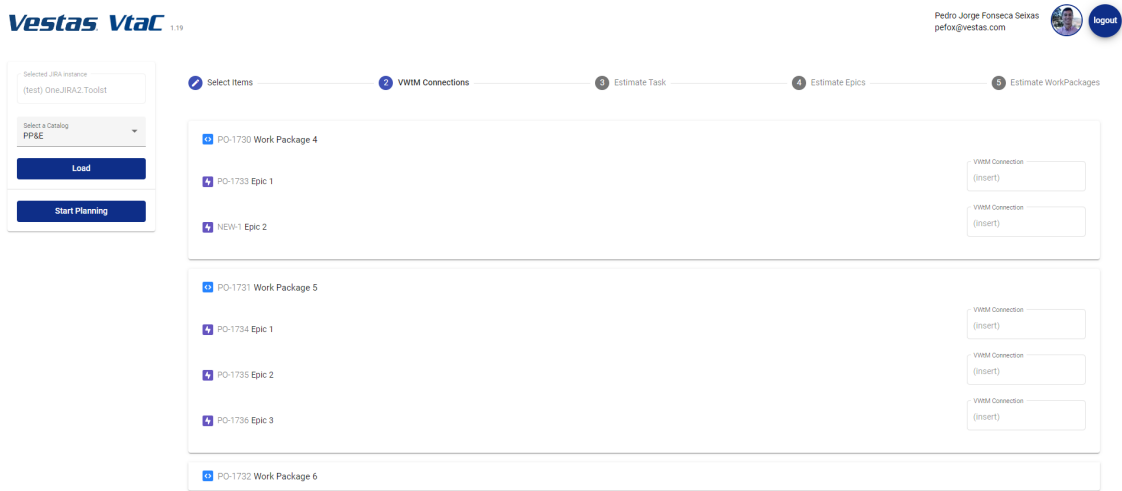


Figure D.3: Work Package Catalog connections to milestones.

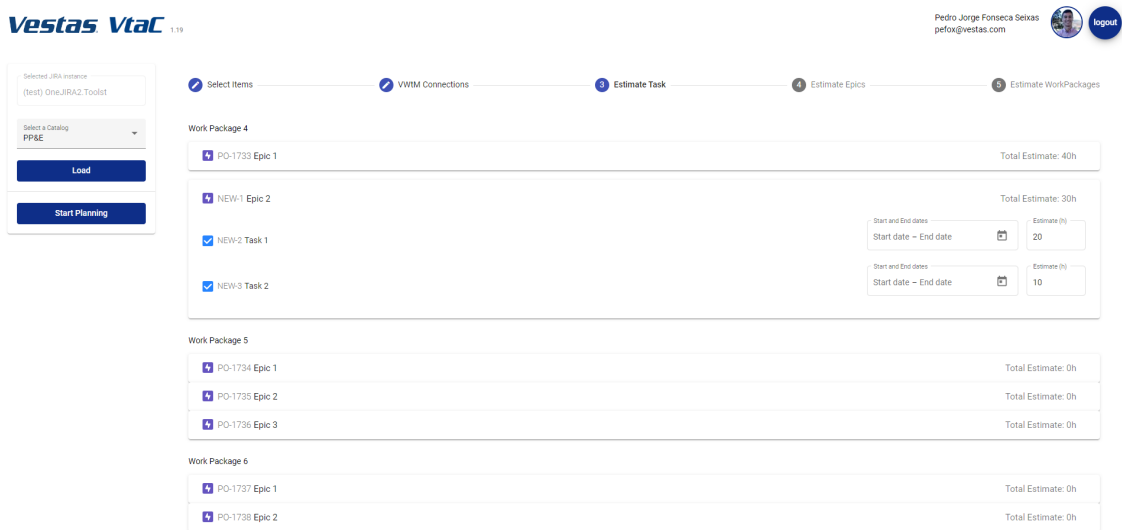


Figure D.4: Work Package Catalog estimate tasks.

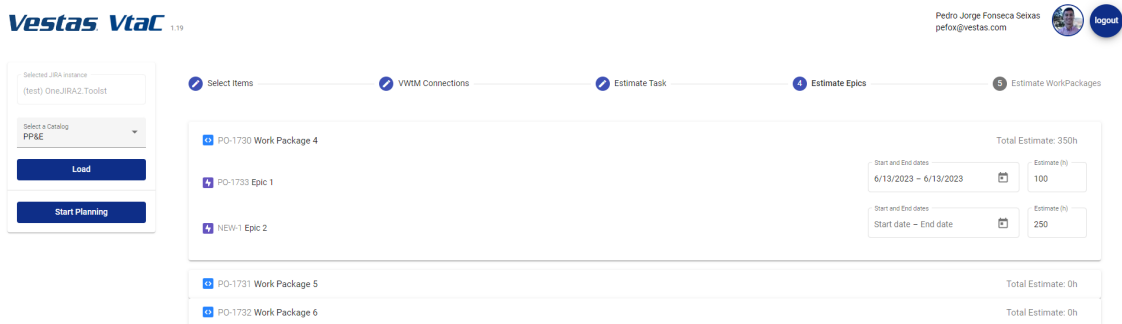


Figure D.5: Work Package Catalog estimate epics.

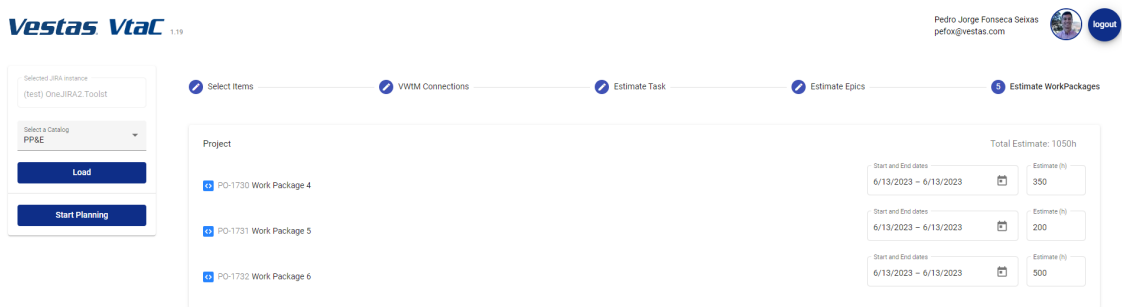


Figure D.6: Work Package Catalog estimate work packages.

Appendix E

Meetings with Stakeholders

This appendix provides a complete history of all stakeholder meetings conducted throughout the development process of the three tools presented in this thesis. To respect the privacy of those involved and to maintain the confidentiality of the process, individual stakeholders are not mentioned by their names but by their roles within the organization. The documentation is divided into three sections corresponding to each tool. Within these sections, individual meetings are further classified as separate entries. This structured approach offers a clear understanding of the sequence of events and allows an in-depth view of how each tool evolved with stakeholder inputs.

E.1 Portfolio Prioritization Tool

E.1.1 Requirements Gathering Meeting

Date: 14/02/2023

Location: Vestas, Porto

Stakeholders: Portfolio Simulation from *Strategic Planning & Portfolio Management*

Purpose/Objective: Ensure the tool's requirements are correctly aligned.

Key Points Discussed:

1. Tool required functionality
2. Possible design implementations.
3. Database fields needed for prioritization.

Decisions Made/Actions Agreed:

1. Start the development using PowerBI and PowerApps.

Follow-Ups Required:

1. Portfolio Manager to send dataset field names for prioritization.

E.1.2 First Draft Presentation

Date: 08/03/2023

Location: Vestas, Porto

Stakeholders: Portfolio Simulation from *Strategic Planning & Portfolio Management*

Purpose/Objective: Present the Portfolio Prioritization Tool's first draft.

Key Points Discussed:

1. Presentation of the first draft with mock data.
2. Improvements to implement.

Decisions Made/Actions Agreed:

1. Continue the development, implementing the suggested improvements.
2. Establish the connection with the PowerBI dataset.

E.1.3 PowerBI Integration Row Limit Solution Discussion

Date: 16/03/2023

Location: Vestas, Porto

Stakeholders: Portfolio Simulation from *Strategic Planning & Portfolio Management*

Purpose/Objective: Discuss possible solutions for the PowerBI integration data row limit.

Key Points Discussed:

1. Limitation on the number of fetched rows from PowerBI Dataset.
2. Possible solutions and workarounds.

Decisions Made/Actions Agreed:

1. Use only the application's high-level program data instead of the entire program structure.

E.1.4 Final Version Presentation

Date: 23/03/2023

Location: Vestas, Porto

Stakeholders: Portfolio Simulation from *Strategic Planning & Portfolio Management*

Purpose/Objective: Present the Portfolio Prioritization Tool's final version.

Key Points Discussed:

1. Presentation of the final version of the tool.

Decisions Made/Actions Agreed:

1. Tool met all the requirements.

Follow-Ups Required:

1. Portfolio Manager to schedule a presentation with the Vice President of Strategic Planning.

E.1.5 Final Presentation

Date: 17/04/2023

Location: Vestas, Porto

Stakeholders: Portfolio Simulation from *Strategic Planning & Portfolio Management* and Vice President

Purpose/Objective: Present the Portfolio Prioritization Tool's final version.

Key Points Discussed:

1. Presentation of the final version of the tool.

Decisions Made/Actions Agreed:

1. Tool met all the requirements and is ready to be used in production.

E.2 Replanning Tool

E.2.1 Requirements Gathering Meeting 1

Date: 17/02/2023

Location: Microsoft Teams

Stakeholders: Project Manager from *Loads and Control*

Purpose/Objective: Gather requirements for the Replanning Tool

Key Points Discussed:

1. Types of Replanning.
2. How was the replanning made, and in which platforms/tools?
3. How much time is spent on this process?

4. Who needs to be involved?
5. To which level of detail is the project replanned?
6. List of Requirements for the Replanning Tool.

Decisions Made/Actions Agreed:

1. Requirements must include synchronization with Jira, and the process must be standard and mandatory for everyone involved.

E.2.2 Requirements Gathering Meeting 2

Date: 17/02/2023

Location: Microsoft Teams

Stakeholders: Project Manager from *Hub*

Purpose/Objective: Gather requirements for the Replanning Tool

Key Points Discussed:

1. Types of Replanning.
2. How was the replanning made, and in which platforms/tools?
3. How much time is spent on this process?
4. Who needs to be involved?
5. To which level of detail is the project replanned?
6. List of Requirements for the Replanning Tool.

Decisions Made/Actions Agreed:

1. Standardized process focused on transparency.

E.2.3 Requirements Gathering Meeting 3

Date: 22/02/2023

Location: Vestas, Porto

Stakeholders: Project Planner from *Strategic Planning & Portfolio Management*

Purpose/Objective: Gather requirements for the Replanning Tool

Key Points Discussed:

1. Types of Replanning.
2. How was the replanning made, and in which platforms/tools?

3. How much time is spent on this process?
4. Who needs to be involved?
5. To which level of detail is the project replanned?
6. List of Requirements for the Replanning Tool.

Decisions Made/Actions Agreed:

1. Standardized process.
2. Automation in Jira.
3. Suggestion of new dates.

E.2.4 Requirements Gathering Meeting 4

Date: 23/02/2023

Location: Vestas, Porto

Stakeholders: Project Manager from *Project Execution*

Purpose/Objective: Gather requirements for the Replanning Tool

Key Points Discussed:

1. Types of Replanning.
2. How was the replanning made, and in which platforms/tools?
3. How much time is spent on this process?
4. Who needs to be involved?
5. To which level of detail is the project replanned?
6. List of Requirements for the Replanning Tool.

Decisions Made/Actions Agreed:

1. Standardized process and automation in Jira.
2. Take into account dependencies when replanning.

E.2.5 First Draft Presentation 1

Date: 18/05/2023

Location: Vestas, Porto

Stakeholders: Project Manager from *Project Execution*

Purpose/Objective: Replanning tool first draft presentation and feedback collection.

Key Points Discussed:

1. First draft presentation.
2. Feedback collection.
3. Possible improvements.

Decisions Made/Actions Agreed:

1. Tool was meeting the expectations.

Follow-Ups Required:

1. Student to deploy the tool to be used and further tested by the stakeholder.

E.2.6 First Draft Presentation 2

Date: 18/05/2023

Location: Vestas, Porto

Stakeholders: Project Planner from *Strategic Planning & Portfolio Management*

Purpose/Objective: Replanning tool first draft presentation and feedback collection.

Key Points Discussed:

1. First draft presentation.
2. Feedback collection.
3. Possible improvements.

Decisions Made/Actions Agreed:

1. Tool was meeting the expectations.

Follow-Ups Required:

1. Student to deploy the tool to be used and further tested by the stakeholder.

E.2.7 First Draft Presentation 3

Date: 19/05/2023

Location: Microsoft Teams

Stakeholders: Project Manager from *Tower*

Purpose/Objective: Replanning tool first draft presentation and feedback collection.

Key Points Discussed:

1. Tool introduction.
2. First draft presentation.
3. Feedback collection.
4. Possible improvements.

Decisions Made/Actions Agreed:

1. Tool had great potential.
2. Request to use the Tower project as a real-scenario case study.

Follow-Ups Required:

1. Student to deploy the tool to be used and further tested by the stakeholder.
2. Student to evaluate the possibility of using this project as a case study.

E.2.8 First Draft Presentation 4

Date: 19/05/2023

Location: Microsoft Teams

Stakeholders: Project Manager from *Loads and Control*

Purpose/Objective: Replanning tool first draft presentation and feedback collection.

Key Points Discussed:

1. First draft presentation.
2. Feedback collection.
3. Possible improvements.

Decisions Made/Actions Agreed:

1. Tool was meeting the expectations.
2. Introduce Manual updates into the tool.
3. Add warning when project structure is not correct.

Follow-Ups Required:

1. Student to deploy the tool to be used and further tested by the stakeholder.
2. Student to implement improvements.

E.2.9 First Draft Presentation 5

Date: 23/05/2023

Location: Microsoft Teams

Stakeholders: Project Manager from *Product Functions*

Purpose/Objective: Replanning tool first draft presentation and feedback collection.

Key Points Discussed:

1. Tool introduction.
2. First draft presentation.
3. Feedback collection.
4. Possible improvements.

Decisions Made/Actions Agreed:

1. Tool had great potential.

Follow-Ups Required:

1. Student to deploy the tool to be used and further tested by the stakeholder.

E.2.10 First Draft Presentation 6

Date: 31/05/2023

Location: Vestas, Porto

Stakeholders: Project Manager from *Project Planning & Execution*

Purpose/Objective: Replanning tool first draft presentation and feedback collection.

Key Points Discussed:

1. Tool introduction.
2. First draft presentation.
3. Feedback collection.
4. Possible improvements.

Decisions Made/Actions Agreed:

1. Tool had great potential.

E.2.11 Feedback Session 1

Date: 01/06/2023

Location: Vestas, Porto

Stakeholders: Project Planner from *Strategic Planning & Portfolio Management*

Purpose/Objective: Collect feedback from the tool's first version.

Key Points Discussed:

1. Application workflow.
2. Major issues that needed fixing.
3. Future improvements.

E.2.12 Feedback Session 2

Date: 05/06/2023

Location: Vestas, Porto

Stakeholders: Project Manager from *Project Execution*

Purpose/Objective: Collect feedback from the tool's first version.

Key Points Discussed:

1. Application workflow.
2. Major issues that needed fixing.
3. Future improvements.

E.2.13 Feedback Session 3

Date: 05/06/2023

Location: Microsoft Teams

Stakeholders: Project Manager from *Loads and Control*

Purpose/Objective: Collect feedback from the tool's first version.

Key Points Discussed:

1. Application workflow.
2. Major issues that needed fixing.
3. Future improvements.

E.2.14 Final Version Presentation and Performance Evaluation 1

Date: 20/06/2023

Location: Vestas, Porto

Stakeholders: Project Manager from *Loads and Control*

Purpose/Objective: Presentation of the tool's final version and performance evaluation exercises.

Key Points Discussed:

1. Tool Presentation.
2. Performance Evaluation (two exercises).

E.2.15 Final Version Presentation and Performance Evaluation 2

Date: 20/06/2023

Location: Vestas, Porto

Stakeholders: Project Planner from *Strategic Planning & Portfolio Management*

Purpose/Objective: Presentation of the tool's final version and performance evaluation exercises.

Key Points Discussed:

1. Tool Presentation.
2. Performance Evaluation (two exercises).

E.2.16 Final Version Presentation and Performance Evaluation 3

Date: 22/06/2023

Location: Microsoft Teams

Stakeholders: Project Manager from *Tower*

Purpose/Objective: Presentation of the tool's final version and performance evaluation exercises.

Key Points Discussed:

1. Tool Presentation.
2. Performance Evaluation (two exercises).

E.3 Work Package Catalog

E.3.1 Idea Presentation

Date: 18/04/2023

Location: Vestas, Porto

Stakeholders: Planning & Analytics Specialist from *Project Planning & Execution*

Purpose/Objective: Discuss the possibility of adding the Work Package Catalog to the scope of this dissertation.

Key Points Discussed:

1. Idea and overall requirements presentation.
2. Adjustments in the dissertation's timeline.
3. Possible Solutions.

Decisions Made/Actions Agreed:

1. Tool was added to the scope of this dissertation.

Follow-Ups Required:

1. Student to formalize tool's requirements.

E.3.2 Alignment of Requirements

Date: 20/04/2023

Location: Vestas, Porto

Stakeholders: Planning & Analytics Specialist from *Project Planning & Execution*

Purpose/Objective: Align the requirements for the tool and discuss possible solutions.

Key Points Discussed:

1. Requirements for the tool.
2. Architecture and possible solutions.

Decisions Made/Actions Agreed:

1. Tool was going to be incorporated into the replanning tool.
2. The learning database was going to be Jira itself, as it already had all project information, and the only necessary step was to add an extra Tag field.

E.3.3 First Draft Presentation 1

Date: 23/06/2023

Location: Microsoft Teams

Stakeholders: Project Manager from *Software Platforms and Networks*

Purpose/Objective: First draft presentation and feedback collection.

Key Points Discussed:

1. Objectives behind this tool.
2. Tool potential in improving planning quality.
3. Possible improvements.

E.3.4 First Draft Presentation 2

Date: 23/06/2023

Location: Microsoft Teams

Stakeholders: Project Manager from *Product Functions*

Purpose/Objective: First draft presentation and feedback collection.

Key Points Discussed:

1. Objectives behind this tool.
2. Tool potential in improving planning quality.
3. Possible improvements.

E.3.5 First Draft Presentation 3

Date: 23/06/2023

Location: Microsoft Teams

Stakeholders: Project Manager from *Base Frame and Yaw System*

Purpose/Objective: First draft presentation and feedback collection.

Key Points Discussed:

1. Objectives behind this tool.
2. Tool potential in improving planning quality.
3. Possible improvements.

E.3.6 First Draft Presentation 4

Date: 28/06/2023

Location: Microsoft Teams

Stakeholders: Project Manager from *Product Functions*, Senior Project Manager from *Product Functions*, Director from *Product Market Support*

Purpose/Objective: First draft presentation and feedback collection.

Key Points Discussed:

1. Objectives behind this tool.
2. Tool potential in improving planning quality.
3. Possible improvements.