FACULDADE DE ENGENHARIA DA UNIVERSIDADE DO PORTO

Maturity Assessment of Large Engineering Projects' Management System

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"Without data
you're just another person
with an opinion."

W. Edwards Deming

Resumo

Há centenas de anos que os combustíveis fósseis são indispensáveis como fonte de energia mais utilizada em todo o mundo. A sua importância para a ascenção económica global, e para a qualidade de vida no quotidiano de cada um de nós foi e ainda é inegável.

Os combustíveis fósseis, como fonte de energia não renovável e finita, tendem para a escassez e aumento de preço, não sendo sustentáveis num futuro próximo. A sua profunda relação com diversos problemas ambientais e de saúde humana é cada vez mais notória, exercendo pressão através de uma consciencialização ambiental coletiva, para que se encontrem e desenvolvam fontes de energia alternativas mais sustentáveis.

Os tempos mudam, as necessidades alteram-se, as prioridades reordenam-se e um novo paradigma impõe-se.

Neste enquadramento assiste-se ao florescimento de empresas que têm por missão mudar o paradigma do setor das energias, investindo nas renováveis.

A Vestas apresenta-se como um dos operadores importantes neste mercado investindo diariamente para melhorar a eficiência e eficácia dos seus processos com o objetivo de tornar as fontes de energia limpas e inesgotáveis mais competitivas, através da redução do custo da energia final entregue ao consumidor.

Em 2019, a Vestas apresentou o que acredita ser a próxima geração de modelos de turbinas eólicas, a sua primeira plataforma modular. Este é um passo estratégico e determinante com impacto significativo na redução dos custos de energia. A implementação desta abordagem modular despoletou um conjunto de desafios e oportunidades para a empresa e para as suas equipas de gestão de projectos. Por forma a alicerçar a nova estrutura organizacional modular surge a necessidade de implementação de um novo software de gestão de projeto com foco no aprimoramento dos procedimentos e aumento da eficiência.

Esta dissertação tem como objetivo a criação de uma nova e adaptada estrutura de gestão de projeto, que responda aos problemas encontrados no sistema de gestão de projeto atualmente em vigor na Vestas e que inclua os mais recentes e exigentes requisitos organizacionais. Esta estrutura deve garantir uma abordagem uniformizada e comum, utilizada e facilmente compreendida por todos os intervenientes nos projetos que a empresa desenvolve.

Os eixos fundamentais desta nova estrutura passam por uma criteriosa análise de maturidade, pela criação de métricas fiáveis e pelo desenvolvimento de um sistema rigoroso de análise de desvios das métricas e da maturidade.

O maior desafio deste projeto passou inquestionavelmente pela oportunidade de implementar na prática o modelo teórico desenvolvido, através da automatização de todos os processos em Power BI. Desta forma a aplicação torna-se acessível a todos os Gestores de Projeto da Vestas, sem comportar custos adicionais, e permitindo uma monitorização constante e mais eficaz de todos os projetos da empresa, em todas as suas fases. A disponibilidade de informação fiável e transparente através de indicadores fiáveis e com um interface amigável, permite antecipar problemas e assim promover a tomada de decisões corretivas e sustentadas em tempo útil.

Um piloto da aplicação desenvolvida foi implementado durante 3 semanas em 2 planos de projeto. Os resultados obtidos foram poderosos e promissores ao ponto de mobilizar a Administração da Vestas para a incorporação da aplicação no sistema de gestão de projeto, sendo, dentro em breve, usada mundialmente em todos os centros de desenvolvimento da empresa.

Abstract

For hundreds of years, fossil fuels have been essential and represent the most used source of energy all over the world. The vital role they play in the growth of worldwide economy, as well as the high quality of life they provide to each and every one of us is surely undeniable.

As a non-renewable, finite source of energy, fossil fuels have become more and more scarce, and together with their increasing price, life on Earth cannot be sustained in the foreseeable future. Their unavoidable deep connection with diverse environmental problems and human health issues is inevitably more and more obvious, thus increasing pressure on collective environmental awareness to find and develop alternative and more sustainable sources of energy.

Times are changing, our needs require constant alterations and priorities are rearranged – a new paradigm has become an unavoidable requirement.

Against this background, we may witness the flourishing of several companies whose mission consists in changing the paradigm in the energy sector, making renewable energies more appealing by investing in them.

Vestas presents itself as one of the important Players in this market, making a daily contribution to improving both the efficiency and efficacy of its processes, with the main goal of making clean and inexhaustible energy sources more competitive, by reducing the final cost of energy which is delivered to the consumer.

In 2019, Vestas introduced what it believes to be the next generation of wind turbine models, its first modular platform. This is a strategic and determinant step that has a significant impact on energy reduction costs. The implementation of this modular approach triggered a set of challenges and opportunities that both companies and their project management teams need to face. In order to support the new modular organisational structure, the demand for a new project management software which focuses on the improvement of procedures and the increase of efficiency also becomes a pressing requirement.

The main purpose of the present dissertation consists in creating a new, updated project management structure which will provide the answer to problems found in the project management system currently being applied at Vestas, and which will include the most recent and demanding organisational requirements. This structure must guarantee a standardised common approach that will be used and easily understood by all parties involved in the projects undertaken by the company.

The fundamental axes of this new structure undergo a thorough maturity analysis through the

creation of reliable metrics and the development of a rigorous metrics and maturity system of analysis.

The greatest challenge of this project has been, without a doubt, the opportunity to implement in practice the theoretical model developed, through the automation of all the processes in Power BI. So, this application becomes available to all Project Managers at Vestas, without entailing additional costs and enabling the constant and more efficient monitoring of all the company's projects, in all stages. The availability of reliable and transparent information through sound indicators and with a friendly interface allows us to anticipate problems, thus promoting corrective and sustained decision-making in a timely manner.

A pilot of the developed application was implemented over a period of 3 weeks, in 2 project plans. The results obtained were, not only powerful, but also promising, to the point of mobilising Vestas' Management toward incorporating the application in the project management system, and soon initiate its widespread use in all the company's R & D centres.

Agradecimentos

Porque acredito profundamente que a gratidão é a melhor forma de expressar o meu apreço por todos os que fizeram de mim quem sou.

Agradeço aos meus pais, Jorge Varela e Maria Figueiredo, e irmão, David Varela, por terem tornado este percurso possível e por me fazerem acreditar em todas as minhas ambições, possibilitado as melhores condições durante todo o meu percurso académico.

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Agradeço à Vestas Wind Systems A/S, pela forma como me fizeram crescer enquanto profissional e pessoa, integrando-me numa equipa de profissionais de excelência, dedicada à gestão de projetos, sempre dispostos a ajudar. Um obrigado especial ao Engº João Pacheco pela sua incansável disponibilidade e apoio nos difíceis obstáculos com que me deparei no desenvolvimento da aplicação deste projeto.

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Um obrigado a todos

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Symbols and Abbreviations

AC	Actual Cost
AT	Actual Time
BI	Business Intelligence
CMMI	Capability Maturity Model Integration
CPI	Cost Performance Indicator
CV	Cost Variance
EA	Earned Value
EAC	Estimate at Completion
ES	Earned Schedule
EVM	Earned Value Management
KPI	Key Performance Indicator
PI	Project Indicator
PM	Project Manager
PV	Planned Value
SAC	Schedule at Completion
SPI	Schedule Performance Indicator
SV	Schedule Variance
VAC	Variance at Completion
VPS	Vestas Power Solutions
TEAC	Time Estimate at Completion
TPI	Time Performance Indicator
TV	Time Variance
TVAC	Time Variance at Completion

Chapter 1

Introduction

In line with the increasing importance of the environmental issues, and aspiring to narrow the gap between the Academia and the pressing concerns and demands of an ever-growing society, the current dissertation project aims to conduct a maturity assessment on a project management system, with the aspiring goal to reduce aeolian power production costs and ultimately shift the World's dependence from fossil fuels towards renewable energy sources.

The current dissertation is integrated in the framework of an internship, as part of the student-worker program of Faculdade de Engenharia da Universidade do Porto, which was accomplished in collaboration with Vestas Wind Systems A/S, and derives from the findings and reflections of the aforementioned stage. Chapter 1 will provide the insights of the hosting institution and the project itself, its main problems and goals, the methodology applied in this process, the work plan and the structure of the present document.

1.1 Problem background and main objectives

Vestas is one of the major energy industry's global partner on sustainable energy solutions. The company is accountable for the design, manufacture, installation, and wind turbines service across the globe, and with more than 113 GW of wind turbines in 81 countries, it has become the leading company worldwide [1].

Last year, Vestas introduced what is believed to be the next generation of wind turbine models, the first modular wind-turbine platform. This step forward represents another significant effort in the continuous demand to lower energy costs and accelerate the global transition to a more sustainable energy mix.

The usage of modular wind-turbines has required major changes in the organisation and mainly

in its project management structure, emphasising the need to implement new project management practices and the overall restructuring of their project management system. A software-based project management tool was implemented, also during this restructuring, for task handling and monitoring purposes, while trying to focus on centralised information, broad information accessibility and synergetic use of data by and for all relevant stakeholders.

During project management, data quality and maturity were, regularly considered low, highlighting the need for further improvement of the methodology for data collection, upload, maintenance and reading. Software standardisation and restructuring was linked with the change required.

The main objective of this project consisted in improving the architecture of Vestas' project management system in order to make it more effective in cross-sectional projects and for all types of projects, while ensuring standardisation and the adoption of a common approach which can be understood by all the company's stakeholders.

The standardised approach is expected to promote clear communication and alignment, and is vital to be able to deliver on-time and on-cost project deliverables, which is a priority for the organisation.

1.2 Project methodology and work plan

To approach this challenge, the author of this dissertation was integrated in the project management team, based on the Porto Design Centre , so as to be acquainted with the hosting institution and its current practices regarding the project management system.

An extensive and comprehensive literature review was accomplished to better understand the concepts of maturity in project management, data quality and project management methodologies, standards and practices. Moreover, a literature review about project management tools already employed in the company was conducted in order to further understanding of the organisation.

Supported by the project management team, both a detailed process review and analysis were performed, leading to a wider overview of current practices and problem identification. Thus, a theoretical framework was designed to enhance project management practices also taking into account the improvement of the quality of data and overall software feasibility. This framework features project plans maturity evaluation, project plans metrics and actions to address project plan pain points.

After that, the framework was automated in Power BI allowing live data flow and real time follow-up of all step of every project across the organisation. Finally, a pilot was conducted in order to validate the Framework effectiveness.

In order to define the execution planning for this project, objectives with a stipulated length of time were defined.

Table 1.1: Work Plan

Task	Week Length	Description
1	2	Understand organisational structure and expected project results
2	2	Literature review of project maturity, methodologies and tools
3	3	Understand Vestas' project management system and perform current state diagnosis
4	5	Development of the Planning Maturity Framework
5	5	Framework implementation using Power BI
6	3	Validation Pilot
7	1	Results analysis, closure of model and conclusions
8	8	Writing of the dissertation

1.3 Document Structure

The document is subdivided in eight chapters:

Chapter 1 introduces the project and its motivations, giving a major scope of the company background, project objectives and how it was planned to be developed,

Chapter 2 details the organisation,

Chapter 3 presents the literature review on the following subjects: maturity, project management methodologies and project management tools.

Chapter 4 sets out the characterisation of the current project management system of the company, as well as a current status diagnosis.

Chapter 5 details the Planning Maturity Framework developed to address the goals of the dissertation project.

Chapter 6 describes the final result of the automated Power BI application and the major steps in order to render it possible.

Chapter 7 overviews the validation pilot and result analysis in order to verify application effectiveness.

Chapter 8 is dedicated to closing notes and future work.

Chapter 2

Vestas Wind Systems A/S Presentation

2.1 Vestas History

Vestas Wind Systems A/S is the world leader in the design, engineering, and manufacturing of aeolian power generation systems. The company develops and manufactures its own proprietary wind turbine technologies, selling a range of products from the bare turbine components to complete turnkey systems, and even entire wind farms. Vestas has been riding the winds of change since the end of the 20th century, as the reduction of global pollution has taken on a greater urgency, in addition to the fact more and more governments have begun mandating the installation of clean and renewable energy sources [1].

Vestas started out in 1898 in Denmark as a blacksmith shop, where H.S. Hansen set up for business with his son Peder Hansen. In 1945, after World War 2, Peder Handson founded the company named "VEstjyskSTålteknik A/S" which was an exclusive producer of household appliances but whose name was unmanageable, hence the shortened version Vestas [2].

The future of the company changed a few years later. While facing the oil crisis of 1970, Vestas started to develop wind turbine technology as an alternative to traditional energy production, and in 1979 the company sold and installed its first turbine with a 10 meter rotor and a capacity of 30KW. After the crisis in 1986, the company decided to focus exclusively on its goal of making wind energy a viable solution to meet the world's energy demands. Much of the group is sold, and a new company, Vestas Wind Systems A/S, is born. Component weight reduction, cutting-edge technology and offshore adaptability convinced investors and a great number of orders started being done. The company goes public, in 1998, on the Copenhagen Stock Exchange .

In 2004, Vestas and NEG Micon merge and the two Danish wind energy giants became the undisputed world leader in the wind power industry with a 32 percent market share. Since then, the company undergoes further expansion and adaptation to the dynamic market of aeolian energy.

In 2018, Vestas realised that it could make wind energy an even more attractive investment. The company was determined to use advanced technology to improve wind energy technology and broke down the turbine's structure into individual modules, by creating a common interface for each module, meaning it can be modified without changing the turbine as a whole.

By the end of 2019, Vestas had installed more than 108 GW of wind turbines in 80 countries, as illustrated in Figure 2.1, more wind power than anyone [2].

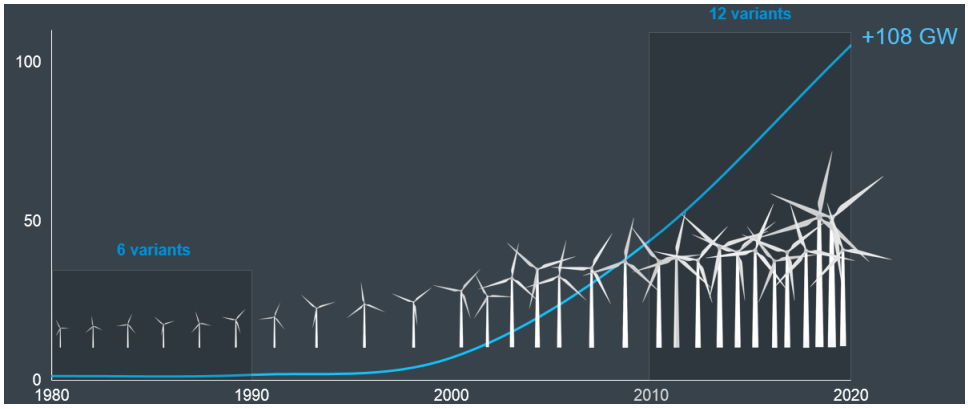

Figure 2.1: Vestas Installed Power Worldwide

2.2 Vestas' High Level Organisational Structure

Vestas' organisational structure is divided into eight areas representing all key disciplines of the company. The good functioning of the company as well as Vestas' overall performance is ensured by the Executive Management, constituted by seven members [3].

As a structurally lean organisation, Vestas understands customer value and focuses its key processes to continuously increase it. The hierarchical structure is illustrated the Figure 2.2 below.

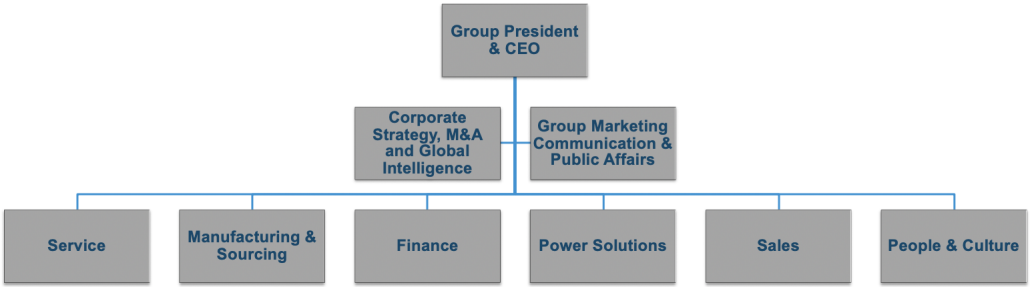

Figure 2.2: Vestas' organisational Structure

2.3 Modular Product Development - New market approach

In the past, Vestas developed single turbine platforms which did not have much in common because they were highly optimised to meet short term customer needs. However, market requirements are continually changing the renewable industry: auctions and forward selling require the fast pace of innovation and the value of energy, which is increasingly important for competitiveness, demanding further optimisation and highly customised solutions.

In the future, turbines will be divided into individual modules [4]. By creating a common interface for each module – meaning they will all fit together in the same way – one module can be changed (made bigger or smaller, or upgraded with the latest technology) without changing any of the adjacent modules.

Modular Product Development (MPD) is Vestas' new way of designing and producing turbines that will help keep up the fast pace of technological innovation, simultaneously saving time, money and working time. MPD will enable development and offer more products demanded by the market, while requiring less time and cost than the old approach. Modularity means that turbine variants share component layout and module interfaces [4]. This idea is illustrated in the figure 2.3.

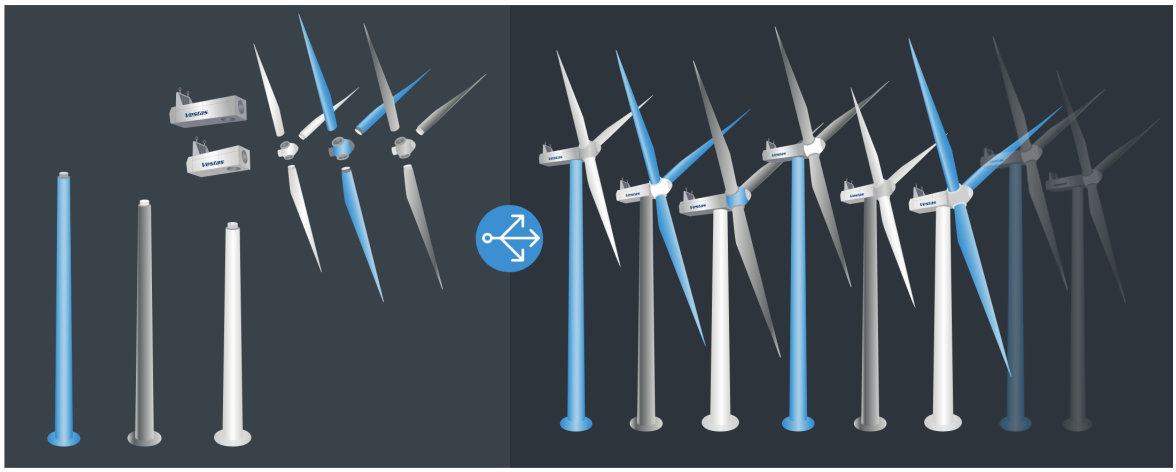

Figure 2.3: Combining standard modules into new products

This new modular approach and the underlying standardisation policy, lead to a major change in the organisational structure and consequently to a new way of working in order to adapt to the new reality. The present dissertation project has originated in the concern to provide further analyses of these changes in the company.

2.4 Porto Design Centre

The office which is located in Porto represents the increasing significance of Vestas' presence in Portugal so as to strengthen its global Research and Development setup. As an R & D centre, the Porto Design Centre not only deals with the development of projects for products designed for the global market, but is also responsible for developing core technology for Vestas' product portfolio in an ever-changing environment, thus ensuring that Vestas continues to have a market leading product portfolio.

Although being a separate department (in fig. 2.5), Porto Design Centre supports Vestas' Power Solutions (VPS) business unit being Turbine Solutions' projects the primary focus. Therefore, to the purpose of this dissertation, Vestas Power Solutions business unit and Turbine Solutions department projects are the ones that will be considered.

2.4.1 Position in the Organisational Structure

At the Porto Design Centre, the budget is mainly assigned to Turbine Solutions projects. Therefore, projects developed there include bringing new products and current product upgrades or services to the market, based on already existing platforms.

With the new modular approach, each turbine is divided into 6 parts which are referred to as modules. The organisational structure has this same division in modules so that the whole platform project can be subdivided into work packages and delivered to each module (depending on the part of the turbine it corresponds to), in order to be managed as an individual part. This structure is illustrated in fig 2.5.

As stated before, the major projects assigned to the Porto Design Centre are part of Vestas' Turbine Solution department which is a sub-division of Vestas Power Solutions (VPS) business unit. Figures 2.2, 2.4, 2.5 and represent the connection between the high level organisational structure and the low (module) level structure.

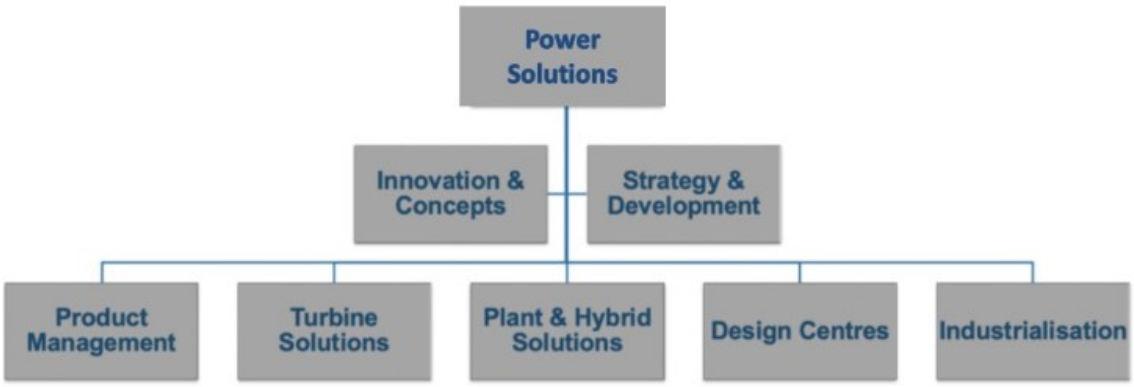

Figure 2.4: VPS Organisational Structure

Business Unit Power Solutions work globally to ensure optimised product profit/loss and deliver the right product, to the right market, at the right time and within accounting.

In this business unit, the full life-time of products is covered, ranging from the early exploration and incubation of new technologies to the handling of computer-integrated manufacturing (CIM) [5].

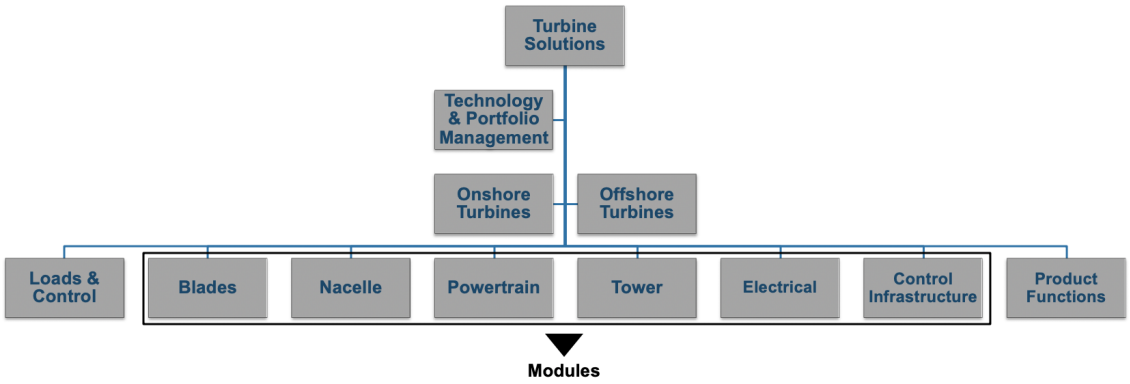

Figure 2.5: Turbine Solutions Organisational Structure

Turbine Solutions is a sub-division of the Power Solution's business unit, organized in Onshore and Offshore turbine products, Loads and Control, Product Functions, and all the **modules** (Blades, Nacelle, Powertrain, Eletrical, Tower and Control Infrastructure). Based on market requirements and needs it has designed, developed and delivered modularised solutions for onshore and offshore turbines.

The staff are engineers and specialists within a large range of mechanical, electrical and subject areas, as well as Project and Line Managers. The team of Project Managers is responsible for ensuring every Turbine Solutions' project is accomplished as planned [6].

2.4.2 Operational and Project Execution Office

The project management team integrated by the author belongs to the Operational and Project Execution Office, located in the Porto Design Centre. This office oversees and provides support in the execution of Vestas' Turbine Solutions' portfolio at the Porto Design Centre.

The new modular approach created inevitable challenges and opportunities of improvement. With the new modular organisational structure comes a new challenge to the company and to the project management team that has to adapt its practises to meet the company's needs, aiming to enhance the procedures and increase efficiency [7].

The present dissertation project is an initiative from the Operational and Project Execution Office with a view to improving the project management system. The Nacelle module projects have been selected for assessment.

Chapter 3

Literature Review

This chapter will presents a literature review of the concept of maturity in projects, project management methodologies and project management tools necessary before approaching Vestas' challenging project.

First the CMMI maturity model is detailed to better understanding the maturity concept. Secondly, PRINCE2 & PMBOK methodologies and proven methods such as Earned Value Management, Earned Schedule and Three Point Estimation are explored. Afterwards, the main project management tools currently employed at Vestas, namely JIRA and Power BI, were studied to better understand their features.

3.1 Maturity Model

This section presents a review of the concept of maturity in Project Management. Following, it is provided an overview of the maturity model principles, highlighting the CMMI- Capability Maturity Model Integration.

3.1.1 Context

All organisations seek excellence in project management however, many do not recognize the need to establish a strategic IT as a way to achieve that excellence. The simple use of project management tools, even if carried out over a long period of time, does not lead to excellence. It may even result in the systematic repetition of the same errors.

It should also be noted that even in organisations lacking discipline:

"some individual projects produce excellent results. When such projects succeed, it is generally through the heroic efforts of a dedicated team, rather than through repeating the proven methods of an organisation with a mature software process. In the absence of an organisation-wide software process, repeating results depends entirely on having the same individuals available for the next project. Success that rests solely on the availability of specific individuals provides no basis for long-term productivity and quality improvement throughout an organisation. Continuous improvement can occur only through focused and sustained effort towards building a process infrastructure of effective software engineering and management practices" [8].

Maturity models are an instrument available to assess, and at the same time guide organisations towards the best policies and strategies with regard to the area of information systems. Over time, several models of maturity in the management of projects were published by prestigious organisations but the CMMI- Capacity Maturity Model Integration is the one that is going to be presented, as it is the grounding for currently used models [8].

3.1.2 Capacity Maturity Model (CMMI)

The Capability Maturity Model Integration is an improvement model that can be adapted to solve any performance issue at any level of the organisation. This model helps organisations find their problems, solve them and therefore improve their performance if well-implemented. For example, CMMI can be used to improve processes for software in an organisation: a process can be the management of the product development.

The CMMI model follows different levels such as capability levels or maturity levels that will be detailed next sections but, in brief, CMMI is a model that provides guidance for developing or improving processes that meet the business goals of an organisation [9].

3.1.3 CMMI Representations

organisations can choose between two approaches to process improvement: process capability approach; and organisational maturity approach. Thus, CMMI has two representations: continuous and staged. Which means that there is a single model that can be seen from two different perspectives [10]:

- **Continuous Representation** - Allows the organisation to select the key process area (or group of key process areas) and thereby improve processes - using the levels of capacity.

  In other words, continuous representation is designed to allow users to focus on specific processes, which are considered important for organisation business objectives or those to which the organisation attributes a high degree of risk.

Furthermore, continuous representation offers maximum flexibility using the CMMI model. An organisation can improve the performance of a single process, related to specific problems, or can work in other areas that are closely aligned with the organisation's business objectives. It also allows organisations to improve processes at different levels.

There are some limitations, in term of choice of the process areas, given the dependencies between the areas of the processes in organisations. If the processes and the dependencies between the areas of the process described in CMMI that need to be improved in the organisation are known, continuous representation is a good choice for the organisation [10].

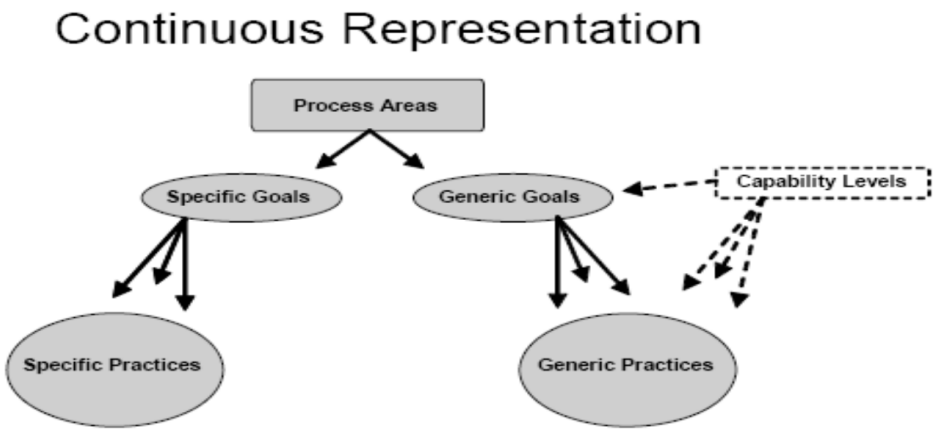

Figure 3.1: Continuous Representation

- **Staged Representation** - Uses a set of process areas defining organisation path for the improvement. This improvement path is characterized by maturity levels and each maturity level provides a set of processes which characterize different areas of organisational behavior [10].

  The representation by stages prescribes an order of execution of the process areas, according to levels, which defines the path for improvement in the organisation from the initial level to the optimized level.

  The staged representation, designed to provide a sequential pattern of improvements, can serve as a basis for comparison to assess the maturity of different projects and organisations [10].

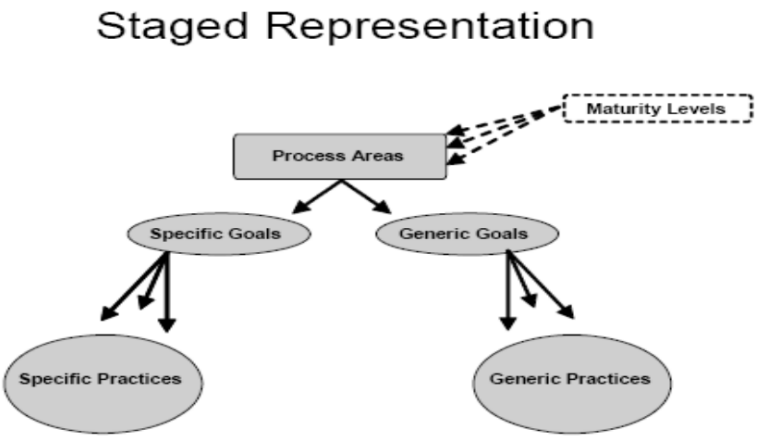

Figure 3.2: Staged Representation

3.1.4 CMMI Maturity Levels

Levels are used in CMMI solutions to describe evolutionary paths recommended for organisations that wish to improve their processes used . The improvement of those organisations is shown by CMMI using levels. In CMMI, there exist two types of levels supported: Maturity levels and capability levels.

Maturity levels provide a staging of processes for improvement across an organisation from maturity level 1 to maturity level 5. Each level is a group of process areas that when implemented satisfies a set of goals and thus making an improvement in a specific area in an organisation.

Capability levels enable your organisation to focus its process improvement efforts by process area from capability level 0 to capability level 3.

Due to the scope of this dissertation project, the focus is on maturity levels.

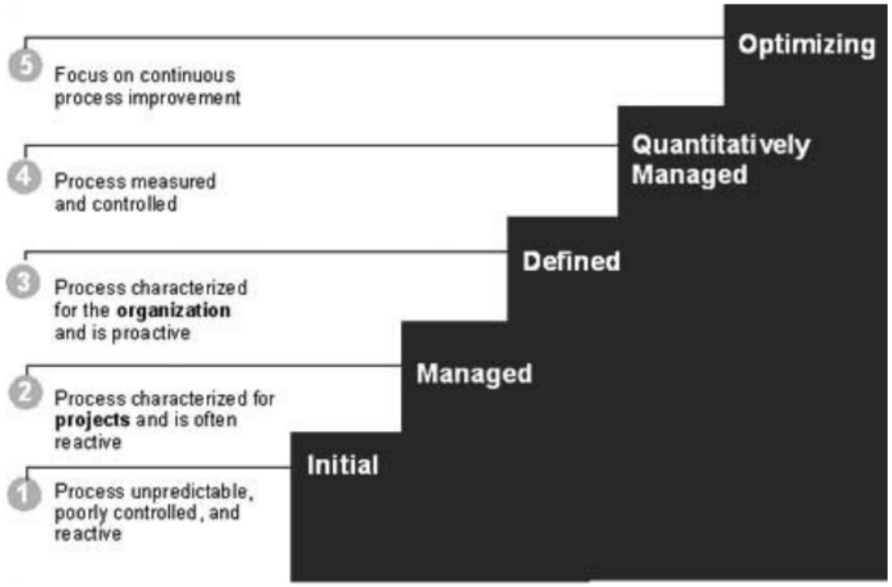

Figure 3.3: CMMI Maturity Levels

A particular level can only be reached after satisfying all the goals of the process areas targeted for improvement. However, If a process meets all criteria for a level, and some criteria for an upper level ,that process will still be considered as a lower level process. In addition to that, each level builds on the previous level [9].

3.1.5 Return on Investment for Process Improvement

Return on investment is a very important measurement needed by organisations to measure their process improvement. The statistics show that the cost can be reduced when a process improvement model is adopted. However, the costs and benefits should be assessed to calculate ROI and understand if the improvement is worth for the organisation. Therefore, a close look at ROI should be into account [9].

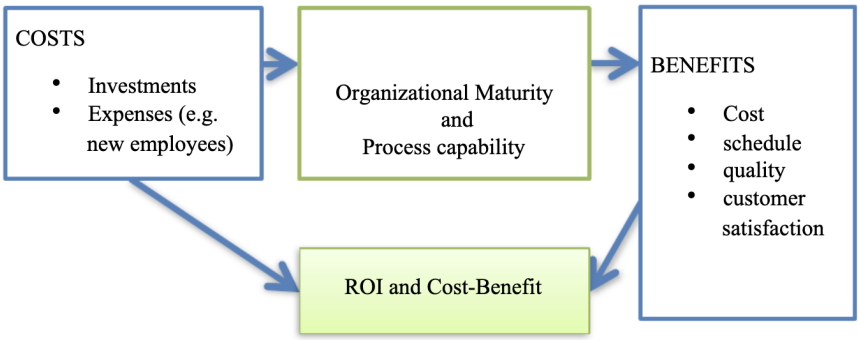

Figure 3.4: Measurements of Performance

3.2 Project Management Methodologies

This section presents PRINCE2 & PMBOK methologies and three proven project management methods, namely Earned Value Management, Earned Schedule and Three Point Estimation. An extensive literature review on these subjects was necessary in order to understand the most widely used project management methodologies and to achieve this dissertation project objectives.

3.2.1 PRINCE2 versus PMBOK Methodologies

A project management methodology provide a guideline for managing the projects and it is one of the important factors for successful completion of the projects. **P**roject **M**anagement **B**ody of **K**nowledge (PMBOK) and **PR**ojects **IN C**ontrolled **E**nvironment Version 2 (PRINCE2) are most widely used project management methodologies in the world. The aim of this section is to compare PRINCE 2 and PMBOK to identify the characteristics of these best practices in order to provide decision criteria for organizations with regard to selecting project management methodology[11].

3.2.1.1 Introduction

Project management has emerged as a separate discipline in 1960's and project management methodologies are widely used in all industry sectors in order to complete projects successfully. Methodology can be defined as "set of guidelines or principles that can be tailored and applied to specific situation"[11].

As delivering on time, on budget and with required features and functions is, more then ever required, organisations and project managers need to utilize proper project management methodologies in order to increase success chance and complete projects on time within specified constraints and with desired features.

Each methodology can be divided into five different groups in line with the level of specificity: "Best practices, standards and guidelines; Sector specific methodology; Organisation specific customised methodology; Project specific methodology and Individualized methodology" [11].

In accordance with this classification, PMBOK and PRINCE2 are included inside "Best practices, standards and guidelines" group. Best practices are independent of sector, organisation and they can be applied to any project. These best practices have been created by international organisations, such as Project Management Institute (PMI) and Association for Project Managers Body of Knowledge (APMBOK) as a result of efforts "to codify the area of knowledge required for competent project management" [12]. This section provides an overview on the two most widely used best practices: PMBOK and PRINCE2.

3.2.1.2 Project Management Methodology Selection

Companies should consider five parameters during the selection of a project management methodology [11]:

1. The overall company strategy, i.e. how competitive is the company.
2. The size of the project team and/or scope to be managed.
3. The priority of the project.
4. How critical the project is to the company.
5. How flexible the methodology and its components are.

In addition to organisation objectives, the characteristics of the methodologies themselves are also critical for the selection of the most suitable methodology for companies and project managers. To achieve decision criteria for organisation it is necessary to identify distinguishing characteristics of PMBOK and PRINCE2 and also find out approaches of methodologies to project characteristics.

3.2.1.3 PMBOK and PRINCE 2 Comparison

PMBOK is developed by PMI and it "defines project management related concepts, contains globally recognized standard and guide for project management profession" [13]. On the other side, PRINCE2 is developed by the UK Office of Government Commerce (OGC). It is a "structured project management method based on experience drawn from thousands of projects" [14]. The general high level comparison is provided below at Table 3.1.

Table 3.1: High Level Comparison between PRINCE2 and PMBOK

Feature	PRINCE2	PMBOK
Definition	Structured PM methodology	Standard and guide
Practical vs. Comprehensive	Practical, focuses on critical areas	Comprehensive
Themes and Knowledge Areas	7 Themes	10 Knowledge Areas
Processes and Activities	7 Processes and 35 Activities	5 Process groups and 47 Processes
Principles	7 Principles	-
Techniques	Only PRINCE2 specific techniques are explained	Covers techniques for each process
Interpersonal Skills	Not Covered	Covered
Focus	Business Case and Product	Customer Requirements
Role of The Project Board	Calls for a Project Board to provide oversight	Only suggests the role the sponsor should be playing
Organisational Assets and Environmental Factors	Partly covered	Strongly integrated with processes
Management Principle	Manage by Exception	-

Based on the comparison of PMBOK vs. PRINCE2 above, it is possible to identify main differences, superiorities and also the similarities of the methodologies. According to Table 3.1, although PMBOK provides more comprehensive approach with detailed techniques, PRINCE2 has also some features that are not covered by PMBOK, such as integration of project board activities and management by exception approach.

In order to complement table 3.1 with the literature mentioned, additional differences can be stated:

1. PMBOK has stronger mechanism for integration of processes.
2. Organisational Process Assets and Environmental Factors are better integrated with processes at PMBOK.
3. PMBOK has stronger communications management mechanism.

4. PRINCE2 covers managing product delivery activities from the perspective of the project team.

3.2.1.4 Conclusion

In accordance with above comparison, it is preferable using PRINCE2 for small size projects; whereas PMBOK is preferable (or needs to be utilized) for the projects with high client commitment, large and complex project teams, high level of outsourcing, comprehensive contracts and high level of stakeholder engagement. As identified from comparison results, it is clear that both practices have some advantages and disadvantages depending on the organisation and the project itself. Organisation needs to choose the one that fits best to them. Another approach may be choosing the one that fits best to organization and utilizing the other methodology as a supportive one. A selected methodology may not cover all requirements of the organisation, project manager and the project.

Moreover, in addition to project management methodology and project characteristics, national standards and bureaucracy related with project management, characteristics of the organisation itself and sector specific critical success factors also effect the decision for project management methodology selection. When considering all these factors, a new methodology that covers all requirements maybe the best choice.

3.2.2 Earned Value Management (EVM)

Projects are a decisive element of any organisation to meet its strategic and functional objectives so companies are increasingly adopting more sophisticated methods to deal with project's essential constraints and manage them effectively.

Tracking is crucial for maintaining projects within their schedule and cost baseline so one of the main problems related to them is monitoring the status on a real-time basis. EVM helps project managers get a handle on project plan management with budget and schedule updates and forecasting of final results. With its bottom-up approach, EVM allows data collection to take place during the entire duration of the project's lifecycle, while requiring in depth information on full project's scope definition and detailed time-cost planning [15].

EVM is effectively being applied in different projects of many kinds as a very powerful project cost and time control system . The EVM's influence on project success encouraged many researchers to work on it and its broad application in controlling projects and also in predicting the target cost and time is undeniable [16].

3.2.2.1 EVM Input Parameters

The method employs three different evaluation parameters to assess project status:

- **Planned Value** - Approved time-phase budget baseline to accomplish the entire project . A project plan identifies the work to be accomplished. Assessment of this planned work is called Planned Value (PV) which is a numeric reflection of the budgeted work that is scheduled to be performed, and it is the established baseline against which the actual progress of the project is measured [15].
- **Earned Value** - "The metric which quantifies the accomplishment of work is called Earned Value (EV). The EV reflects the amount of work that has actually been accomplished to date, expressed as the planned value for that work" [16].
- **Actual Cost** - This metric reflects the actual costs of the project, therefore , this amount can be compared with the others above-mentioned in order to apply the EVM method. This index includes the total expenditure for tasks or sub-tasks at any point in time and it is an indication of the level of resources that have been expended to achieve the actual work performed to date [16].

3.2.2.2 Earned Value Importance

During project execution, real costs rarely equal planned costs. Looking at the figure 3.5, any project manager without knowledge of the EVM method can easily conclude that the project is over the budget until the second half of third month and, after that within budget.

In figure 3.5 it is not provided the work released which is very important to draw conclusions because there are two possible scenarios here: the actual cost may be associated to tasks that are being executed in an inefficient way or that were executed behind or ahead of the baseline. Therefore, earned value analyses is essential for the understanding of project real state.

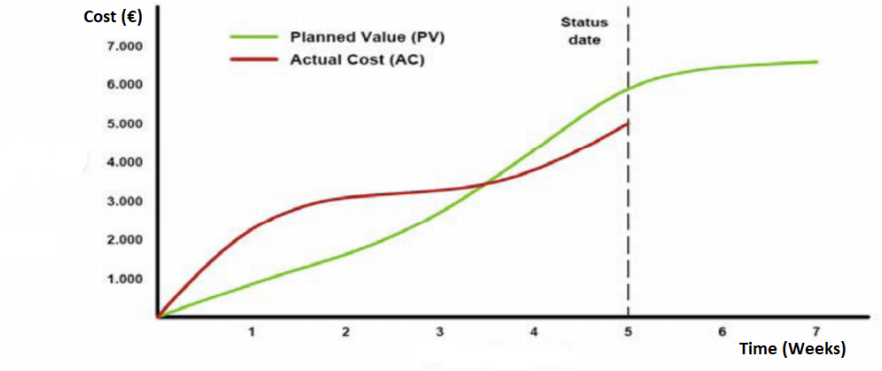

Figure 3.5: Planned Value vs. Actual Cost

With the Earned Value inclusion, illustrated in the picture 3.6, it is deduced that even with the Actual Cost below the Planned Value after the the second half of third month, the project is always over the budget because actual costs are greater than earned value. Consequently, it can be concluded that an assessment conducted without taking into consideration earned value metric can lead to the wrong outcome that the project is within the budget which is not true.

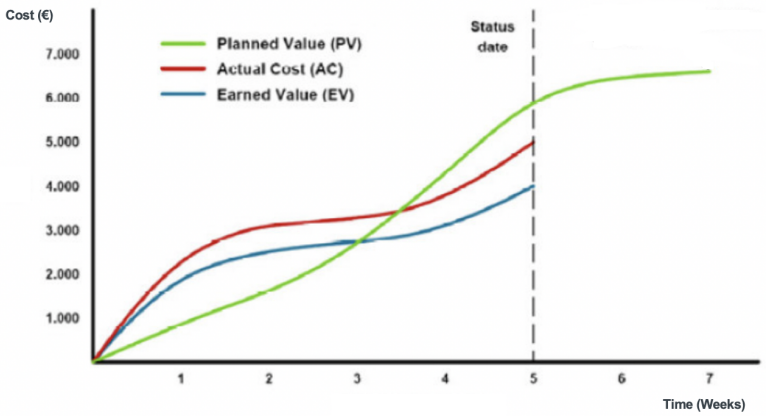

Figure 3.6: Planned Value vs. Actual Cost vs. Earned Value

3.2.2.3 EVM Indicators

"The Earned Value Analysis aims to answer capital management questions. Indeed, the three inputs allow calculating time and cost indicators, and their interpretation gives information regarding time and cost performance of the current project at a given time, and also forecasts" [17]. The indicators can be divided in three categories:

- **Status indicators**
- **Performance indicators**
- **Forecast indicators**

3.2.2.4 Status Indicators

There are two status indicators, one related to budget and another related to schedule. These indicators help the project manager know if the project is over or under budget and ahead or behind schedule [13].

1. **Cost Variance (CV)**

   Cost Variance is used to analyze the project in terms of cost performance. A Project manager by using the CV is able to check whether the project is under or over budget [16]. If CV is positive the project is costing less than planned, if it is negative, the project is over budget.

   The CV is the result of the following equation:

$$CV = EV - AC \tag{3.1}$$

2. **Schedule Variance (SV)**

   Schedule Variance is used to analyze the project in terms of schedule performance. The SV enables the project manager to check whether the project is ahead or behind schedule [16]. If SV is positive the project is ahead of scheduled and if it is negative, the project is behind scheduled.

   The SV is the result of the following equation:

$$SV = EV - PV \tag{3.2}$$

   These two indicators are illustrated in the figure 3.7

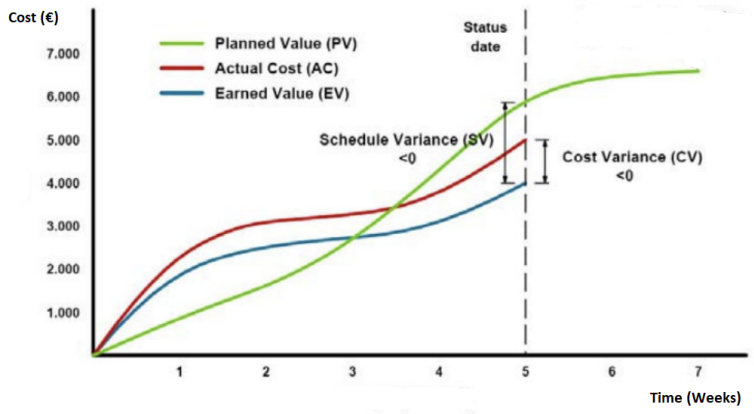

Figure 3.7: EVM Status Metrics

The table 3.2 summarises and explain the status indicators:

Table 3.2: Status indicators

Project Critical Issue	EVM Status Indices	Explanation
Under or over budget?	Cost Variance (CV) CV = EV – AC CV (%) = CV/EV	CV < 0: over budget; CV = 0: on budget; CV > 0: under budget. The project is CV % over/under budget.
Ahead or behind schedule?	Schedule Variance (SV) SV = EV - PV SV (%) = SV/PV	SV < 0: behind schedule; SV = 0: on schedule; SV > 0: ahead schedule. The project is SV % behind/ahead schedule.

3.2.2.5 Performance indicators

Performance indicators appraise the efficiency which cost and schedule are being handled in the project evidencing the current performance of the project. Using these indicators it can be assessed if the budget and schedule are being efficiently used [13].

1. **Cost Performance Indicator (CPI)**

   The Cost Performance Indicator is used as a key measure for analyzing the project cost efficiency. It measures the rate at which value is earned for the actual costs incurred or a measure of the cost efficiency of the work accomplished [16]. The CPI gauges how efficiently the team is using its resources and can be interpreted as the project having an efficiency

which provides CPI cost units worth of work for each cost unit spent in the project to date [13].

It is the result of the following equation:

$$CPI = EV/AC \tag{3.3}$$

2. **Schedule Performance Indicator (SPI)**

   Schedule Performance Indicator (SPI) is used as a crucial measure for analyzing the project efficiency in terms of its schedule. The SPI is the rate of progress against the original schedule with respect to time, or a measure of schedule efficiency of the work accomplished [16].

   It can be interpreted as on average, for each month worked on the project, considering X working days, only X*SPI days worth of the planned work is being performed [17].

   It is the result of the following equation:

$$SPI = EV/PV \tag{3.4}$$

The table 3.3 summarises and explain the performance indicators:

Table 3.3: Performance indicators

Project Critical Issue	Performance Metrics	Explanation
How efficient is the use of resources?	Budget Performance (BP) BP = EB/AB	BP < 1: poor cost performance BP = 1: efficient cost performance BP > 1: excellent cost performance
How efficient is the schedule?	Time Performance (TP) TP = EB/PB	TP < 1: poor schedule performance TP = 1: efficient schedule performance TP > 1: excellent schedule performance

The table 3.4 compacts all the possibilities and meanings of the status and performance indicators.

Table 3.4: Performance indicators results interpretation

	SV>0 & SPI>1	SV=0 & SPI=1	SV<0 & SPI<1
CV>0 & CPI>1	Ahead schedule Under Budget	Within Schedule Under Budget	Behind schedule Under Budget
CV=0 & CPI =1	Ahead schedule Within Budget	Within Schedule Within Budget	Behind schedule Within Budget
CV<0 & CPI<1	Ahead schedule Over Budget	Within Schedule Over Budget	Behind schedule Over Budget

3.2.2.6 Forecast indicators

One of the main advantages of EVM method is the possibility of performing forecasts, in terms of Budget and Schedule, for the final date of the project. Using those forecasts, managers can have a bigger picture of the overall project and decide what actions should be addressed to the project [13].

1. **Estimate at Completion (EAC)**

   This indicator is very important because it estimates the final cost of the project. Assuming that the CPI remains constant for the duration of the project the index is result of the following equation [13]:

$$EAC = BAC/CPI \tag{3.5}$$

2. **Estimate to Complete (ETC)**

   This indicator provides a forecast of the amount of resources that will be necessary to finish the project. Assuming that the CPI remains constant for the duration of the project the indicator result of the following equation [13]:

$$ETC = (BAC - EV)/CPI \tag{3.6}$$

3. **To Complete Performance Indicator (TCPI)**

   To achieve the defined budget at completion (BAC), the Cost Performance Indicator (CPI) for the remaining work must improve to TCPI. This indicator helps to determine how efficient must be the remaining work to meet a specific endpoint [16].

$$TCPI = (BAC - EV)/(BAC - AC) \tag{3.7}$$

4. **Variance at Completion (VAC)**

The metric used for a project manager to discover whether the project will finish under or over budget. The VAC is the result of subtraction of the Estimate at Completion (EAC) from the Budget at Completion (BAC) [16].

$$VAC = BAC - EAC \tag{3.8}$$

$$VAC(\%) = VAC/BAC \tag{3.9}$$

When VAC>0, project manager finds that the project will finish under budget. On the other hand, when VAC<0, the project manager finds that the project will finish over budget.

The table 3.5 summarises and explain the performance indicators [17]:

Table 3.5: Forecast indicators

Project Critical Issue	**EVM Forecast Indices**	**Explanation**
How much is the project likely to cost?	Estimate at Completion (EAC) EAC = BAC/CPI.	Assuming a constant CPI, the project is likely to cost at completion EAC.
What will be the remaining work cost?	Estimate to Complete (EtC) ETC = (BAC – EV)/CPI	Assuming a constant CPI, the remaining work will cost ETC.
How efficiently must we use our remaining resources?	To Complete Performance Index (TCPI) TCPI = (BAC – EV) / (BAC – AC)	To achieve the BAC, the CPI for the remaining work must improve to TCPI.
Will we be under or over budget?	Variance at Completion (VAC) VAC = BAC - EAC VAC (%) = VAC/BAC	VAC < 0: over budget at completion VAC = 0: on budget at completion VAC > 0: under budget at completion There will be an additional cost of VAC (%) of the initial cost.

3.2.3 Earned Schedule

Although Earned Value method is one of the most appreciated and well-known project management cost analysing tools, its success has not extended to schedule performance. EVM schedule indicators are, contrary to expectation, reported in units of cost rather than time which makes it difficult to compare with schedule base indicator (like critical path end dates).Therefore, it was necessary to developed other time (schedule) related metrics which seemed more appropriate [18].

To solve the problems mentioned above, some other factors and metrics can be introduced. The Earned Schedule (ES) idea is analogous to EVM. It allows EVM metrics to be transformed to time or duration metrics to enhance the evaluation of project schedule performance and to forecast the duration needed to complete the project. ES extends the use of EVM data to the assessment of the project's schedule status and the forecast of its completion time. These additional insights regarding the schedule are gained without the need for additional data collection and related cost [16].

3.2.3.1 Earned Schedule Indicators

1. **Schedule at Completion (SAC)**

   Can be defined as the Original planned project duration (in days,weeks,months, etc.) of the project.

2. **Earned Schedule (ES)**

   The idea of Earned Schedule is the same as Earned Value but for schedule. In other words, it can be defined as the duration from the beginning of the project to the date on which the Planned Value should have been equal to the current value of Earned Value[13].

3. **Actual Time (AT)**

   Represents the duration from the beginning of the project to status date.

4. **Time Variance (TV)**

   Time variance is the difference between Actual Time and the Earned Schedule. If TV value is negative, the project is behind schedule and if it is positive, it is ahead of schedule.

$$TV = AT - ES \tag{3.10}$$

$$TV(\%) = TV/AT \tag{3.11}$$

Figure 3.8 demonstrates the indicators above mentioned, as an example purpose, for a project.

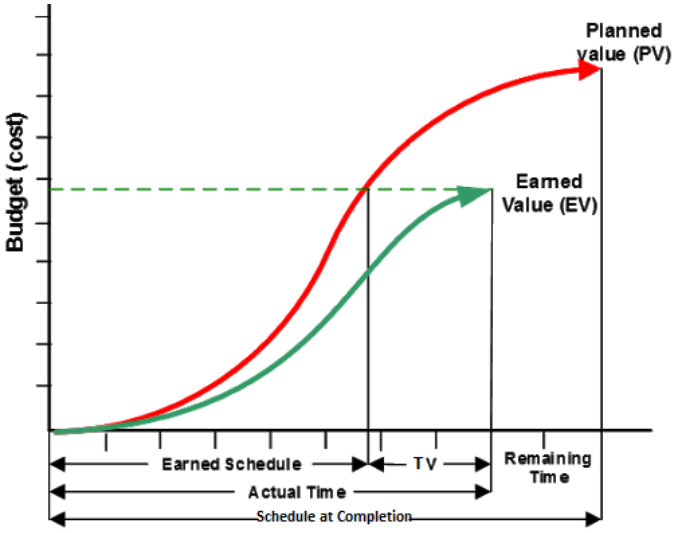

Figure 3.8: Earned Schedule Example Chart

5. **Time performance Indicator (TPI)**

   As with SPI, if TPI is greater than 1, then the project is ahead of schedule and if it is less than 1, then the project is behind schedule.

   Can be defined as:

$$TPI = ES/AT \tag{3.12}$$

6. **Time Estimate at Completion (TEAC)**

   The forecasting of time at completion can be named the time estimate at completion. If the the remaining work will be performed while maintaining the same rate of doing work for the rest of the project:

$$TEAC = SAC/TPI \tag{3.13}$$

7. **Time Variance at Completion (TVAC)**

   Gives an indication of the estimated amount of time that the project will be completed ahead or behind schedule:

$$TVAC = SAC - TEAC \tag{3.14}$$

In this equation, 0 indicates that the project is expected to be completed on schedule, a positive value indicates that the project is expected to be completed ahead of schedule, and a negative value indicates that the project is expected to be completed behind schedule.

3.2.3.2 EVM Implementation

To effectively implement Earned Value Management it is necessary that the team defines the project scope using a work breakdown structure, planning activities in a logical way so that the lower level tasks support the following elements and their higher level milestones.

Project team need also to assure project control by analyzing the cost and time deviations, evaluating the final costs, checking the changes with respect to the project baseline and developing corrective actions when necessary.

3.2.4 Three Point Estimating

Time estimates are a crucial part of any project success. Indeed, it drives the setting of deadlines for delivery and planning of projects, determine the pricing of contracts and hence the profitability of the project so, an accurate time estimation is essential for the project success.

However, knowing how long a project will take can be difficult because there are a lot of factors that can affect the duration of a project: missed deliveries by suppliers, holidays, absence of key stakeholders and dependent critical tasks may significantly lengthen the time and cost needed to complete a project.

Therefore, when it is necessary to estimate the time of a task it is recommended to lean on reliable techniques that helps a company be more accurate in estimating: three-point estimating is a tool that companies can use to help increase the accuracy of cost and time estimates and there are three scenarios which get three different estimates [13]:

- **Most likely (tM):** This estimate is based on the duration of the activity, given the resources likely to be assigned, their productivity, realistic expectations of availability for the activity, dependencies on other participants, and interruptions.
- **Optimistic (tO):** The activity duration based on analysis of the best-case scenario for the activity.
- **Pessimistic (tP)** The activity duration based on analysis of the worst-case scenario for the activity.

When having the estimates, them can be plugged into two different formulas: Triangular Distribution or Beta Distribution

3.2.4.1 Triangular Distribution

The simplest three point estimate is an average of the three values. The Triangular Distribution will usually results in a sharp peak, thus the name Triangular Distribution [19]. The distribution is defined by:

- **Mean Time** = $(tO + tM + tP)/3$
- **Standard deviation** = $(\sqrt{((tO - MeanTime)^2 + (tM - MeanTime)^2 + (tP - MeanTime)^2/2)})$
- **Mean optimistic time** = $Mean - StandardDeviation$
- **Mean pessimistic time** = $Mean + StandardDeviation$

3.2.4.2 Beta Distribution

This is a weighted average in which more weight is given to the most likely estimation. The Beta Distribution usually will result in an more uniform curve, and therefore, can be considered a normal distribution [19]. The distribution is defined by:

- **Mean Time** = $(tO + 4tM + tP)/6$
- **Standard deviation** = $(P - O)/6$
- **Mean optimistic time** = $mean^{-}StandardDeviation$
- **Mean pessimistic time** = $Mean + StandardDeviation$

3.2.4.3 Confidence Intervals

The standard deviation σ allows determination of the percentage probability of the confidence level for a given estimate. Depending on the number of sigmas σ, the confidence level of the estimate is as follows [20]:

Table 3.6: Confident Intervals for 3-Point-Estimation

Number of Sigmas	Confidence Level
1	68.25 %
2	95.46 %
3	99.73 %

3.2.4.4 Triangular or Beta Distribution: When and why?

The Triangular Distribution is used when there is no previous historical data of similar projects to fall back on as there is no basis to give more weight to the most likely estimate.

If the project is similar to an usual type of projects and there is a lot of historical data, the Beta Distribution is preferred and more useful because the estimates of the optimistic, pessimistic and most likely values rely on historical evidence and experience.

As with all estimates, the fundamental part of any of the distributions is the three scenario estimates. The more accurate the estimates, the better the Triangular and Beta distributions describe reality, and the better we are able to estimate the project risk and its completion on budget and schedule [20].

3.3 Project Management Tools

Project management tools help project managers plan, track and control the most important aspects of the projects. With increasingly complex projects, companies invest in these tools to allow an overview of all projects, trying to ensure that each task is completed on time and within budget.

This section overviews the two main project management tools currently employed at Vestas, namely JIRA and Power BI.

3.3.1 JIRA Software

JIRA Software is a commercial software that combines issue collection and project management capabilities into a single application, allowing the monitoring of tasks and monitoring of

projects and ensuring the management of all its activities is in one place [21]. Therefore, using JIRA Software helps plan, organize tasks and workflows for the project management team more efficiently [22].

The JIRA tool is used for creation of the task level planning and allows project tasks handling on a daily basis.

As it is an organisational objective to use JIRA across all teams, the current structure and rules of managing the software will be detailed this section.

3.3.1.1 JIRA Project Breakdown Structure

The first step to set the project in JIRA is the issue creation. Issues are the building blocks of any JIRA project and could represent a story, a bug or a task in the project. When creating an issue in JIRA it is necessary to breakdown the work structure, as it is illustrated in Fig 3.9.

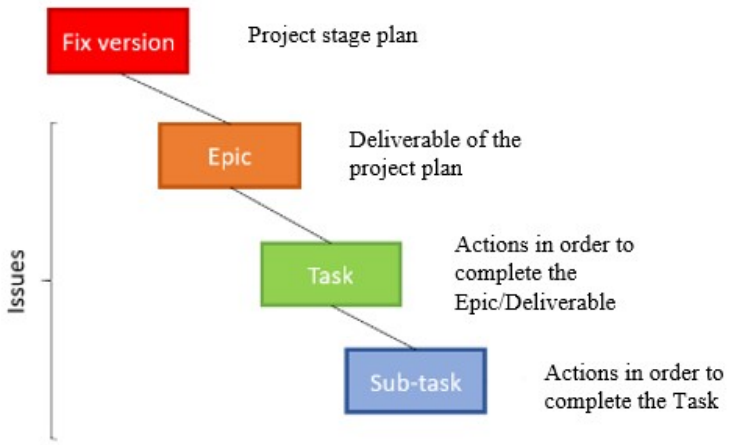

Figure 3.9: JIRA Project Breakdown Structure

When creating an issue in JIRA it is mandatory to set:

- **Project stage plan (fix version)**
- **Issue Type**
- **Issue Start and End Dates**
- **Issue Assignee and Reporter**
- **Issue Original Duration Estimate**

However, more fields are available in order to detail the plan even more in the software if necessary.

3.3.1.2 JIRA Tracking

After issue creation, JIRA allows issue tracking. In order to track issues in an effective way with the software it is necessary that the JIRA Project reflects exactly the real one. Therefore, all work must be logged and JIRA project fields must be updated when changed.

For time tracking there are three different fields: Original Estimate, Remainig Estimate and Logged/Spent Time. Figure 3.10 illustrate how JIRA displays these fields.

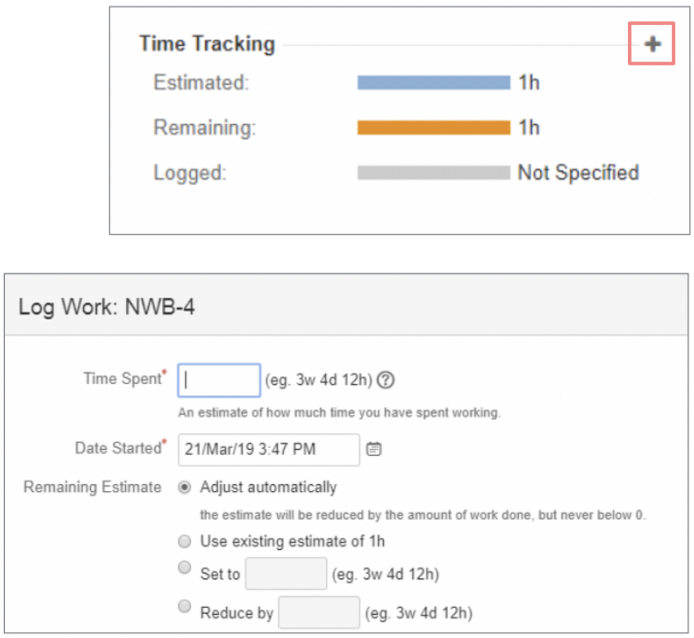

Figure 3.10: JIRA Time Tracking

Another important tracking field is workflow. In JIRA, workflow is used to track the lifecycle of an issue. Workflow is a record of statuses and transitions of an issue during its lifecycle. A status represents the stage of an issue at a particular point. An issue can be in only one status at a given point of time like To Do, In Progress or Released. The tasks workflow/status must also be updated to reflect the project real state.

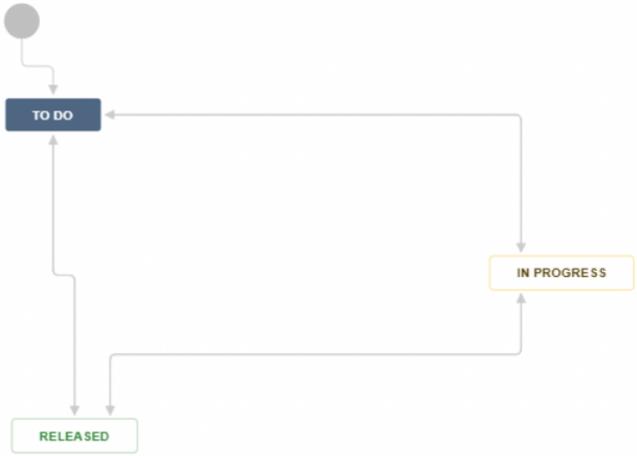

Figure 3.11: Workflows

3.3.1.3 Big Picture JIRA add-on

JIRA is a highly customizable tool so it allows the installation of add-ons for tailoring the software to fit the company needs the best. JIRA add-ons are pieces of software that plug into the JIRA task management platform and provide new and augmented functionality. The Big Picture add-on, adopted by Vestas, features:

- **Gantt chart** - To keep a portfolio-level view of all the projects easily
- **Scope** - WBS of the project, multi-level hierarchies, quick filters, and advanced aggregation
- **Resources** - Allows analyze the availability of resources (teams and skills), assign and schedule particular tasks and update capacities automatically.
- **Risks** - Allows a matrix to be designed to show a visual representation of sensitive issues.

3.3.2 Power BI

Nowadays, it is undeniable that "Business intelligence systems are becoming increasingly important for many organisations as the volume of data gathered from operative processes, environment, and customers grows" [23]. Businesses have more data available to support their decision-making processes than ever since softwares (like JIRA, used in Vestas) have led to a rapid increase in the amount of data being gathered, culminating in a lot of potential information to be used.

However, the continuously growing amount and complexity of data being gathered is not valuable by itself because people have a limited capability to process information. Therefore, it is necessary the development of tools to assist in making the relevant information available to those who need it for making decisions [23].

More than ever, we live in data culture, where business decisions are based on facts and not opinions. So, data is imperative to make these supported decisions.

According to Microsoft, Power BI makes this data analysis easier because the data becomes charts and graphs with unchallenging interpretation. Instead of long lists or tables of numbers and words, the data insights are colorful and compelling visuals that show for themselves the insights in the data as in figure 3.12.

Figure 3.12: Power BI report Example

Power BI service also features browser and mobile device access, meaning that the reports produced in a personal computer can be accessed from other devices .

Figure 3.13: Power BI devices connection

As the content isn't static, it is possible to dig in, looking for trends, insights, and other business intelligence: slice the content, send alerts when data changes, and email reports on a schedule settled [24].

3.3.2.1 Vestas' Automated Reporting

In Vestas, Power BI is used for reporting purposes being a placeholder of the most relevant information on a project, time, cost and resources.

Power BI is purely a viewing tool which allows visualization of a broad range data through easy-to-use dashboards and analysis of data with greater speed, efficiency, and understanding.

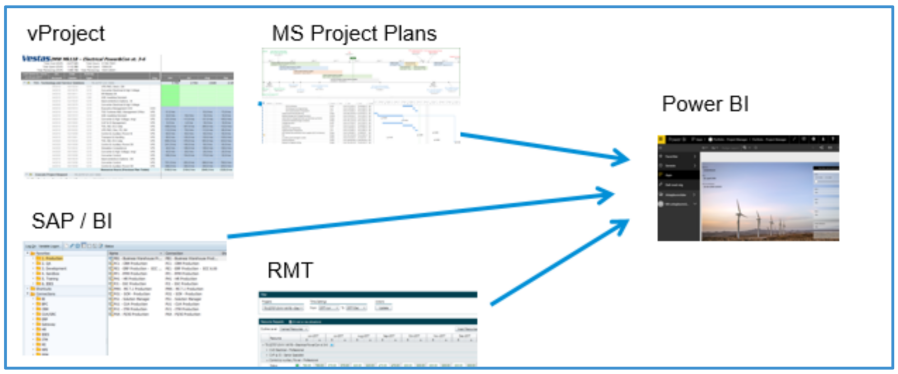

Figure 3.14: Power BI Reporting in Vestas

Chapter 4

Current Situation

This chapter is divided into two parts. Firstly, a presentation of the Vestas Management System will be provided, focusing on the Vestas Power Solutions Business unit, bearing in mind the scope of this project. Secondly, a Current State Diagnosis will be conducted, in other words, a problem identification and description is performed to assess if Vestas Management System practices are followed by everyone and if they can be improved and how.

4.1 Introduction

Vestas is divided in multiple areas which are highly dependent on each other. Therefore, it is very common for people with different levels of expertise and from diverse departments to work together in cross functional projects.

Projects are considered cross functional when the project scope is within two or more functional areas and when people from those areas are required to develop and implement it. Since this is a company that comprises both operational and technological sides, projects usually fall into this category as new products or improvements require the technical implementation or involvement from other areas.

The dynamic environment of the renewable energies market and the rapid growth of the company in the past years, associated with the new organisational restructuring due to modularization are making the project management process more complex. Thus, project managers face a more challenging environment than ever, requiring adaptation of the current project management processes and methods.

4.2 Vestas Management System

The current section is aimed at providing insight into Vestas' current Management System in Vestas Power Solution business unit.

4.2.1 Project Execution Model

Vestas is organized in a matrix organisational structure that facilitates a combination of a project organisation structure and a functional organisation structure.

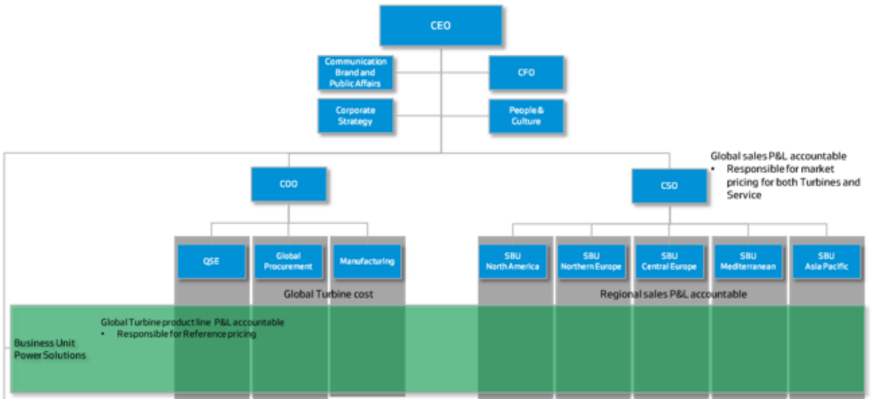

Figure 4.1: Matrix organisational Structure

Vestas has decided that the foundation of the governing principles and definitions should be based on the methodology of PRINCE2 project management.

In conjunction with the methodology and terminology provided by PRINCE2, Vestas defined a clear process landscape, Stage gate Model and Execution approach that guide and align project work:

- **Vestas Process Portal (VPP)** is the compilation of Vestas' internal ways of working which are described in process flows that convey information regarding the what, who and how of executing activities.
- **Vestas Way to Market (VWtM)** is the internal Stage Gate Model designed to give a structured framework that enables both planning and governance of a generic list of deliverables for projects based on processes described in VPP.

4.2.1.1 What is a Project?

In Vestas Power Solutions, all projects have the following generic definition and characteristics:

- A temporary and finite lifecycle with defined start and end.
- A defined and measurable business products with a fixed scope and a specified business case.
- A defined and assigned cross functional project organisation handling a set of activities. required to achieve the outcomes
- A business approved budget which includes project expenses and man-hours.
- A standardized governance with clear awareness of accountability and responsibility.
- Changes over time which generate uncertainties that require risk management.

At the Porto Design Centre, the budget is mainly assigned to Product Development Projects, and **modules** work especially for them so, taking into account the perspective of the current dissertation, Product Development projects are the ones that will be outlined.

4.2.1.2 Product Development Projects

Product Development Projects consist in bringing new products to market and marking upgrades based on already existing platforms. The projects can be either major changes from existing products or the way the product is made or delivered.

Product Development projects are divided into different subcategories, including Wind Turbine Generator Platforms as well as Modular Product Development (MPD). As stated in the previous chapter, MPD is the future structured way to deliver products to market, although it is still in the early stages of development.

4.2.1.3 Project Framework

The Project Framework consists in a structure of principles and guidelines that is used throughout the project life-cycle as a foundation for creating, selecting, bringing in and using methods and the best practice of project management.

The 7 principles can be used irrespective of the size, type or organisation of the project:

1. Continued Business Justification
2. Learn from experience
3. Defined roles and responsibilities
4. Manage by stages
5. Manage by exception
6. Focus on products
7. Tailor to suit the project environment

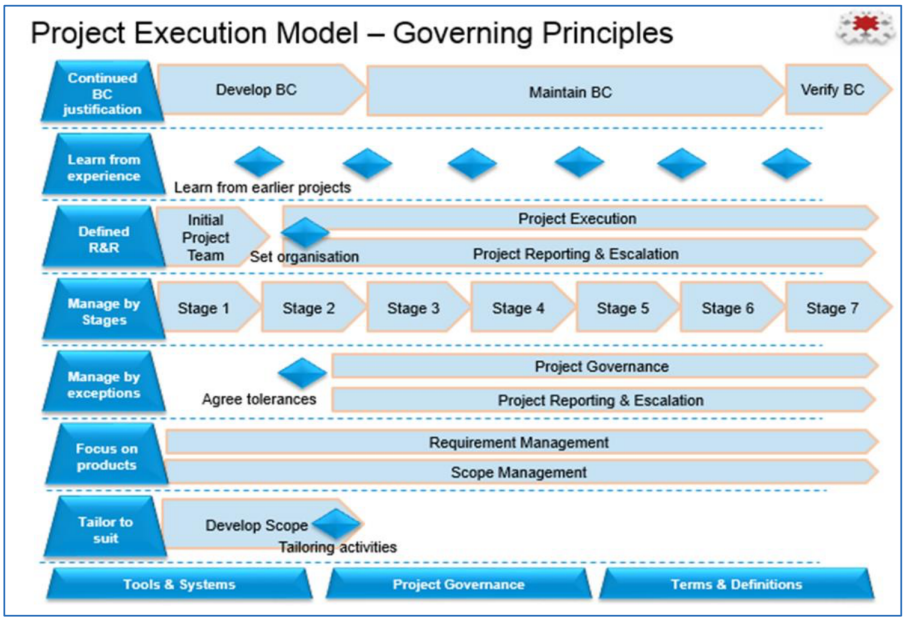

Figure 4.2: Framework Principles and guidelines in the Vestas Environment

4.2.2 The Project organisation

A successful project organisation has a well-defined structure, which clearly defines both accountability and responsibility, and ensures that all parts of the project organisation work together so as to enable the project that will deliver the required products and achieve targets.

The Project organisation should also reflect the most efficient setup in relation to making the right decisions on the right level of the project. Each project present its unique characteristics in terms of scope and deliverables, budget, timeline, risk profile, stakeholders etc. To deliver

the project results and integrate the solution into the business, it requires good cross functional collaboration across the value chain.

This balance is handled in the Project Steering Committee (Steer Co), where the Project Owner is the chairperson of the Committee and has the responsibility to represent the Business and commercial perspectives.

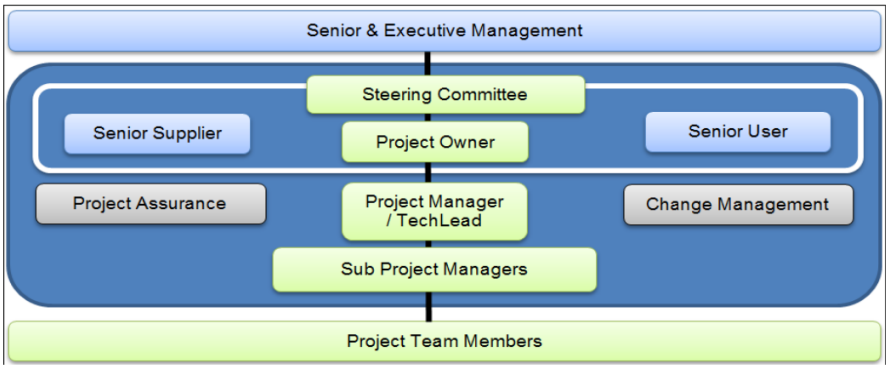

Figure 4.3: Project organisation

The Senior and Executive Management is not a part of the Project organisation but sets the overall scope framework for the project, which Roadmap the project is linked to, and what are the high-level project KPIs involved in the execution of the project.

- **Project Owner** - Is a representative from the Senior and Executive Management and accountable for delivering the project in accordance with the Business Case.
- **Project Steering Committee** - The Project Owner and representatives from Senior Users and Senior Suppliers form the highest level of management within the Project organisation - The Project Steering Committee - which is responsible for the overall management and control of the Project. Therefore the accountability of the project's success and failures lies the Steer Co carries.
- **The Project Manager (PM)** - requested by the Project Owner to manage the project execution. The Project Manager is responsible for the daily management of the project and will be responsible for setting the Project organisation needed to secure delivery of project products and achieve targets. Taking the size and number of specialist areas required to deliver the project result into account, the Project Manager designs the project organisation to fit with the organisation and the needs of the project.

  Depending on the size of the project, other project managers may be allocated to the project to secure detailed organisation, planning and follow up.

- **Technical Lead (TL)** - is appointed to ensure that the right technical solutions are developed in the project. The request and recommendation are typically the output of dialogues between the PM and Line Managers (Resource Owners).

4.2.2.1 Dynamism in Project organisation

The way of working with projects in Vestas also is reflected in a dynamic project organisation where project participants can be changed throughout the project depending on the required competences in the different stages of the project.

To identify and allocate the project organisation for the project execution, the Project Manager start the tailoring process for the full project in the initiation phase, where the project scope is compared with the standard processes in VWtM: standard milestones and activities that are not adding value to the specific project products and targets are taken out of scope. The tailoring is done across the value chain to ensure representation of the full project life cycle.

After the tailoring, the Project Manager links the remaining milestones and activities to the needed roles and responsibilities upon agreement with Line organisation; the Project organisation is established, followed by a final signature of the Project Owner.

Depending on whether the project is a low, medium or high complexity project, the project organisation is set accordingly.

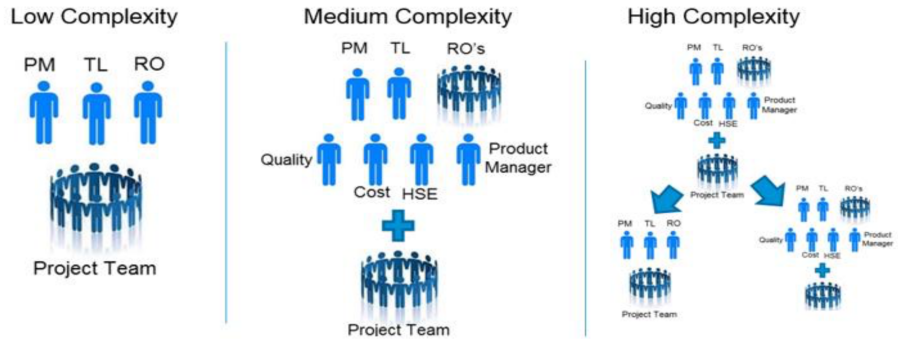

Figure 4.4: Project Complexity

4.2.2.2 Main project and Subproject link

Projects are sometimes broken into a number of more manageable subprojects or work packages:

- **Subproject:** A defined scope with budget, timing and quality targets delivering into the main project (aligned with the overall Business Case targets). The subprojects are often managed by a Project Manager (Project Role).
- **Work Package:** A defined smaller and simpler scope with budget, timing and quality targets delivering either into a subproject or the main project (aligned with the overall Business Case targets). The Work Packages are often managed by the Line Manager or delegated to a Technical Lead.

The Business Case is anchored in the main project and from here it is broken down into more manageable subprojects or work packages if necessary.

To link the main project and subproject together, the following elements are necessary:

- Milestone Planning (Level A) on Business Case project is broken down into deliverable planning (Level B) on the subprojects in the Microsoft Project planning tool.
- Ensure readiness for next stage with regard to plans, resources and budget
- A Communication Strategy in place, which contemplates how to secure a structured communication with the subprojects.
- Project Documentation is anchored in a standard Project Directory

4.2.3 Project Planning, Tailoring and Monitoring

The purpose of project planning consists in taking control of the individual project and being able to monitor it, as well as providing follow-up at each project level. The software systems used for project planning are SAP PPM, Microsoft Project and JIRA.

In Vestas, there are different Planning levels as illustrated below.

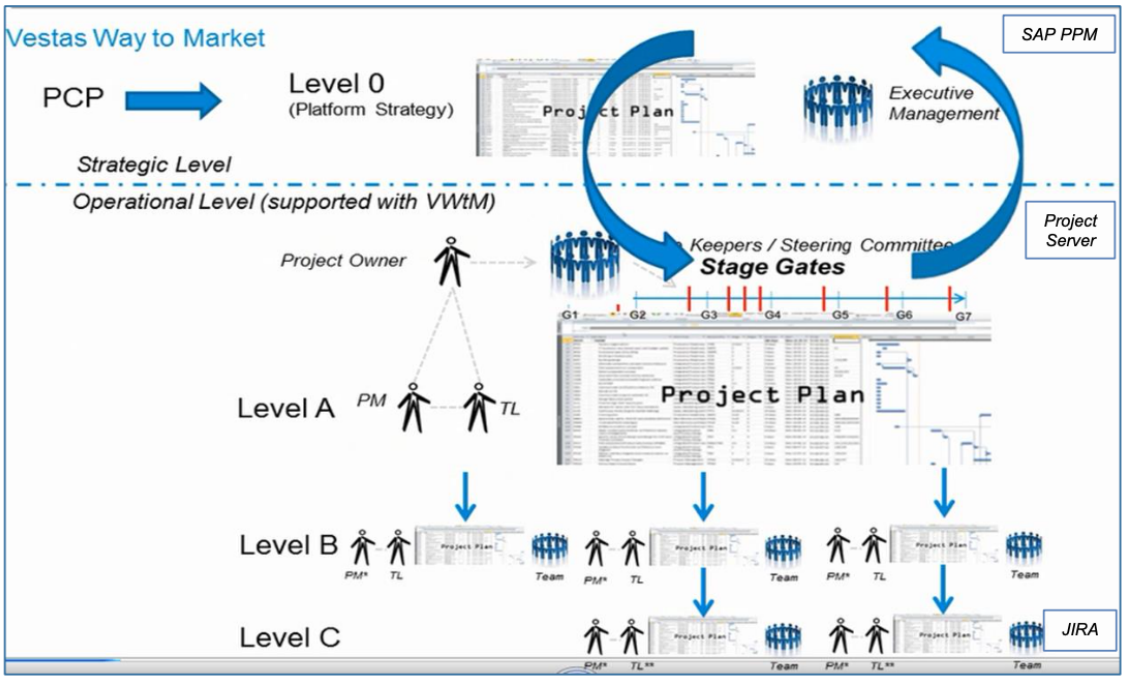

Figure 4.5: Planning and Communication levels

The highest level of planning in Vestas is the strategic level which aims at having control over the overall Portfolios and Programs in VPS. The system used for Portfolio and Program Planning is SAP PPM.

- **Level 0** is the Business Case high-level plan and is named Project Control Plan (PCP) and includes VWtM Gates and selected VWtM milestones.
- **Level A** is the PMs overall project plan and includes VWtM Milestones Delivery Sheet (MDS) and Activity Delivery Sheet (ADS)
- **Level B** is typically the System level plans. A PM is responsible for each level B plan including Work packages/ ADS/ MDS.
- **Level C (Task level)** is the detailed level plan where a task is assigned to a project participant and includes executable tasks. This level is the main analytical basis for the drafting of the current dissertation project .

Figure 4.6 illustrates the creation of Level A and B plans.

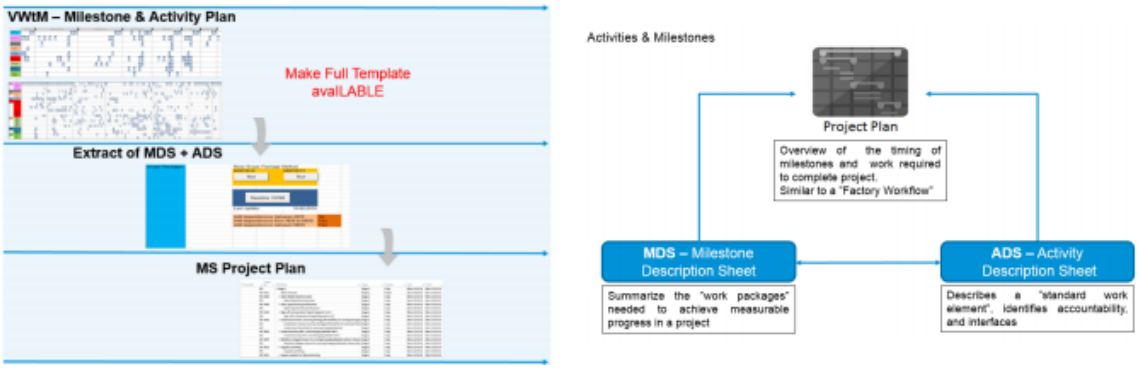

Figure 4.6: Level A and Level B Planning

4.2.3.1 Level B to level C (Task Level) planning: Dissertation Project Scope

Once work packages are finalized and agreed upon, the scheduling process is initiated. At this point, potential deviations are identified and suggestions for mitigation activities will become part of the plan.

Regular iterations will ensure that work packages are refined and detailed further according to the rolling wave planning principle.

After establishing the overall schedule, workshops/planning sessions are conducted where the Technical Lead, Project Manager and other relevant parties' breakdown the work packages into executable tasks. This forms the overall structure of level C or Task level plan.

These tasks are individually generated and managed in JIRA by engineers, and specialists are allocated to those specific tasks (Not all projects and teams are using JIRA yet, but the organisation objective consists in having the whole Power Solutions organisation make use of the tool). Furthermore, based on the change in priorities and scope, the Project Plan and Schedule are updated accordingly in the software.

It is imperative that the project has a reliable correlation between level B Plan and level C plan (JIRA), and ensures request and allocation of resources to the identified tasks in level C plan.

Figure 4.7 illustrates all planning levels and used software for tracking.

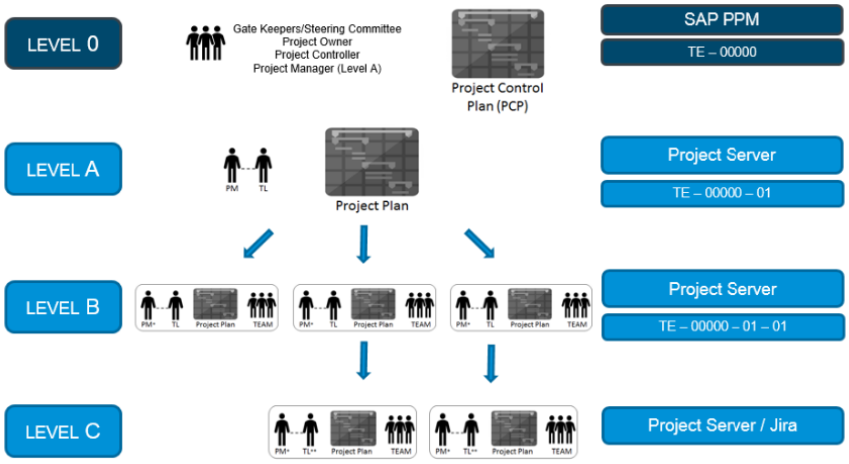

Figure 4.7: Breakdown of Planning levels and Systems

4.2.4 Project Reporting

The Project Progress Report is a primary source of communication from the Project Manager to the relevant project stakeholders regarding project status and progress. The Report constitutes a means of drawing attention to the project's progress by raising potential risks, and communicating challenges for the different performance targets. The report must be concise and precise, since misleading information and inconsistency will eventually lead to a management misalignment of the project status.

All PMs are expected to deliver a Project Progress Report on a regular basis. In Power Solutions, as far as contents are concerned, the Project Progress Report should include the elements listed below:

- Progress according to plan
- Potential resource constraints
- Financial status
- Top project risks
- Hot issues

The progress reports include traffic lights (green, yellow, red) to provide information of status on time, resource and budget. If issues should escalate, the escalation report for these issues is to be included in the project report.

Figure 4.8: Reporting Template

4.3 Current State Diagnosis

As outlined in the previous section, the lyfecycle of a project begins with the approval of the high level project team by Vestas, when a budget and schedule is assigned to the project. After that, Project Managers and Technical Leads break down the high level project in order to identify all the tasks that form the low level plan which is the task level (level C planning).

After task identification, budget and schedule for each task are defined, tasks are assigned to technicals in order to be performed. Projects must be delivered always taking into account the agreed project sphere within the tolerances for time, cost, quality, scope, risks and benefits.

In order to achieve this, it is necessary to have perfect execution and control of the project. Therefore, the projects' plans should be mirrored and managed using JIRA software so that daily management and close follow-up can be performed. All stakeholders must update JIRA software data in order to reflect the daily work that is being performed.

Moreover, communication is needed to secure the information flow in relation to project the performance status, and escalations must occur when necessary. Therefore, all important information must be reported to relevant stakeholders.

Although Vestas has defined a clear process landscape, Stage Gate Model and Execution approach that guide and align project work, the MPD implementation brings new management requirements and more demanding methods to assure correct project management. Given this need, the maturity of projects' plans needs to increase.

In this section, identification and description of current management system problems are presented, based on several Project Managers surveys and statistical analyses of finalized project plans, so that a new Planning Framework can be developed to improve the management system.

4.3.1 Problem Identification

Projects in Vestas are not mature enough, therefore in order to improve organisational efficiency regarding plans, in 2020 Vestas launched a new organisational efficiency challenge that aims to refine the way people work, so that more time can be made available to the things that really matter.

By simplifying work processes and focusing on the value adding activities, further time will be available to design new products, to increase the pace and be more flexible, as well as to achieve richer job content. This is a key enabler for the implementation of Modular Product Development.

The organisation established six efficiency key points to be developed as a priority:

1. **Focus on upfront planning & daily/weekly follow up**: improve the way of planning, making sure to stick to the plan and manage follow up more efficiently.
2. **Focus on design**: spend less time on administrative work and more time on the design processing.
3. **Focus on the deliverables and timeline first – then the hours**: have a mindset where the focus is on getting deliveries right on time, rather than on the hours spent.
4. **Faster decision-making**: speed up the decision-making time.
5. **Take a stand and make a decision**: make sure the most suitable people are gathered at meetings in order to make the decisions needed.
6. **Focus on uniformity to ensure flexibility**: streamline the way work is done to ensure flexibility.

"Deliver on Time" was the major point which motivated Vestas' focus to improve planning methods and the maturity of project plans. In order to better understand other problems managing projects, two different project plans belonging to the Nacelle module (pilot module for this dissertation project) were assessed.

Projects chosen for analysis were Project Nacelle AMT and Project Nacelle REAR. As explained in section 4.2.1.3, projects are managed by stages (each stage is a new plan with different deliverables, budget and timeline).

In the moment of the analysis, five stages of the Projects were already completed, being stage five the last stage that occurred for both projects. Therefore, in order to obtain current and realistic data, plans chosen were Nacelle AMT - stage 5 and Nacelle REAR - stage 5, the last ones performed. These plans belong to the Nacelle module, the one considered in this dissertation project.

Moreover, two reports were used to assess the pain points as reporting is a fundamental area of a project. Reports include more than the 2 projects mentioned above but they work as an example purpose.

All the information mentioned above is necessary to reach the intended goal of the proposed dissertation project, which consists in ensuring that project managers have a uniform, standardized and structured management and decision framework that is logical, robust, repeatable and which guarantees that all stakeholders are provided with clear information regarding the project status.

4.3.2 Problem Description

Pain Points identified may be organised in three different dimensions of the Plan Timeline: Planning Dimension, Tracking Dimension and Reporting Dimension.

4.3.2.1 Planning Dimension Pain Points

Using the data made available by the organisation, a statistical assessment was conducted and is summarised in table 4.1.

Table 4.1: Planning Dimension Assessment

Plan	Overbudget Issues	Overschedule Issues	Dependencies Identified	Critical Path Identified	Other Scheduled Activities	Between 8 & 80 Hours Issues
AMT Stage 5	19%	82%	No	No	No	37%
REAR Stage 5	15%	78%	No	No	No	30%

After careful analysis, it may be concluded that:

- Plans show more than 10% overbudget tasks, which is an organisational target.
- The result for overschedule tasks is extremely high. That may happen because schedule estimations are not performed, thus the efficiency key point 3 is not verified.

- Dependencies were not identified for both plans and therefore no critical path was identified either, which increases uncertainty regarding project, and the efficiency key point 3 is not verified.
- Time spent, mostly on vacations, was not considered when assigning and estimating tasks.
- The Project Execution Model rule of breaking down the project tasks into an 8 to 80 hour period was not followed consistently.

Using the PM's survey information and the statistical information, the pain points of the planning dimension were summarised:

- Accuracy when estimating Budget is not enough
- Estimations or any other type of measurements are not performed for Schedule
- Relevant dependencies between tasks are not identified and not linked
- Critical path is not defined
- Other scheduled activities of project stakeholders are not considered in planning timeline
- Task Duration of all tasks is not comprehended between 8 and 80 hours, which is an organisational rule

4.3.2.2 Tracking Dimension Pain Points

Using the data of JIRA software made available by the organisation, a statistical assessment was conducted and is summarised in table 4.2, displayed below.

Table 4.2: Tracking Dimension Assessment

Plan	JIRA Original Estimates Filled	JIRA Start & End Dates Filled	JIRA Issues Status Updated	Other Programs Used to Track	Project Assessment Metrics
AMT Stage 5	78%	100%	66%	SAP Microsoft Projects	No
REAR Stage 5	57%	100%	80%	SAP Microsoft Projects	No

Upon analysis of the information presented above, the following conclusions can be drawn:

- Although Start & End Date fields are all filled in JIRA software, Original Estimates fields are not, which represents a problem to track budget and also schedule during the project.
- Tasks were not updated as expected which is a problem because if tasks fields are not updated in JIRA, the software cannot be used to reliably track projects and wrong conclusions may be taken.
- In order to track the project, it was necessary to use other programs rather than JIRA because all the necessary information was not available, which breaks the efficiency key points 4 and 6.
- JIRA does not feature metrics for project status, performance and forecast, hence it has not been possible to verify the efficiency key point 1.

Using the PM's survey information and the statistical information, the pain points of the tracking dimension were summarised:

- A lot of information has been left unfilled in JIRA software.
- Project information is spread across multiple programs because JIRA information fields currently used are not enough.
- The tracking system that is implemented at the moment provides no forewarning for cost and schedule overruns.
- There are no standard metrics that quantify the plan status or performance.

4.3.2.3 Reporting Dimension Pain Points

The two reports assessed in this subsection are reports that have been accomplished for the same project from two different project managers with four weeks difference:

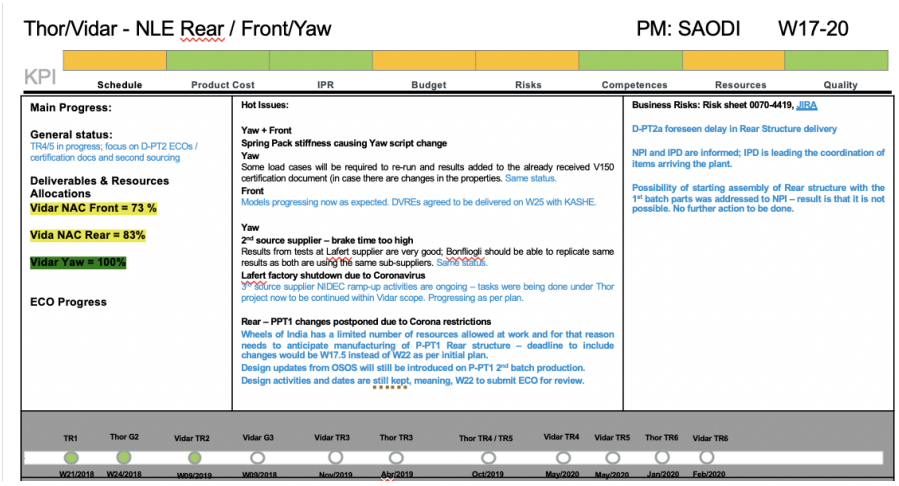

Figure 4.9: Report 1

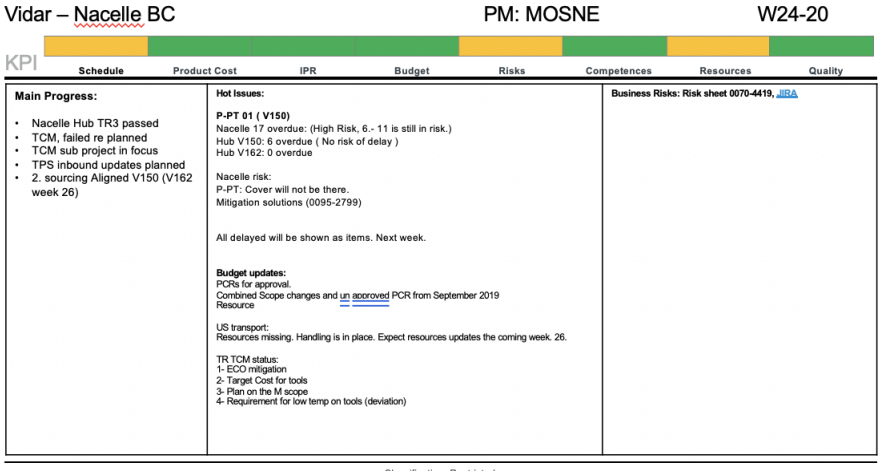

Figure 4.10: Report 2

The following conclusions have been drawn:

- The two reports contain different ways of reporting information for the same parameters: Main Progress, Hot Issues and Business Risk.
- KPIs are indicated in a scale of colours which is subjective and not quantified.

Using the Project Managers' survey information and information from the reports, the pain points of the reporting dimension were summarised:

- No standard criteria for reporting in different plans were established, therefore it was impossible to verify the efficiency key point 6.
- Subjective way of reporting project indicators.

Upon diagnosis of pain points of the current status, and based on the efficiency key points defined by the company, in addiction to the rules which were not followed from Vestas Management System, a framework of action was defined in order to address the pain points.

Chapter 5

Planning Maturity Framework

The current chapter will be devoted to the presentation of the fundamentals of the Planning Maturity Framework tool created, based on the identified pain points and efficiency key points.

This Framework was inspired by the CMMI maturity levels framework and project management methodologies outlined in chapter 3 and was tailored to meet Vestas' organisational objectives. Its purpose consists in: streamlining all the project management rules of the organisation for every dimension of the project, from planning, to tracking and reporting, in order to improve the overall maturity of the projects' plans; introducing project metrics that are necessary to achieve faster and more informed decision making; and providing personalised actions for every plan so that maturity can be improved and metrics deviations can be addressed.

The Framework overview is illustrated in figure 5.1, displayed below.

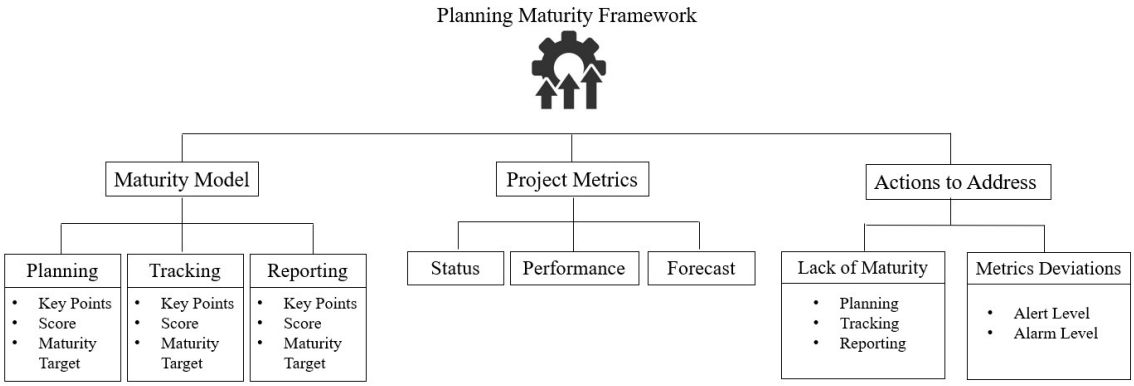

Figure 5.1: Planning Maturity Framework

The first area presents a Maturity Model tailored that is best suited to Vestas. The maturity assessment is based on criteria which are important and constitute a priority to Vestas, in addi-

tion to being necessary to quantify maturity results and allow fair comparisons between company projects.

The second area is a Budget and Schedule metrics system. Vestas has a Project Management System but it does not include a quantified way of measuring the status and performance of a project and, therefore, does not allow forecasting which one is a priority for the company.

The last area is Actions to Address. Based on the maturity assessment and calculated project metrics, deviations will be analysed and actions will be suggested for each plan in order to address each deviation in maturity and in project metrics.

As stated in chapter 4, JIRA software is used in order to have all the information in one place, in order to keep projects visible across teams and stakeholders efficiently. The information in JIRA is the only data source available to assess the project. Therefore, one challenge towards the creation of the Planning Maturity Framework consisted in setting the rules for uploading information of project plans to JIRA software so that necessary and reliable data was assured. If data currently available was not enough, a careful cost/ benefit analysis would be conducted so as to understand whether the inclusion of new fields/features in JIRA software was worth it (more data increases the effort asked from each employee).

5.1 Maturity Model

The first area and the grounding of the Planning Maturity Framework is the JIRA Maturity Model. This area is extremely important because project performance is highly correlated to data maturity. Indeed, company maturity is data maturity nowadays, so it is very important to know the current situation of the organisation.

In order to determinate that, it is necessary to:

- create a model with standard criteria for every module across the organisation so that performance indicators could be obtained to draw conclusions
- define the maturity target (named “Target Maturity”), which reflects the best ratio between the maturity improvement and the effort level needed to achieve that maturity.

The maturity model is divided into the three dimensions set in the last chapter regarding the pain points: **Planning**; **Tracking** and **Reporting**. These three dimensions are connected because it is impossible to achieve a good maturity in tracking without a good planning, and the same applies for reporting - it is impossible to have good reporting without good tracking and planning.

Prior to the presentation of the Planning, Tracking and Reporting Dimensions, the score system of the maturity model will be described.

5.1.1 Maturity Model score system

As stated before, the final objective of the Maturity Model is to get a quantified result to allow comparison between plans. Thus:

1. each dimension has key points which are assessed to get a key point score.
2. the sum of all key point scores provides the dimension score.
3. after several meeting with the PMs team, weighted scores for each dimension were defined.
4. PMs want a stronger focus in the planning and tracking maturity as they believe that problems in reporting could be mitigated improving first the maturity of these two dimensions.
5. was set that the Planning & Tracking Dimensions score would contribute 40% each to the final maturity score. The Reporting dimension score would contribute 20% to the final maturity score. This lower dimension score impact assigned to the Reporting Dimension is attributed to the fact that good reporting comes from good planning and tracking, thus Reporting Dimension score is also being measured in the Planning and Tracking score.
6. the final maturity score, upon agreement with PMs, is calculated using the equation below:

$$FinalMaturityScore = 0,4(PlanningScore + TrackingScore) + 0,2ReportingScore \quad (5.1)$$

Figure 5.2 illustrates the maturity score system logic:

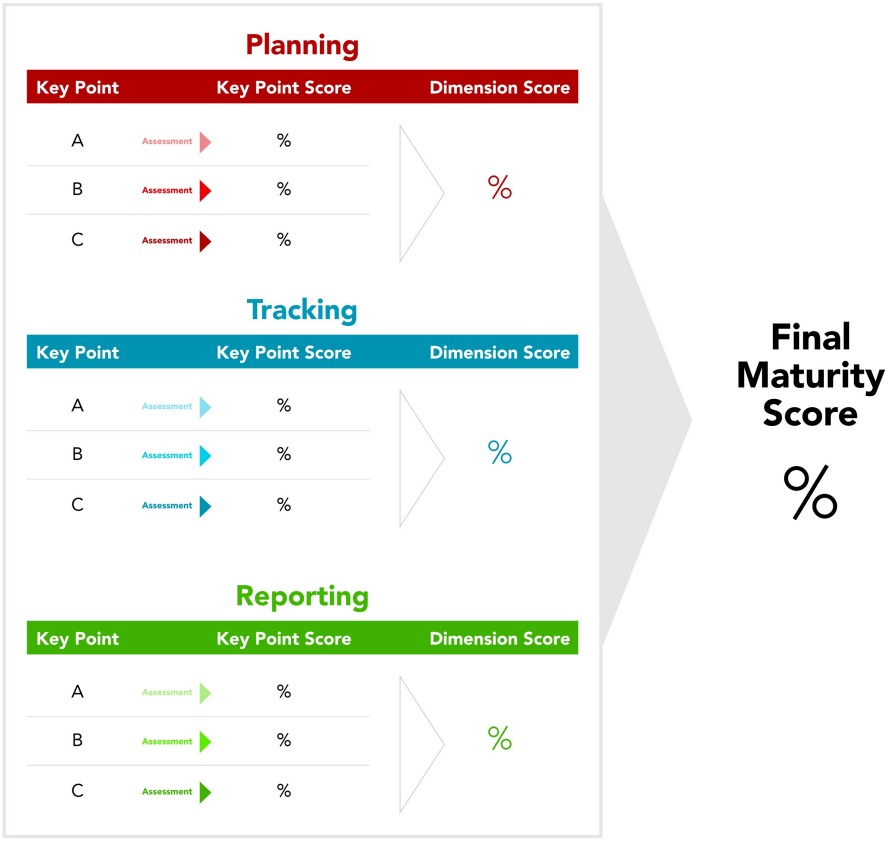

Figure 5.2: Maturity Model score system logic

The scores for each key point and for each dimension were agreed upon with the project management team, taking into account their organisational objectives.

5.1.2 Planning Dimension

Planning is the most vital part of managing projects for reducing risk and failure rates. When planning, the scope of the project for the timeline, costs, deliverables and details is defined. This is where expectations are set and assumptions are identified.

Without good planning, the project team is bound to miss crucial details, deadlines and eventually deliverables.

The Key Points defined/Questions asked to assess the Planning Dimension are:

1. **Tasks** - Are all tasks identified?
2. **Budget Estimation** - Has the 3 Point Estimation been performed for task duration estimation and are confident intervals being used?
3. **Schedule Estimation**- Has the 3 Point Estimation been performed for schedule estimation and are confident intervals being used?
4. **Dependencies** - Are all project tasks' dependencies identified ?
5. **Vacations** - Has the Vacation Plan of all project stakeholders been considered in the plans?
6. **Task Duration** - Is the work on task level between 8 and 80 hours?
7. **Critical Path** - Is the critical path identified ?

At this point, for each one of the key points a brief explanation regarding its importance, the criteria used to assess it and its score impact in the planning dimension are provided.

1. Tasks

Vestas has defined processes so that every new project plan is created based on the standard tasks that similar projects usually have.

Identification of all tasks of the project constitutes a vital process because it decomposes the work packages into schedule activities that provide a basis for estimating, scheduling, executing, monitoring, and controlling the project work.

Concerning the Tasks key point Maturity Assessment, table 5.1 details the criteria to assess it and its planning dimension impact.

Table 5.1: Tasks Maturity Assessment Overview

How To Assess	Criteria To Assess	Planning Dimension Impact
All tasks identified	Yes – 100 % No – 0%	10%

2. Budget Estimation

In Vestas, budget is measured in hours. One of the key challenges in projects is when time was spent and the required result was not achieved in time. This may happen due to problems related to the project and unexpected work that had to be performed, but it may also happen because estimates were performed incorrectly. Indeed, if estimations are not well performed, wrong conclusions will be taken, hence, to get to any conclusion about what happened, a good estimate for budget must first be guarantee.

Budget estimations must be performed for each task using the 3 point estimation method (Beta Distribution). It has also been defined that estimates should include standard deviations in order to be more accurate, as stated in chapter 3.

Concerning the Budget Estimation key point Maturity Assessment, table 5.2 displayed below details the criteria to assess it and its planning dimension impact.

Table 5.2: Budget Estimate Maturity Assessment Overview

How To Assess	Criteria To Assess	Planning Dimension Impact
3-Point-Estimation	Yes – 100 % No – 0%	10%
Confident Intervals	1σ – 70 % 2σ – 90% 3σ– 100%	5%

3. Schedule Estimation

Applying the same idea used for Budget Estimation, Schedule should also be estimated, as focus on timeline is the major organisational efficiency key points and an identified pain point.

The Schedule Estimation must be performed using the duration (days) between tasks' start and end date. The 3 point estimation (Beta Distribution) is the method chosen for the estimation . It has been established that schedule estimates should include standard deviations in order to achieve more accuracy, as has been mentioned already in chapter 3.

Concerning the Schedule Estimation key point Maturity Assessment, table 5.3 below details the criteria to assess it and its planning dimension impact.

Table 5.3: Schedule Estimate Maturity Assessment Overview

How To Assess	Criteria To Assess	Planning Dimension Impact
3-Point-Estimation	Yes – 100 % No – 0%	10%
Confident Intervals	1σ – 70 % 2σ – 90% 3σ– 100%	5%

4. Dependencies

Identification of dependencies between the critical project tasks is essential to sequence the tasks in a project plan, and it is necessary to calculate the critical path (longest path/duration). However, identification of all tasks' dependencies, even of the not critical ones, is useful to identify resource and schedule issues, make supporting decisions as well as monitor and manage as part of the overall project plan.

Concerning the Dependencies key point Maturity Assessment, table 5.4 below details the criteria to assess it and its planning dimension impact.

Table 5.4: Dependencies Maturity Assessment Overview

How To Assess	Criteria To Assess	Planning Dimension Impact
Critical Tasks' Dependencies	Yes – 100 % No – 0%	10%
Not Critical Tasks' Dependencies	Some – 0% to 50 % Most – 50% to 99% All – 100%	20%

5. Vacations

The organisation needs to reduce people's dependency and ensure that work goes on even in the absence of key resources. In this context, it is important for managers to monitor vacation planning carefully, so as to ensure that the work does not suffer and their teams do not delay the deliverables.

Concerning the Vacations key point Maturity Assessment, table 5.5 below details the criteria to assess it and its planning dimension impact.

Table 5.5: Vacation Maturity Assessment Overview

How To Assess	Criteria To Assess	Planning Dimension Impact
Vacation Plans of All Stakeholder	Yes – 100 % No – 0%	10%

6. Task Duration

The rule that establishes a time frame between 8 and 80 hours rule is a general guideline that breaks work down into manageable tasks. This rule states that a task should not exceed 80 hours of work and should not be less than 8 hours of work. This breakdown is necessary to correctly detail the task and measure its real progress reliably.

Concerning the Tasks Duration key point Maturity Assessment, table 5.6 below details the criteria to assess it and its planning dimension impact.

Table 5.6: Task Duration Maturity Assessment Overview

How To Assess	Criteria To Assess	Planning Dimension Impact
Tasks between 8 & 80 Hours	Some – 0% to 50 % Most – 50% to 99% All – 100%	10%

7. Critical Path

Defining the critical path involves identifying all tasks necessary to complete the project. The Project Manager sets the critical path by detailing each task required and identifying which ones rely on the completion of other tasks. In other words, the critical path needs identification of all dependencies of project tasks. This identification is crucial to correctly define and track the project schedule.

Concerning the Critical Path key point Maturity Assessment, table 5.7 below details the criteria to assess it and its planning dimension impact.

Table 5.7: Critical Path Maturity Assessment Overview

How To Assess	Criteria To Assess	Planning Dimension Impact
Critical Path Identified	Yes – 100 % No – 0%	10%

5.1.2.1 Planning Dimension Assessment Overview

Table 5.8 summarises all the planning dimension presented key points, the criteria to assess them and the maturity impact of each one in the planning dimension.

Table 5.8: Planning Dimension Maturity Overview

Key Point	How To Assess	Criteria To Assess	Maturity Impact
Tasks	All Tasks Identified	Yes or No	10%
Budget Estimation	3-Point-Estimation Confident Intervals	Yes or No 1σ 2σ 3σ	15%
Schedule Estimation	3-Point-Estimation Confident Intervals	Yes or No 1σ 2σ 3σ	15%
Dependencies	Critical Not Critical	Yes or No Some – 0% to 50 % Most – 50% to 99% All – 100%	30%
Vacation	Vacation Plans of All Stakeholders	Yes or No	10%
Task Duration	Between 8 and 80 Hours	Some – 0% to 50 % Most – 50% to 99% All – 100%	10%
Critical Path	Critical Path Field	Yes or No	10%

5.1.3 Tracking Dimension

Project Tracking consists in checking how project managers follow the progress of plans' tasks allowing potential issues to be spotted.

Project tracking begins early with planning and goes on until the completion of the project. It should include monitoring project progress to identify potential problems in a timely manner, in order to take corrective action, and measuring project performance regularly to identify variances from the project plan to ensure projects are on track. Correct tracking leads to informed decision making and this is what will increase project success rates.

As mentioned before, all tracking in Vestas is supported by JIRA software. Thus, the assessment criteria for this dimension is based on setting the rules for the software information that needs to be available, in order to track the project correctly thereby allowing a reliable metrics system.

The Key Points defined/Questions asked to assess Tracking Dimension are:

1. **Original Estimate** - Is an Original Estimate defined for all tasks of the project?
2. **Time Spent**- Are all Spent Hours being logged into the JIRA software?
3. **Remaining Estimate** - Is a Remaining Estimate defined for all tasks of the project and is the value updated to reflect reality?
4. **Start & End Date** - Are Start & End Dates defined for all tasks of the project and does the plan have due tasks?
5. **Critical Path Field** - Has a JIRA Critical Path field been created?

At this point, for each one of the key points a brief explanation of its importance, the criteria used to assess it and its score impact in the tracking dimension are provided.

1. Original Estimates

The Original Estimate value for each task (obtained from the 3 point estimation when the project is planned) is fixed and used as planned duration/budget for the task. Therefore, it is necessary to assure that all tasks have an original estimate in the software, to track their status.

JIRA software features an Original Estimate field which is currently used. Therefore, no changes were necessary in the software.

Concerning the Original Estimates key point Maturity Assessment, 5.9 below details the criteria to assess it and its tracking dimension impact.

Table 5.9: Original Estimate Maturity Assessment Overview

How To Assess	Criteria To Assess	Maturity Impact
Fill Range	Reliable Reading – 95% to 100 % Not Accurate Enough – 80% to 95% Insufficient – < 80%	15%

2. Time Spent

In JIRA software, the Time Spent field measures the time that the assignee of the task spent working on it. Every task has a Time Spent field and it is mandatory that every stakeholder updates this value while working on the task, in order to have all the time spent logged to JIRA. This value represents the cost of the project (in hours), so a correct tracking is crucial.

In order to assess if all spent hours are reflected in JIRA, we need to compare logged time in JIRA with to the real value of time spent. This real value is available in the SAP software. SAP is the enterprise software used to manage business operations in Vestas and is not outlined since it falls out the scope of this dissertation project. It is just important to note that this value obtained from SAP software is the real time spent and therefore used for comparison.

In order to know if all time spent was registered in JIRA, the JIRA Hours vs. Sap Hours indicator is used. If they match, the indicator returns 100%.

Concerning the Time Spent key point Maturity Assessment, see table 5.15, which details the criteria to assess it and its tracking dimension impact.

Table 5.10: Time Spent Maturity Assessment Overview

How To Assess	Criteria To Assess	Maturity Impact
JIRA Hours Vs. SAP Hours	Reliable Reading – 95% to 100 % Not Accurate Enough – 80% to 95% Insufficient – < 80%	25%

3. Remaining Estimates

In JIRA software, Remaining Estimate field represents the expected remaining time to complete a task.

Previously, the Remaining Estimate field value was automatically calculated by JIRA software:

$$RemainingEstimate = OriginalEstimate - TimeSpent \tag{5.2}$$

This automatic mode does not reflect the real remaining time for the task because some unforeseen event may arise and the task may take longer than initially planned. This difference between the initially planned time and the real accomplishment rate (progress) of the task is very important to measure.

A new way of using Remaining Estimate field is proposed to improve real progress measuring. At present, Remaining Estimates must be manually updated by the task assignee in order to reflect what is the real remaining time to finish the task regardless of what was initially planned.

Concerning the Remaining Estimate key point Maturity Assessment, table 5.11 provides details of the criteria to assess it and its tracking dimension impact.

Table 5.11: Remaining Estimate Maturity Assessment Overview

How To Assess	Criteria To Assess	Maturity Impact
Field Update	Once a Week – 80% to 100 % Every 2 Weeks – 50% to 80% Once a Month – 0% to 50%	25%

Remaining Estimate does not feature a fill range criterion because for every Original Estimate field filled, Jira creates a Remaining Estimate field automatically. Thus, the remaining estimate fill range is the same as the original estimate fill range.

4. Start & End Date

Start & End Dates tracking is vital to control the agreed schedule of the project. Therefore, it is necessary to assure that all tasks have a Start & End Date in the software, in order to track their status. It has also been defined that the maturity of the project depends on the due tasks, as due tasks may influence project overall due dates.

JIRA software features a Start Date and an End Date field which is currently used. Therefore, no changes were necessary in the software.

Concerning the Start & End Date key point Maturity Assessment, table 5.12 below details the criteria to assess it and its tracking dimension impact.

Table 5.12: Start End Dates Maturity Assessment Overview

How To Assess	Criteria To Assess	Maturity Impact
Fill Range	Reliable Reading – 95% to 100 % Not Accurate Enough – 80% to 95% Insufficient – < 80%	15%
Due Tasks	Up To Date – 0 % A Few – 0% to 10% Some – 10% to 50% A Lot – 50% to 100%	10%

5. Critical Path Field

The identification of critical path is crucial to correctly define and track the project schedule. At the moment, there is no way to identify critical path tasks in JIRA and therefore, tracking is not performed. In order to do it, a Critical Path field creation is proposed to mark tasks that belong to it. This way, they can be monitored.

Concerning the Critical Path Field key point Maturity Assessment, table 5.12 below details the criteria to assess it and its tracking dimension impact.

Table 5.13: Start End Dates Maturity Assessment Overview

How To Assess	Criteria To Assess	Planning Dimension Impact
Critical Path Field	Yes – 100 % No – 0%	10%

5.1.3.1 Tracking Dimension Assessment Overview

Table 5.14 summarises all the criteria for the tracking dimension maturity assessment.

Table 5.14: Tracking Dimension Maturity Overview

Key Point	How To Assess	Criteria To Assess	Maturity Impact
Original Estimate	Fill Range	Yes or No	15%
Time Spent	JIRA Hours Vs. SAP Hours	Reliable Reading – 95% to 100 % Not Accurate Enough – 80% to 95% Insufficient – < 80%	25%
Remaining Estimate	Field Update	Once a Week – 80% to 100 % Every 2 Weeks – 50% to 80% Once a Month – 0% to 50%	25 %
Start & End Date	Fill Range	Reliable Reading – 95% to 100 % Not Accurate Enough – 80% to 95% Insufficient – < 80%	15%
	Due Tasks	Up To Date – 0 % A Few – 0% to 10% Some – 10% to 50% A Lot – 50% to 100%	10%
Deliverables	JIRA Critical Path Field	Yes or No	10%

5.1.4 Reporting Dimension

A project status report is a critical part of an effective communications and management strategy to update project stakeholders. Reports play a crucial role in the startup, ongoing development and even survival stages of a project. Through reports, the company is able to document the progress over time, build an audit trail of the past and help in decision making, whether to continue a project, discontinue it, expand the budget or extend the deadlines.

Vestas established as main goal for reporting, to determine if the company is delivering on time and within budget. Previously, budget, schedule and risks were reported using only a scale of colours depending on how well the parameter was managed in a project (green for good, red for bad). However, this scale is subjective, so it was necessary to introduce measures to assess how well the project is performing.

The Key Points defined/Questions asked to assess Reporting Dimension are:

1. **JIRA Feasibility for reporting** - Is all time spent in tasks reflected in JIRA?
2. **Project Planned Budget** - What is the Planned Budget at the time of reporting?
3. **Project Earned Budget** - What is the Earned Budget at the time of reporting?
4. **Project Actual Budget** - What is the Actual Budget at the time of reporting?
5. **Project Earned Time** - What is the Earned Time at the time of reporting?
6. **Risks** - Are Priority Tasks identified and are Risks being managed?

At this point, for each one of the key points a brief explanation of its importance, the criteria used for assess it and its score impact in the reporting dimension are provided.

1. JIRA Feasibility for reporting

In order to correctly provide a report, all project spent time must be reflected in JIRA, otherwise the real project status is not reflected in the software.

Using the same idea from Tracking Dimension, the JIRA feasibility is assessed using JIRA vs. SAP hour indicator.

Regarding the JIRA feasibility for reporting key point maturity assessment, 5.15 below details the criteria to assess it and its tracking dimension impact.

Table 5.15: Time Spent Maturity Assessment Overview

How To Assess	Criteria To Assess	Maturity Impact
JIRA Hours Vs. SAP Hours	Reliable Reading – 95% to 100 % Not Accurate Enough – 80% to 95% Insufficient – < 80%	35%

2. Planned Budget

The Planned Budget is an indicator that measures the Planned Hours that the project is expected to perform. This indicator must be included in reporting so as to document the status of the project. This indicator is outlined in section 5.2.

3. Earned Budget

The Earned Budget is an indicator that measures, in hours, the progress of the project. This indicator must be included in Reporting to document the project progress. This indicator is outlined in section 5.2.

4. Actual Budget

The Actual Budget is an indicator that measures the hours (cost) that the project's stakeholders spent working in the project. This indicator must be included in reporting to document if the project is on budget. This indicator is outlined in section 5.2.

5. Earned Time

Using the same idea for Earned Budget, the Earned Time indicator is a measure of the schedule of the project. This indicator must be included in reporting to document if the project is on time. This indicator is outlined in section 5.2.

6. Risk

Risks are specific events or conditions that might affect project objectives. Therefore, understanding individual risks can help in determine how to apply effort and resources to enhance the rates of project success.

In JIRA software, risks can be tracked using 2 different resources: the Task Priority Field and the Risk Management Module. The Task Priority field must be used in order to know if task priority is urgent, high or normal. Risk Management Module is a JIRA feature that must be used to monitor risks.

For the Risk key point maturity assessment, table 5.16 below details the criteria to assess it and its reporting dimension impact.

Table 5.16: Risks Maturity Assessment Overview

How To Assess	Criteria To Assess	Maturity Impact
Urgent Priority Field	Yes – 100 % No – 0%	10%
Others Priority Field	Some – 0% to 50 % Most – 50% to 99% All – 100%	5%
Risk Management Module	Yes – 100 % No – 0%	10%

5.1.4.1 Reporting Dimension Assessment Overview

Table 5.17 summarises all the criteria for the reporting dimension maturity assessment.

Table 5.17: Reporting Dimension Summary Table

Key Point	How To Assess	Criteria To Assess	Maturity Impact
JIRA Feasibility For Reporting	JIRA Hours Vs. SAP Hours	Reliable Reading – 95% to 100 % Not Accurate Enough – 80% to 95% Insufficient – < 80%	35%
Project Planned Budget	EVM PB Indicator	Yes or No	10%
Project Earned Budget	EVM EB Indicator	Yes or No	10%
Project Actual Budget	EVM AB Indicator	Yes or No	10%
Project Earned Time	EVM ET Indicator	Yes or No	10%
Risk	Urgent Priority Field	Yes or No	25%
	Others Priority Field	Some – 0% to 50 % Most – 50% to 99% All – 100%	
	Risk Management Module	Yes or No	

5.1.5 Organisational Target Maturity

Setting a value of Target Maturity is not easy because it depends on a variety of factors and is different for every organisation. Some maturity levels are fairly easy to reach, while others are harder to achieve and more expensive. Consequently, a meticulous analysis was conducted and several meetings were scheduled in order to understand which are Vestas' objectives.

The Maturity Model of the Planning Maturity Framework is divided into three dimensions hence, a target value of maturity was set for each dimension.

Target maturity was agreed upon with Vestas' Project Management Team and is based on the organisational priorities and on criteria which is necessary to ensure in order to calculate metrics.

5.1.5.1 Planning Dimension

As far as the Planning Dimension is concerned it is, at least, necessary to assure that:

- **All tasks are identified** - To guarantee that no task is missing and not taken into account in calculations
- **3 Point Estimation for Budget & Schedule** - 3 Point Estimation must be performed as this is the value used as planned budget for the project. If estimates aren't reliable, metrics aren't either.
- **Critical Dependencies** - In order to understand the dependencies of start & end dates between tasks.
- **Task Duration between 8 and 80 hours** - To guarantee that tasks are not too short or too long in order to correctly measure progress.

Based on the score for each Key Points presented in subsection 5.1.2, when all the criteria above are validated, the Planning Dimension of the project gets 60% score. Thus, this value is the considered maturity target for the Planning Dimension.

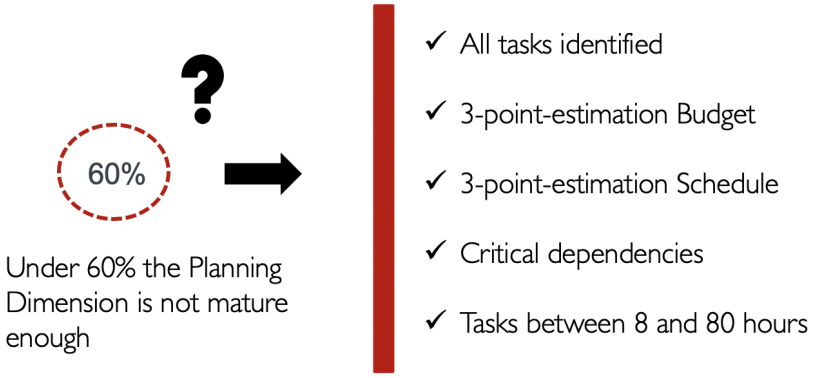

Figure 5.3: Planning Dimension Target Maturity

5.1.5.2 Tracking Dimension

Regarding the Tracking Dimension it is, at least, necessary to assure:

- **Original & Remaining Estimates fill range** - It is necessary to guarantee that at least 95% of Original and Remaining Estimates fields, in JIRA, are filled in order to allow correct tracking of Planned Budget and Progress, respectively.
- **Remaining Estimates update** - Updates of this field must be performed at least once a week to assure that progress of tasks is updated in JIRA.
- **Start & End Dates fill range**- It is necessary to guarantee that at least 95% of Start and End dates fields in JIRA are filled in, so as to allow correct tracking of project Schedule.
- **Due Tasks** - The organisational target is to have less than 10% of the tasks overdue.
- **JIRA Hours vs. SAP Hours** - This indicator must be above 90% to assure that working hours are being logged to JIRA so that correct analysis about time spent is performed.

Based on the score for each Key Points presented in subsection 5.1.3, when all the criteria above are validated, the Tracking Dimension of the project gets 70% score. Thus, this value is considered the maturity target for the Tracking Dimension.

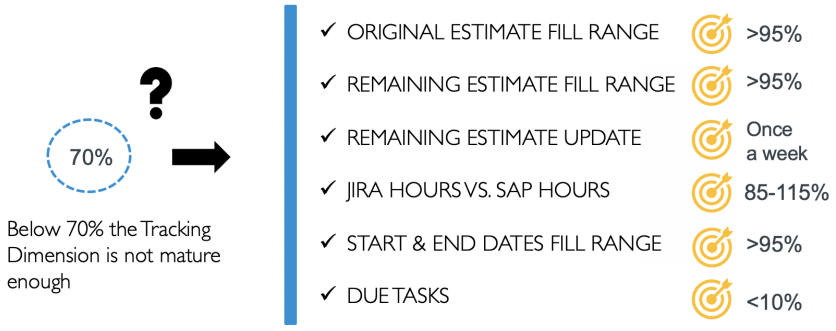

Figure 5.4: Tracking Dimension Target Maturity

5.1.5.3 Reporting Dimension

Concerning the Reporting Dimension it is, at least, necessary to assure:

- **JIRA hours vs. SAP hours** - This indicator must be above 90% to guarantee that working hours are being logged to JIRA so that a correct report about Time Spent can be performed.
- **Urgent Priority Field** - It is necessary to guarantee that at least the urgent priority field is filled so that Project Managers know which tasks are urgent.
- **Risk Management Module** - Since project risks must be reported, usage of the Risk Management module is imperative to monitor and closely follow risk for precise reporting.

Based on the score for each of the Key Points presented in subsection 5.1.4, when all the criteria above are validated, the Reporting Dimension of the project gets 70% score. Thus, this value is considered the maturity target for the Reporting Dimension.

Figure 5.5: Reporting Dimension Target Maturity

5.2 Metrics

One of the most critical problems that project managers encountered was the management of the performance on their projects. Indeed, after surveying the Vestas Project Management Team, the most common complaints are cost and schedule overruns.

Using the current tracking system, in many instances, there is no forewarning and the PM is faced with the near impossible task of explaining why each impact occurred, due to the fact that there are no standard metrics that quantify how the project is performing.

Without sustained project management tracking, credibility can easily be eroded. This is especially true if one project after another has a bad surprise when it is too late to recover. Project executives soon think projects are out of control and question everything. The solution consists in presenting hard-edged data, not guesses, in status reports, allowing problems to be spotted at an early stage when they are small and easier to fix.

To address this problem, the second Area of Planning Maturity Framework is Project Metrics.

The metrics of this Planning Maturity framework are based on the Earned Value Management method outlined in chapter 3, which is a method that allows the project manager to measure quantitatively how projects are performing and additionally forecast results based on the current status analyses. So, in essence, the metrics provide more reliable information to make better management decisions.

Metrics used in Planning Maturity Framework are divided into three dimensions: status, performance and forecast. Status metrics are calculated with the JIRA software fields information. Performance metrics are calculated based on deviations from status metrics. Using Performance metrics and Status metric, Forecast metrics are calculated, which allow estimation of budget and schedule upon completion of the project.

The name of the metrics vary from the names in the Earned Value Management because they were tailored to suit Vestas' environment.

5.2.1 Status Metrics

Status metrics allow understanding of the current status of the project. All status metrics used in this model are summarised in tables 5.18 and 5.19.

Table 5.18: Budget Status Metrics Table

Project Critical Issue	Budget Status Metrics	Explanation
What is the amount, in hours, of work to be performed to date?	**Planned Budget** (PB) PB = ∑ Original Estimate for each task to date	Budgeted cost, in hours, for tasks planned
What are the costs, in hours, to date?	**Actual Budget** (AB) AB = ∑ Time Spent for each task to date	Time spent, in hours, in tasks performed
What is the amount, in hours, on the actual worked performed?	**Earned Budget** (EB) EB = ∑ Progress for each task to date	Progress, in hours, for tasks in progress and released
What is the total budget, in hours, assigned to the project?	**Budget at Completion** (BaC) BaC = ∑ Original Estimate for each task	Total budget, in hours, assigned to the project when plan was approved.
Under or over budget?	**Budget Variance** (BV) BV = EV – AC BV (%) = BV/EB	BV < 0: over budget; BV = 0: on budget; BV > 0: under budget. The project is BV % over/under budget.

Table 5.19: Schedule Status Metrics Table

Project Critical Issue	Schedule Status Metrics	Explanation
What is the duration from the beginning of the project to current date?	**Actual Time** (AT)	Day of project since the project started
What is the real day of project based on work performed?	**Earned Schedule** (ES)	Day of project according to the initial plan baseline, correspondent to the current progress in tasks to date.
What is the total number of days assigned to the project?	**Time at Completion** (TaC)	Total time, in days, assigned to the project when plan was approved.
Ahead or behind schedule?	**Time Variance** (TV) TV = ES - AT TV (%) = TV/ES	TV < 0: behind schedule; TV = 0: on schedule; TV > 0: ahead schedule. The project is TV % behind/ahead schedule.

5.2.2 Performance Metrics

After calculating status metrics, performance metrics can be obtained. All performance metrics used in this model are summarised in table 5.20.

Table 5.20: Performance Metrics Table

Project Critical Issue	Performance Metrics	Explanation
How efficient is the use of budget?	**Budget Performance (BP)** BP = EB/AB	BP < 1: poor cost performance BP = 1: efficient cost performance BP > 1: excellent cost performance
How efficient is the schedule?	**Time Performance (TP)** TP = EB/PB	TP < 1: poor schedule performance TP = 1: efficient schedule performance TP > 1: excellent schedule performance

5.2.3 Forecast Metrics

Finally, having calculated status and performance metrics, Forecast metrics are calculated in order to estimate budget and Schedule at completion. All forecast metrics used in this model are summarised in table 5.21 and 5.22.

Table 5.21: Forecast Budget Metrics Table

Project Critical Issue	Budget Forecast Metrics	Explanation
How much is the project likely to cost?	**Budget Estimate at Completion (BEaC)** BEaC = BaC/BP.	Assuming a constant BP, the project is likely to cost at completion BEaC.
Will we be under or over budget?	**Budget Variance at Completion (BVaC)** BVaC = BAC - BEaC BVaC (%) = BVaC/BAC	BVaC < 0: over budget at completion BVaC = 0: on budget at completion BVaC > 0: under budget at completion There will be an additional cost of BVaC (%) relative to the initial cost.

Table 5.22: Forecast Schedule Metrics Table

Project Critical Issue	Schedule Forecast Metrics	Explanation
How many days is the project likely to take?	**Time Estimate at Completion (TEaC)** TEaC = TaC/TP.	Assuming a constant TP, the project is likely to cost at completion TEaC.
Will we be on or over time?	**Time Variance at Completion (TVaC)** TVaC = TaC - ETaC TVaC (%) = TVaC/TaC	TVaC < 0: over budget at completion TVaC = 0: on budget at completion TVaC > 0: under budget at completion There will be an additional duration of TVaC (%) relative to the initial scheduled.

5.3 Actions to Address

The last area of the Planning Maturity Framework is divided into two parts: a database with a set of actions to address the Lack of Maturity in projects, and an Alarm System to address Metrics Deviations.

So the overall idea of the Planning Maturity Framework is:

1. To define the standard values of maturity for each dimension to compare with the maturity assessment result of a plan.
2. After that, metrics are calculate for the plan and their reliability is proportional to the maturity score of the plan.
3. Depending on the lack of maturity and metrics deviations, we get personalized actions to improve maturity.
4. After implementing the actions, maturity will improve and metrics deviations will be mitigated.

5.3.1 Lack of Maturity

In this area, based on the maturity assessment, we get personalised Planning, Tracking and Reporting actions for the real needs of the projects. This helps to upgrade the overall maturity which will lead to more precise metrics, which will result in better control of both budget and schedule.

The actions to be addressed are divided in the Planning, Tracking and Reporting dimensions and it is suggested that they are ordered by the improvement of maturity they will add.

The following tables illustrate all the possible actions for the three different dimensions ordered by maturity improvement (the % of improvement is the score presented in section 5.1).

In a real project plan, only the actions for identified pain points will be provided.

Planning Dimension Actions	Maturity Improvement
Identify All Tasks with Critical Tasks' Dependencies	↑ 20%
Identify All Project Tasks	↑ 10%
Identify all the Tasks with Dependencies	↑ 10%
Include Vacation Plan of All Stakeholders in Planning	↑ 10%
Reduce Task Duration to interval between 8 and 80 Hours	↑ 10%
Identify Critical Path	↑ 10%
Use Planning Template and perform 3 Point Estimations for Budget	↑ 10%
Use Planning Template and perform 3 Point Estimations for Schedule	↑ 10%
Use Planning Template and estimate using Confident Intervals for Budget	↑ 5%
Use Planning Template and estimate using Confident Intervals for Schedule	↑ 5%

Figure 5.6: Planning Dimension actions to be addressed

Tracking Dimension Actions	Maturity Improvement
Fill Original Estimate Field for All Tasks	↑ 15%
Fill Remaining Estimate Field for All Tasks	↑ 15%
Fill All Start/End Dates Fields in JIRA	↑ 15%
Fill Time Spent Field for All Tasks	↑ 15%
Assure Remaining Estimate Field Update	↑ 10%
Assure Stakeholders are Logging All Working Hours in JIRA	↑ 10%
Assure Remaining Estimate Field Update	↑ 5%
Create JIRA Critical Path Field for the Project	↑ 5%
Create JIRA Baseline Field for the Project	↑ 5%
Assure at least 10% Due Tasks	↑ 5%

Figure 5.7: Tracking Dimension actions to be addressed

Reporting Dimension Actions	Maturity Improvement
Fill Priority Field for All Tasks	↑ 15%
Report Projects Risk in JIRA Risk Management Module	↑ 15%

Figure 5.8: Reporting Dimension Actions to be addressed

5.3.2 Metrics Deviations - The Alert System

Vestas wants to manage projects on time and within budget. With the introduction of metrics, it is possible to quantify budget and schedule status, performance and forecasts. In order to achieve that, first the meaning of "on time and within budget" must be clarified.

To assess whether projects are on time and within budget, 4 metrics from previous section will be used:

- Time Variance
- Budget Variance
- Time Variance at Completion
- Budget Variance at Completion

In agreement with the Vestas Project management team, it was defined that **Project Budget and Schedule deviation at completion** must be lower than 10%.

To address this objective an alert system was created . This alert system consists in analysing deviations from what was initially planned for the project and return an alert or alarm depending on the magnitude of the deviation.

For Time metrics, as the company target is to have less than 10% deviation at completion of the project, the Time Variance at Completion metric is used. The Alert level was set for 5% deviation and the Alarm level was set for 10% deviation.

For the Time Variance metric, which measures current status deviation, the Alert Level was set for 10% and the Alarm Level for 15%. This wider criteria is due to the confident intervals of metrics. Since metrics are calculated from fields in the software program which are not always updated or correctly filled, a wider range has to be assumed, in order to get minimum false alerts and alarms.

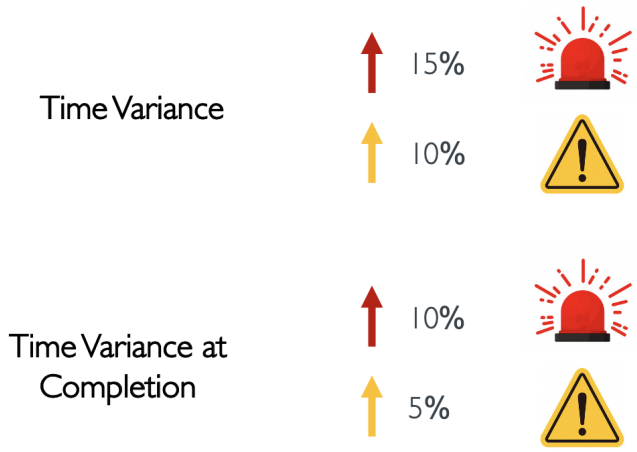

Figure 5.9: Time Variance Alarm System

Following the same idea for Budget, the Alarm level was set for 10% deviation for Budget Variance at Completion metric. For Budget Variance metric, which measures current status deviation, the Alert Level was set for 10% and the Alarm Level for 15%.

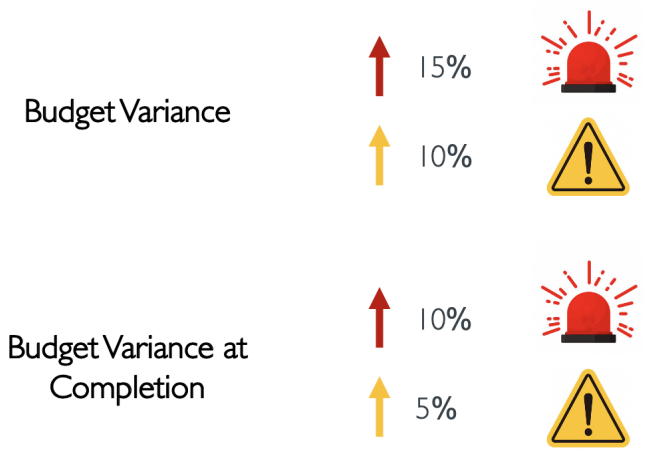

Figure 5.10: Budget Variance Alarm System

Chapter 6

Planning Maturity Framework Implementation

The present chapter will provide a description off all the steps necessary towards making the theoretical model 'Planning Maturity Framework' a functional tool available to every Project Manager in the organisation. First and foremost, it is essential to proceed to the presentation of the implementation plan. Secondly, the final result of the implementation in power BI will be introduced, providing an overview of the result application user interface . Finally, the main steps to implement the Framework in power BI will be detailed.

6.1 Implementation Plan

The Planning Maturity Framework constitutes a theoretical model developed to improve Vestas' project management system. Currently, the objective of the company is to make the Framework available to every project manager in the organisation using Power BI in order to address the efficiency key points outlined in chapter 4, namely: to provide faster and correct decision making for Project Managers, focus on daily follow up & upfront planning and to streamline the way work is done.

Moreover, the Power BI selection meets the Planning Maturity Framework's needs: it features real time data modelling which allows for the assessment of maturity, metrics calculation and actions output. All this is possible using power BI, also meeting organisational demands, with no extra costs as the software is already in use and accessible to everyone in the organisation.

In other to set a strategy to approach this challenge, meetings with the project managers were scheduled and an implementation plan was defined as illustrated in figure 6.1.

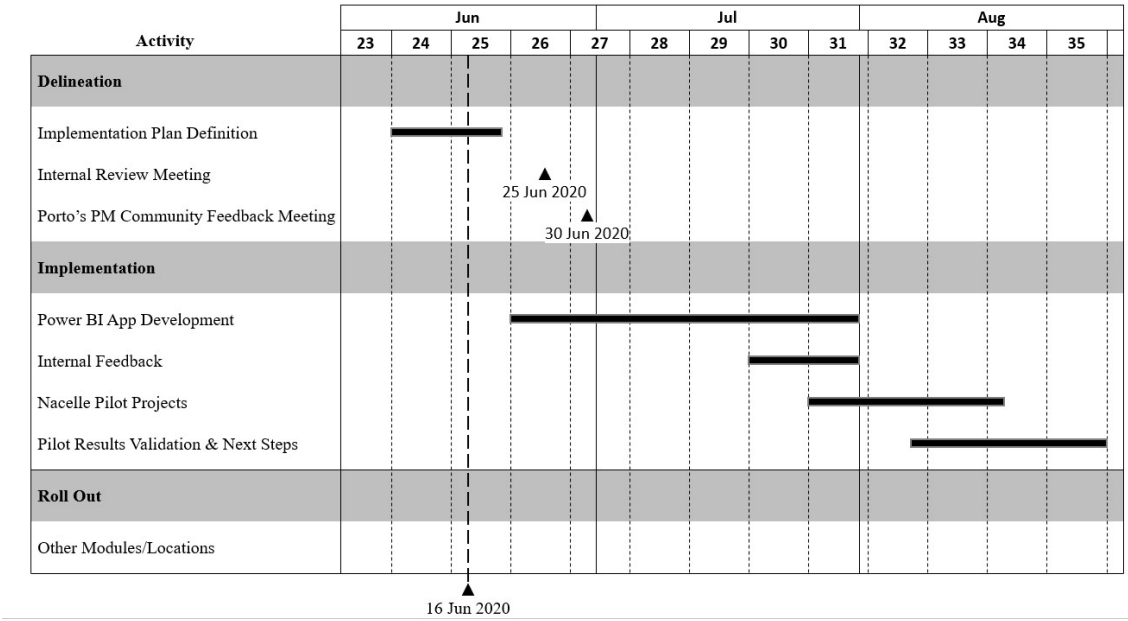

Figure 6.1: Tool Implementation Plan

The Framework automation in Power BI includes the three areas of the Planning Maturity Framework: Maturity Model, Project Metrics and Actions to Address. While Project Metrics and Actions to Address could be fully automated, some Maturity Model Key Points needed data currently unavailable in JIRA to be automated.

Consequently, due to the time available, the organisation prioritized implementation of the maturity indicators that could be fully automated with the current available data in JIRA, for a first version of the application.

Tables 6.1, 6.2 and 6.3 summarise the key points implemented for each one of the Maturity Model dimensions, and the JIRA field used to assess the key point.

Note: All available JIRA fields for modelling information and a brief description of their role in the project is provided in subsection 6.3.

Table 6.1: Planning Key Points implementation

Planning Key Point	Implemented	JIRA fields
All tasks Identified	No	-
Budget Estimation	No	-
Confident Intervals	No	-
Schedule Estimation	No	-
Confident Intervals	No	-
Dependencies	No	-
Vacation Plans	No	-
Tasks between 8 & 80 hours	Implemented	Assessed using Original Estimate field
Critical Path	No	-

Table 6.2: Tracking Key Points implementation

Tracking Key Point	Implemented	JIRA fields
Original estimate fill range	Yes	Assessed using Original Estimate field
Remaining estimate fill range	Yes	Assessed using Remaining Estimate field
Remaining estimate update	Yes	Assessed using Updated field
Time spent fill range	Yes	Assessed using Time spent field
JIRA hours vs. Sap hours	No	-
Start & End dates fill range	Yes	Assessed using Start & End dates fields
Due Tasks	Yes	Assessed using Start & End dates fields
Critical path field	No	-
Baseline field	No	-

Table 6.3: Reporting Key Points implementation

Reporting Key Point	Implemented	JIRA fields
JIRA hours vs. Sap hours	No	-
Project planned budget	Yes	App features planned budget metric
Project earned budget	Yes	App features earned budget metric
Project actual budget	Yes	App features actual budget metric
Project earned time	Yes	App features earned time metric
Priority fill range	Yes	Assessed using priority field
Risk Management module	Yes	Assessed using issue type field

6.2 Power BI application

The result of the development process was a Microsoft Power BI application, published in Vestas' network and accessible to every Project Manager through Power BI online website. It comprises 15 pages: 3 for navigation, 3 for overview and 9 for drill-through. The structure of the app is illustrated in figure 6.2.

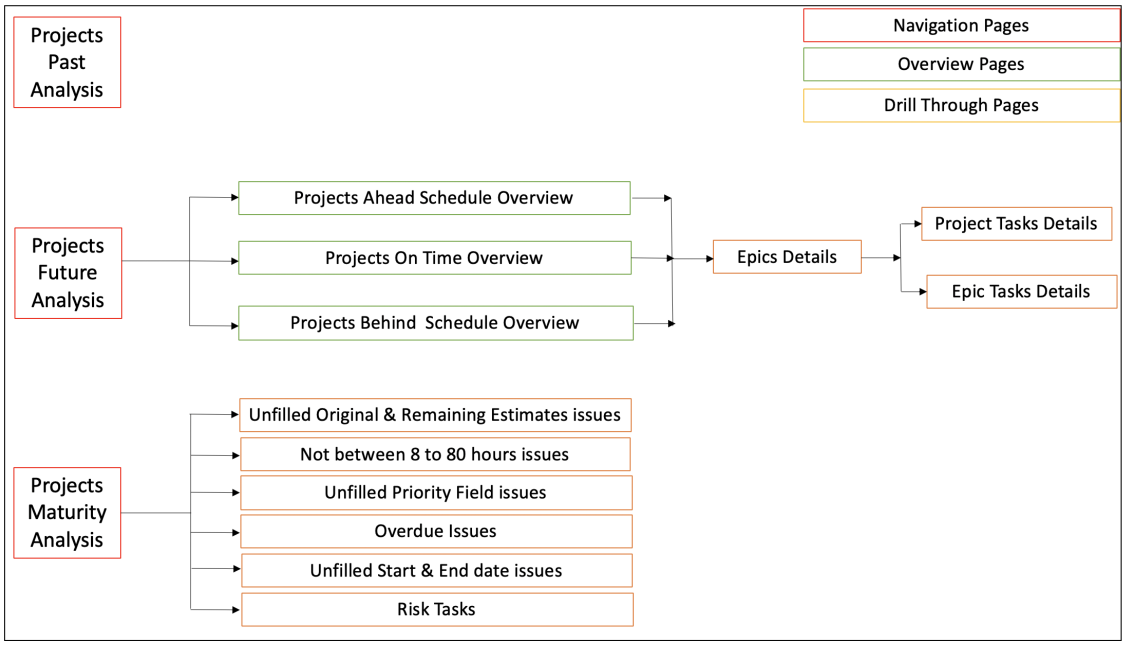

Figure 6.2: Diagram of Power Bi app pages

6.2.1 The Slicer System

The app features a slicer system that allows filtering the information in projects from different levels of aggregation. These different levels of aggregation of data are necessary to address all Project Managers, regardless of the level in the organisational structure: high level Project Managers want KPIs for all performing projects from a Business Area (Bucket Level 1), whereas low level Project Managers find the fix version filter more useful to track a specific project plan.

With the slider system, the high and low planning level organisation can use the same app and filter the relevant information.

Figure 6.3: The slicer system

6.2.2 Navigation Pages

The objective of the application consisted in assessing the project status in terms of maturity, budget and schedule in different levels of aggregation and with live data flow. The pages of the app, user interface and workflow are presented next:

1. Past Analysis dashboard

Figure 6.4 below depicts the Past Analysis Dashboard.

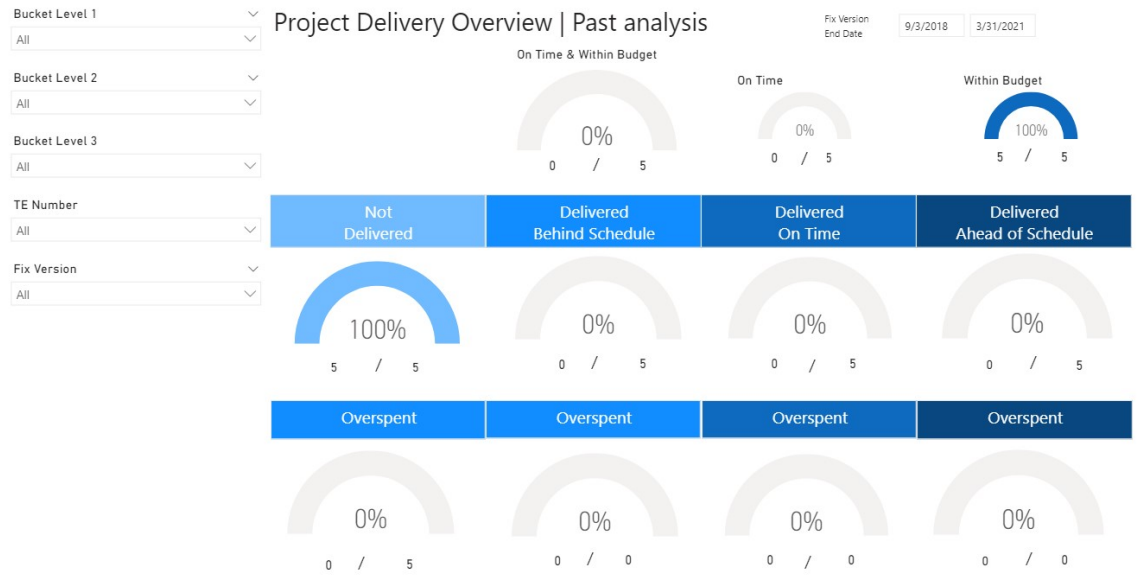

Figure 6.4: Project Delivery Past Analysis

This page enables visualisation of past project plans in the organisation, therefore this page should be accessed to understand how finished plans were performed:

- Using the slicer system and date, any type of filtering can be chosen for the data that is being assessed within the range of days chosen.
- The first 3 gauges show how many project plans were finished on time, within budget, and both on time & within budget.
- Gauges in the second row assess the project plans in terms of Schedule: if the project plan is finished, it will count as ahead of schedule, behind schedule or on time, depending on the way it was delivered. If the filtered project plan is still in progress, the project plan will count as Not Delivered.
- The third row gauges work as a vertical filter. For all the projects (Not Delivered, Ahead of Schedule, On Time and Behind Schedule) they count the overspent plans.

2. Maturity Analysis dashboard

Figure 6.5 depicts the Past Analysis Dashboard.

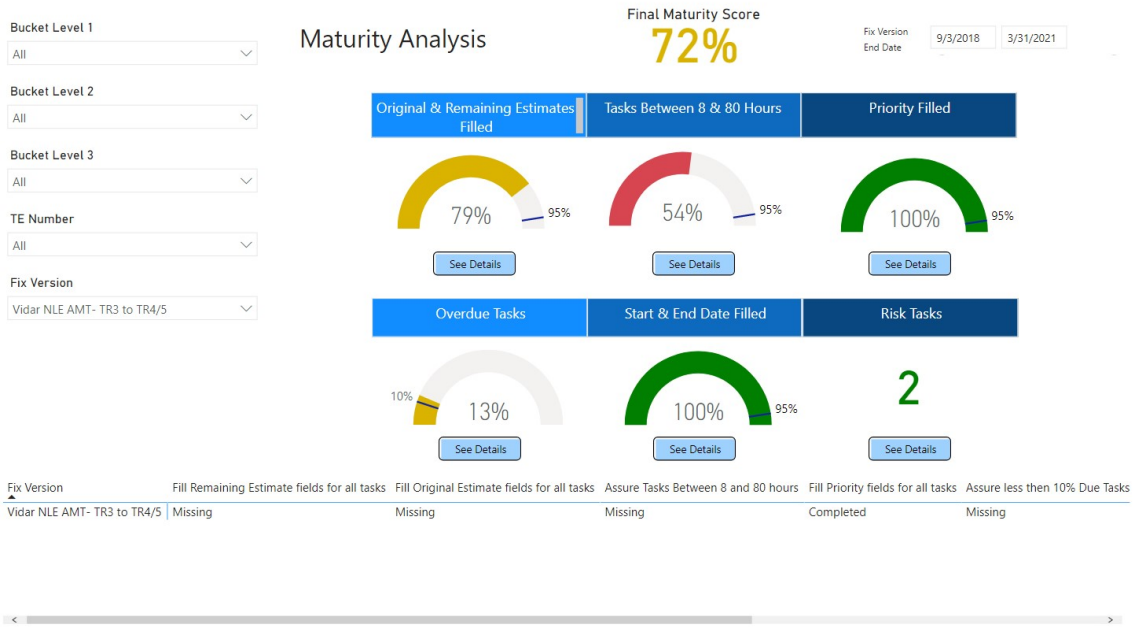

Figure 6.5: Maturity Analysis dashboard

This page allows the visualisation of the maturity of projects in the organisation:

- Using the slicer system and date, a specific project plan/ project stage (fix version) to assess can be chosen.
- As header is displayed the final maturity score of the selected plan, result of the maturity criteria assessment under it.
- The 6 gauges show the status of the maturity criteria and different colours are used to illustrate the result of the assessment. The targets for each criterion are the ones defined in the previous chapter.
- The "See Details" buttons allow visualisation of the specific issues that are not respecting the maturity criteria, so that Project Managers can act directly on them.
- At the bottom, there is an Actions to Address table which complements the Maturity Gauges. Looking at this table, Project Managers have the actions needed to improve the maturity result for the selected plan.

3. Future Analysis dashboard

Figure 6.6 depicts the Future Analysis Dashboard.

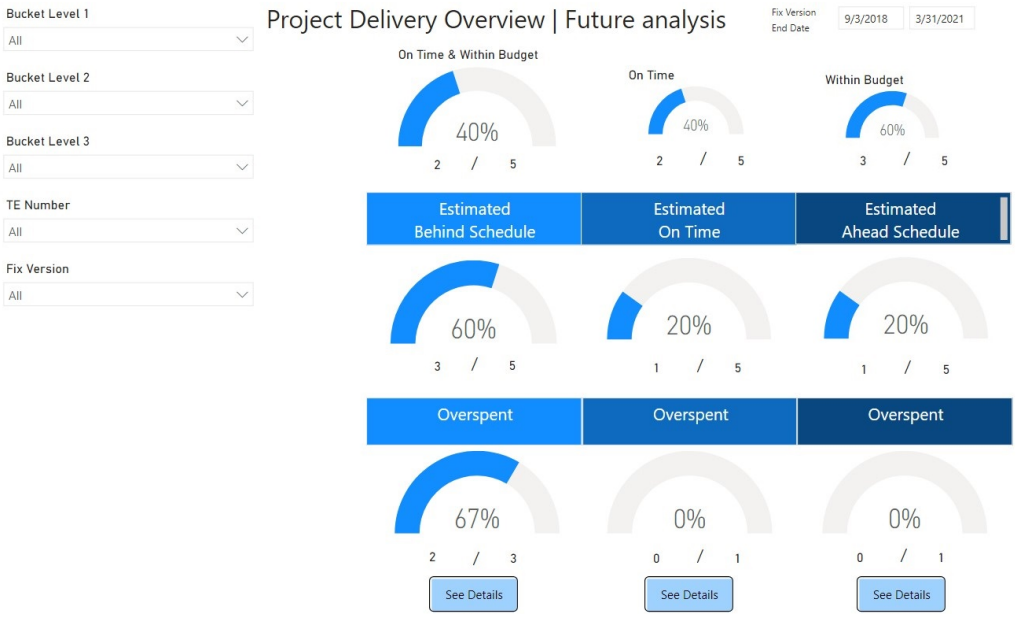

Figure 6.6: Project Delivery Future Analysis

This page allows visualisation of "in progress" projects in the organisation, therefore this page may be accessed to obtain an overview of current project status, schedule and budget:

- Using the slicer system and date, a specific project plan/ project stage (fix version) to assess can be choosen.
- The first 3 gauges show how many project plans are estimated on time, within budget and on time & within budget.
- The second row of gauges show how many plans, keeping the same performance, are estimated to finished behind schedule, on time or ahead of schedule.
- The third row of gauges work as a vertical filter. For all the project plans (Ahead of Schedule, On Time and Behind Schedule) they count the overspent ones.
- Clicking on the 3 "See Details" buttons allows opening an overview page of the project plans. Each button filters the plans within Behind Schedule, On Time and Ahead Schedule.

4. Behind Schedule Overview - Future Analysis

The Behind Schedule Overview is accessed when clicking the "See Details" button in the Future Analysis dashboard, under the Behind schedule indicator. When clicking the "See Details" button for on Time and Ahead of schedule, the overview dashboard is identical to the one below. The only difference is that the projects presented are filtered according to their schedule status. Therefore, only this dashboard is presented as an example of the three.

Figure 6.7 depicts the Behind Schedule Dashboard.

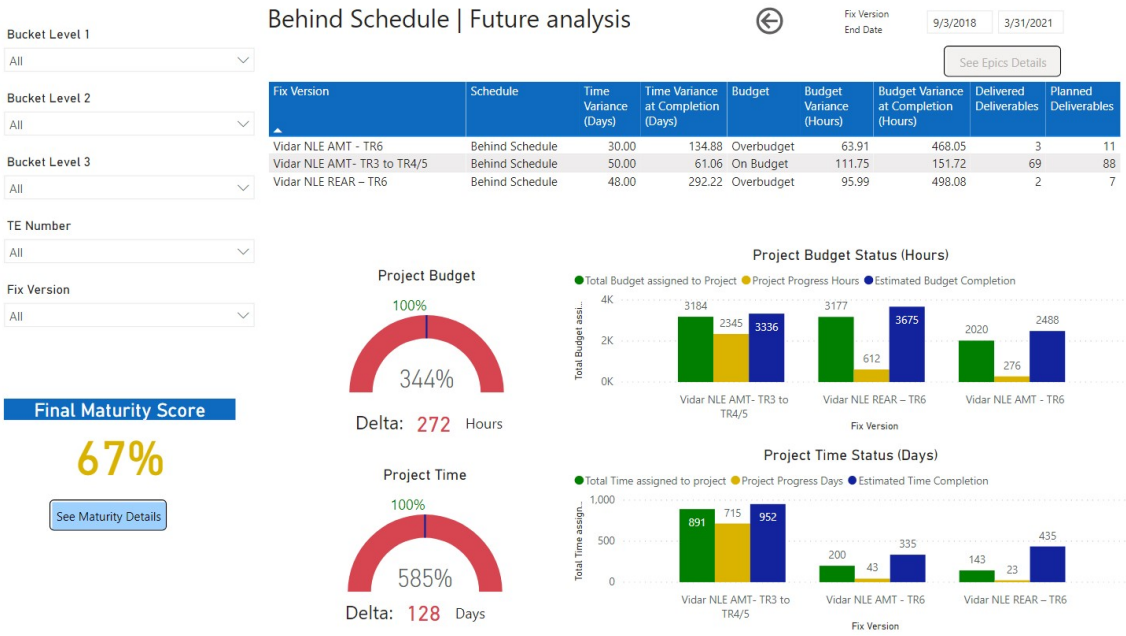

Figure 6.7: Behind Schedule - Future Analysis

This overview presents all behind schedule plans, their total budget and schedule deviation, average maturity score and a current status chart for budget and schedule.

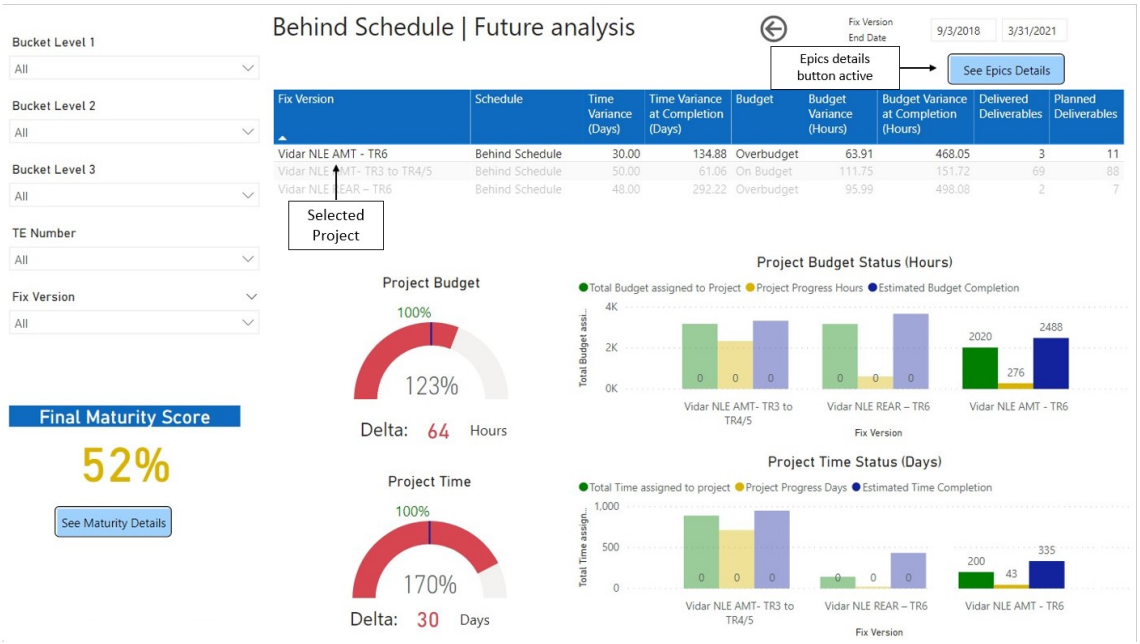

Figure 6.8: Selected Project in Behind Schedule - Future Analysis

When a specific plan is selected, the indicators change and present only data for the chosen plan:

- The table summarises current status and forecast information for plan budget and schedule.
- The maturity score for the plan is presented and it is possible to click on "See Maturity Details" which would lead to the Maturity Analysis dashboard for the plan.
- The current deviations (absolute and in percentage) for budget and schedule are presented in gauges and is complemented by the information in the charts.
- This page is a project plan status overview. However, if we want to drill through and assess plan epics and tasks, it is possible to see the Epics Details for the selected project by clicking on the "See Epics Details" button.

5. Epics Overview - Future Analysis

The Epic Overview is accessed when clicking on the "See Epic Details" button in Behind/On Time/Ahead of Schedule dashboard, when a project plan is selected. This dashboard features all the Epics/Deliverables belonging to the plan, as well as the same metrics used for the plan about their status and a Gantt Chart.

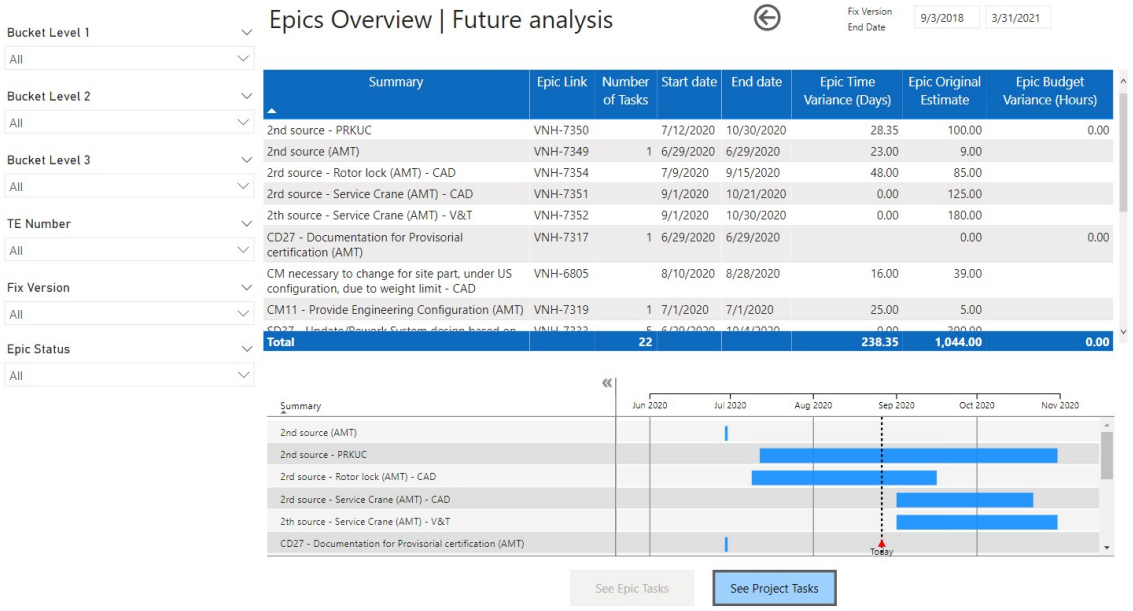

Figure 6.9: Epics Drill Through Page

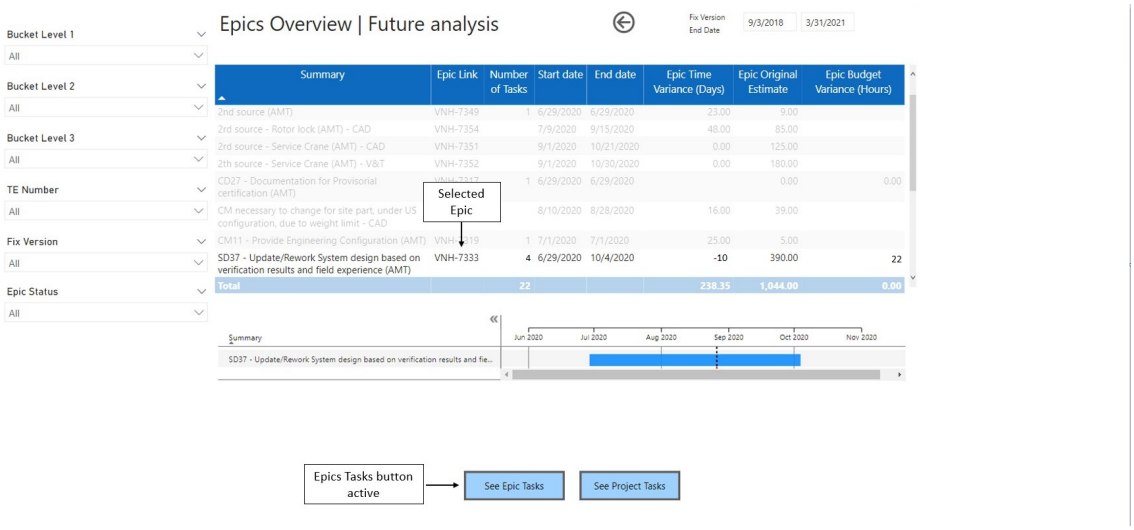

Figure 6.10: Epics Drill Through Page - selected epic

When a specific Epic is selected, the Gantt chart shows only the selected Epic/Deliverable, and the "See Epic Tasks" button becomes active. That will present the tasks that belong to the Epic. It

is also possible to select the "See Project Tasks" button which will show all tasks of the project, regardless of the epic.

6. Tasks of the Epic - Future Analysis

The Tasks of the Epic overview is accessed when clicking on the "See Tasks Details" button in Epics Overview dashboard, when an Epic is selected.

This dashboard features all the tasks belonging to the selected Epic , as well as the same metrics used for the Epics about their status.

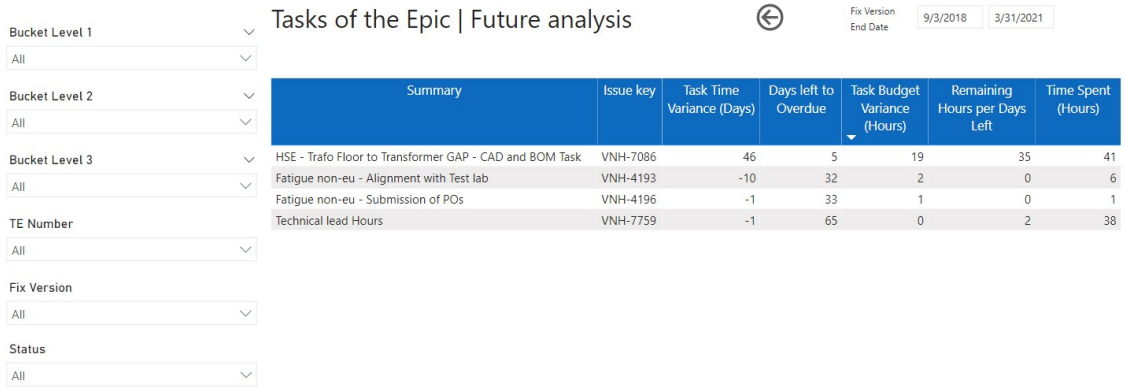

Figure 6.11: Tasks of the Epic Drill Through Page

When clicking on the "See Project Tasks" button in Epics Overview dashboard, the overview dashboard presented is identical to this one. The only difference is that in the Tasks of the Epic dashboard, the tasks displayed are filtered according to the selected Epic. In "See Project Tasks" case, all tasks belonging to the project plan are considered. Therefore, only this dashboard is presented as an example of the two.

6.3 Implementation in Power BI

This subsection is devoted to the presentation of the steps toward the cretion of the application (from the source to the data modelling and programming necessary to implement the framework

in a BI solution), and the maturity criteria and metrics implemented as well as the logic underlying it.

6.3.1 Data extraction from source - JIRA

The first step consisted in connecting JIRA software to power BI in order to get all information related to projects. JIRA allows filtering the desired projects plans and exporting them as a csv link in order to be used in a data analysis tool. Figure 6.12 illustrates the process of obtaining the link, in this case for NLE Projects (Nacelle projects, the module considered in this project)

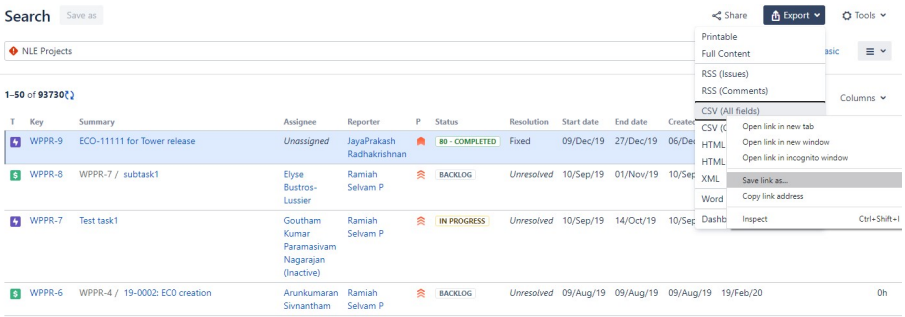

Figure 6.12: JIRA Source

Vestas does not use any type of intermediary data modelling and storage processes, so the data was loaded directly into Power BI in order to be modelled. Figure 6.13 below illustrates the process of loading the information into Power BI

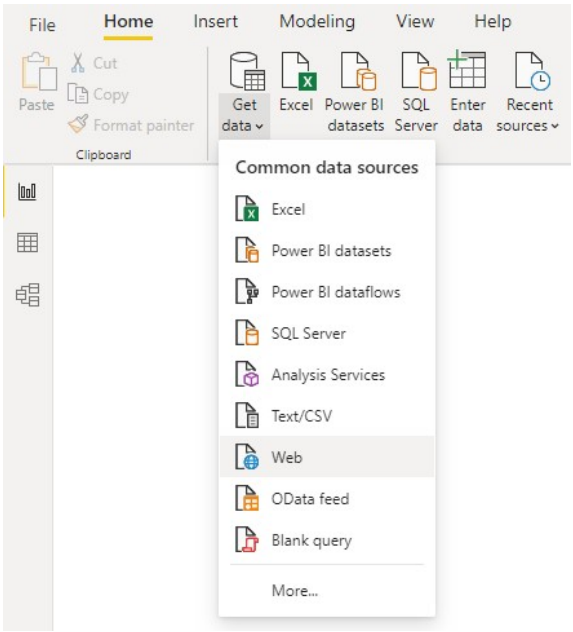

Figure 6.13: JIRA Source - Get Data

Figure 6.14: Source JIRA

The csv link resulted in a table featuring all the projects plans data available in JIRA software. In this imported table, every row is a project issue and each column is a project field. Figures 6.15 and 6.16 illustrates all the imported fields from JIRA software and ten issues (rows) as an example purpose.

Issue Type	Issue key	Issue id	Summary	Assignee	Reporter	Priority	Status	Resolution	Start date	End date
MECH:Subtask	VNH-8081	243957	Tower Seal TPS - A006-1203	abrak	didia	Normal	To Do		8/3/2020	9/30/2020
MECH:Subtask	VNH-8069	241919	Porto Support - DIDIA	didia	didia	Normal	In Progress		8/3/2020	10/30/2020
MECH:Subtask	VNH-8068	241918	Porto Support - FCMDA	fcmda	didia	Normal	In Progress		8/10/2020	8/28/2020
MECH:Task	VNH-7764	237815	Porto Support	didia	jeavr	Urgent	In Progress		8/3/2020	10/2/2020
MECH:Task	VNH-7763	237814	Follow up with test activities	abrak	jeavr	Urgent	In Progress		8/3/2020	10/30/2020
MECH:Task	VNH-7762	237813	TR6: Peer Review Actions	abrak	jeavr		To Do		9/14/2020	10/2/2020
MECH:Task	VNH-7761	237812	Prepare Peer Review Presentation	abrak	jeavr		To Do		9/7/2020	9/14/2020
MECH:Task	VNH-7760	237811	TL support Hours	prakm	jeavr	Urgent	To Do		8/3/2020	10/30/2020
MECH:Task	VNH-7759	237810	Technical lead Hours	abrak	jeavr	Urgent	In Progress		8/3/2020	10/30/2020
Epic	VNH-7758	237809	Project management hours - user		jeavr		To Do		7/10/2020	7/10/2020

Figure 6.15: Imported Data Table - Part1

Due Date	Time Spent	Remaining Estimate	Original Estimate	TE Number	Fix Version	Labels	Parent id	Resolved	Custom field (Epic Link)
9/25/2020				TE-23915	Vidar NLE COVER – TR6		237793		
10/30/2020	10800	144000	154800	TE-23915	Vidar NLE COVER – TR6		237815		
10/30/2020	68400	0	57600	TE-23915	Vidar NLE COVER – TR6		237815		
10/2/2020	3600	0	3600	TE-23915	Vidar NLE COVER – TR6	COVERS			VNH-7758
10/30/2020	7200	147600	154800	TE-23915	Vidar NLE COVER – TR6	COVERS			VNH-7758
10/2/2020		151200	151200	TE-23915	Vidar NLE COVER – TR6	COVERS			VNH-7758
9/14/2020		93600	93600	TE-23915	Vidar NLE COVER – TR6	COVERS			VNH-7758
10/30/2020		108000	108000	TE-23915	Vidar NLE COVER – TR6	COVERS			VNH-7758
10/2/2020	80100	423900	504000	TE-23915	Vidar NLE COVER – TR6	COVERS			VNH-7758
		0	0	TE-23915	Vidar NLE COVER – TR6	COVERS			

Figure 6.16: Imported Data Table - Part2

Table 6.4 illustrated all the available fields for modeling information and a brief description of their role in the project plan:

Table 6.4: Imported data fields from JIRA

JIRA Field	Role
Issue Type	Defines if the issue is a task, epic or risk
Issue Key	Unique code for each issue
Issue id	Unique number for each issue
Summary	Description of the issue
Assignee	Responsible for performing the issue
Reporter	The one that Tasks' assignee need to report task status to
Priority	Defines the priority of the issue: urgent, high or normal
Status	Not used
Resolution	Defines the status of the issue: not started, in progress or done
Start Date	Planned start date of the issue
End Date	Planned end date of the issue
Due Date	Date on which issues fall overdue
Time Spent	Spent hours in an issue
Remaining Estimate	Remaining hours to complete an issue
Original Estimate	Hours estimated for the issue when planning
TE Number	Project's unique code
Fix Version	Project's stage plan name
Labels	Sub-module assigned to the sub-project
Parent id	Not used
Resolved	Date on which the issue is done
Custom field (Epic Link)	Id which links tasks to epics

6.3.2 Maturity Criteria automation

In order to obtain the Maturity dashboard presented last chapter, maturity metrics had to be programmed using metrics and calculated columns in power BI. The concept is explained in diagram 6.17:

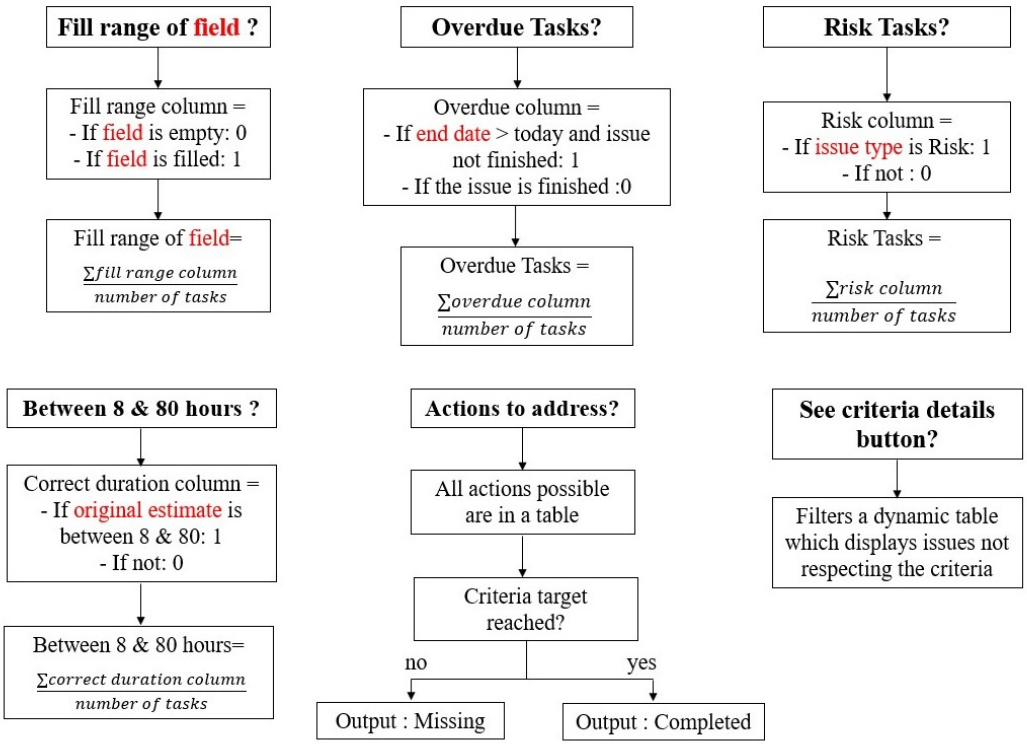

Figure 6.17: Maturity criteria logic

As an example purpose, the metric (M_Tasks_80) and calculated column (Correct Duration) necessary to obtain the between 8 & 80 hours criterion is presented in figure 6.18.

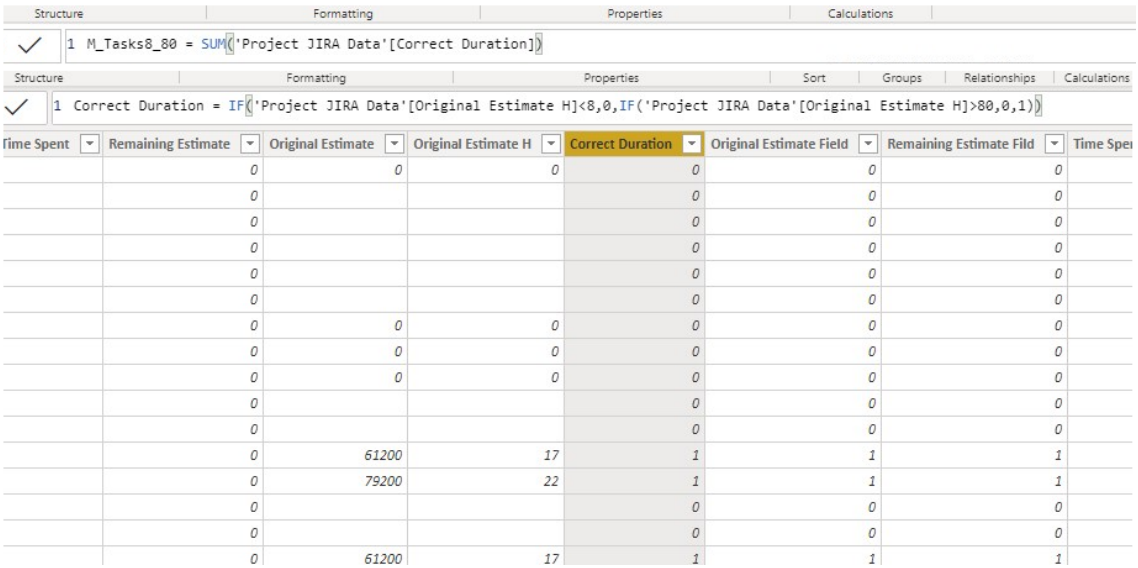

Figure 6.18: Metric and Calculated Column of Tasks Between 8 & 80 hours criterion

6.3.3 Metrics

All the metrics outlined in section 5.2 were implemented in the application in order to perform forecasts and display the projects plans status and performance in the dashboards.

The major step in order to obtain the metrics was to calculate Planned Budget, Actual Budget, Earned Budget and Earned Schedule. Since all the other implemented metrics are obtain directly from the equations presented in section 5.2, only these four metrics are explained as an example purpose.

1. Planned Budget

The planned budget or, in other words, the planned effort in hours for each day of project, must be calculated in order to calculate all the other metrics.

However, a daily effort is not defined. Rather, only a start date, end date and original estimate are provided for the issue. Therefore, in order to obtain the daily planned effort for the project plan, a linear effort for each issue was considered.

Diagrams 6.19 and 6.20 below demonstrate, as an example purpose, the logic of obtaining the planned budget for a project plan with 3 different issues:

Issue 1	Issue 2	Issue 3
Start date: 01/01/2020 **End date**: 03/01/2020 **Original estimate**: 120 h	**Start date**: 03/01/2020 **End date**: 08/01/2020 **Original estimate**: 600 h	**Start date**: 05/01/2020 **End date**: 10/01/2020 **Original estimate**: 1200 h

Day	Issue Planned Budget
01/01/2020	40h
02/01/2020	40h
03/01/2020	40h
04/01/2020	0h
05/01/2020	0h
06/01/2020	0h
07/01/2020	0h
08/01/2020	0h
09/01/2020	0h
10/01/2020	0h

Day	Issue Planned Budget
01/01/2020	0h
02/01/2020	0h
03/01/2020	100h
04/01/2020	100h
05/01/2020	100h
06/01/2020	100h
07/01/2020	100h
08/01/2020	100h
09/01/2020	0h
10/01/2020	0h

Day	Issue Planned Budget
01/01/2020	0h
02/01/2020	0h
03/01/2020	0h
04/01/2020	0h
05/01/2020	200h
06/01/2020	200h
07/01/2020	200h
08/01/2020	200h
09/01/2020	200h
10/01/2020	200h

Figure 6.19: Issue linear effort distribution

After obtaining the distributed effort for each task, the final project plan planned budget for each day can be obtained by summing up all the issues' planned budget in the respective day:

Project Planned Budget

Start date: 01/01/2020
End date: 10/01/2020
Original estimate: 1920 h

Day	Planned Budget	Cumulative Planned Budget
01/01/2020	40h	40h
02/01/2020	40h	80h
03/01/2020	140h	220h
04/01/2020	100h	320h
05/01/2020	300h	620h
06/01/2020	300h	920h
07/01/2020	300h	1220h
08/01/2020	300h	1520h
09/01/2020	200h	1720h
10/01/2020	200h	1920h

Figure 6.20: Project Planned Budget and Cumulative Planned Budget

When implementing this logic in power BI, it was necessary: creation of a calendar table with all the days of the project and cross-join (Power BI feature) it with the project data table, a issue accomplishment rate metric to store the linear effort for each issue and a table to store the planned budget for each day and for each project. Figure 6.21 presents the steps and DAX code necessary to obtain the planned budget in power BI:

Figure 6.21: Power BI steps to implement Planned Budget

2. Actual Budget

The actual budget represents the time spent for each task to date. Using the time spent field, this metric can be obtained. Figure 6.22 presents the DAX code to obtain Actual Budget:

```
Actual Budget (Hours) = CALCULATE((SUM('Project JIRA Data'[Time Spent]))/3600, FILTER('Project JIRA Data', 'Project JIRA Data'[Fix Version]='Schedule'[Fix Version]))
```

Figure 6.22: Actual Budget metric in Power BI

3. Earned Budget

This metric quantifies the accomplishment of the work. It reflects the amount of work that has actually been accomplished to date, comparing it with the planned budget for that work. Diagram 6.23 presents the logic of obtaining earned budget for an issue. The project earned budget is the sum of all the issues' earned budget.

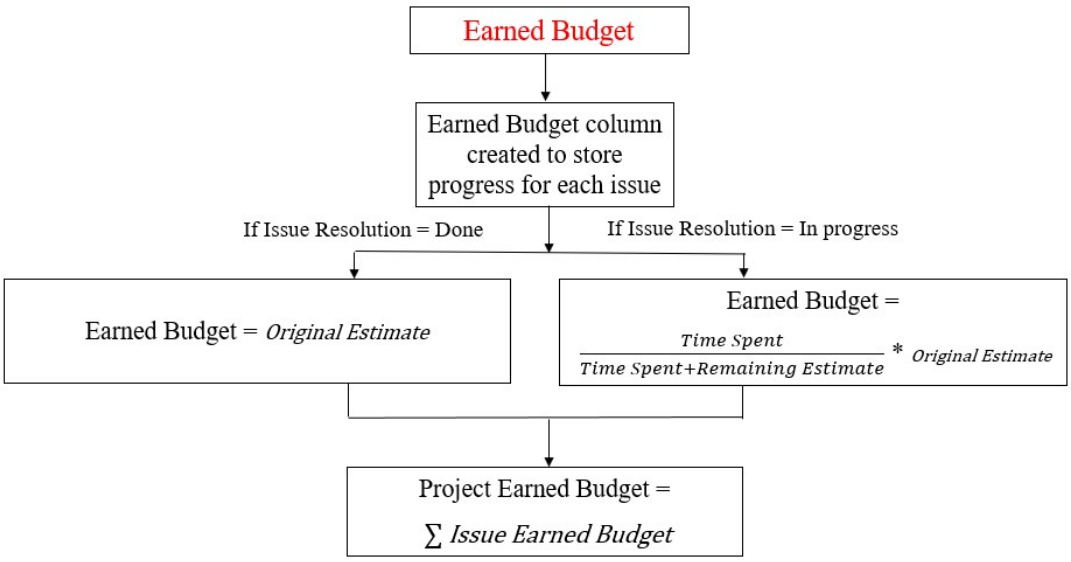

Figure 6.23: Earned Budget logic

Figure 6.24 presents the DAX code to obtain the calculated columns for Issue Earned Budget and for Project Earned Budget, in Power BI:

```
Issue Earned Budget = IF('Project JIRA Data'[Resolution]="Done",'Project JIRA Data'[Original Estimate H],IF('Project JIRA Data'[Resolution]="",('Project JIRA Data'[Time Spent]/('Project JIRA Data'[Time Spent]+'Project JIRA Data'
[Remaining Estimate]))*'Project JIRA Data'[Original Estimate H],0))
```

```
Project Earned Budget (Hours) = CALCULATE((SUM('Project JIRA Data'[Issue Earned Budget])), FILTER('Project JIRA Data', 'Project JIRA Data'[Fix Version]='Schedule'[Fix Version]))
```

Figure 6.24: Earned Budget metrics Power BI

4. Earned Schedule

The earned schedule represents the real day of project, based on work performed. For calculation of this metric, planned budget and earned budget must be calculated first. Diagram 6.25 presents a project example to explain the earned schedule logic:

Project Earned Schedule

Start date: 01/01/2020
End date: 10/01/2020
Original estimate: 1920 h

Day	Cumulative Planned Budget	Cumulative Earned Budget
01/01/2020	40h	10h
02/01/2020	80h	70h
03/01/2020	220h	150h
04/01/2020	320h	195h
Today 05/01/2020	620h	225h
06/01/2020	920h	-
07/01/2020	1220h	-
08/01/2020	1520h	-
09/01/2020	1720h	-
10/01/2020	1920h	-

Figure 6.25: Cumulative Planned Budget and Earned Budget for a project

Assuming that the current day of project is 05/01/2020, as an example purpose, the planned budget for the day is 620h. However, the earned budget (real progress in hours) is only 225h, thus the project is behind schedule.

In order to calculate the earned schedule, it is necessary to understand when the current earned budget was planned to be obtained. For this purpose, a new column referred to as "difference" must be calculated. This column is the absolute difference between cumulative earned budget and cumulative planned budget, and the objective of its calculation is to obtain the real day of project (in other words, the day in which the current earned budget was planned to be obtained). Diagram 6.26 represents the logic of this calculation:

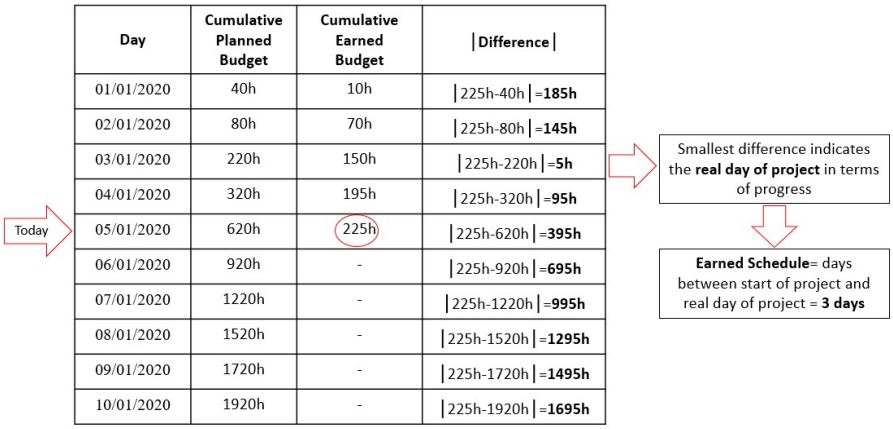

Figure 6.26: Earned Schedule logic

As it can be deduced from the diagram, the current earned budget (225h) was planned to be obtained 2 days earlier, in 03/01/2020 (Planned Budget = 220h) and therefore, it can be stated that the project is 2 days behind schedule.

When implementing this logic in power BI, it was necessary to create the difference column and a new table refereed to as "Schedule" in order to store all project schedule related information. Figure 6.27 presents DAX code necessary to obtain the mentioned parameters in power BI:

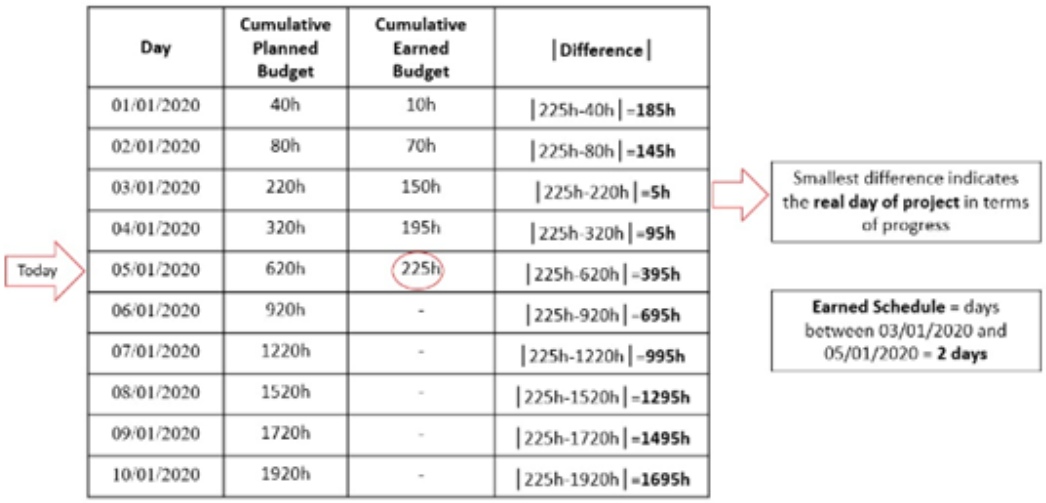

Figure 6.27: Power BI steps to implement Earned Schedule

6.3.4 Data Model & Process Diagram

As stated in the beginning of this chapter, Vestas does not use any intermediary type of data modelling between the source and Power BI therefore, the source data system (JIRA software) connects directly to the Power BI Desktop. This decision simplifies the BI solution because everything is in one place, so performing troubleshooting in the case of errors is easier and, in addition, it speeds up the development process. The process used in the final solution is illustrated in figure 6.28.

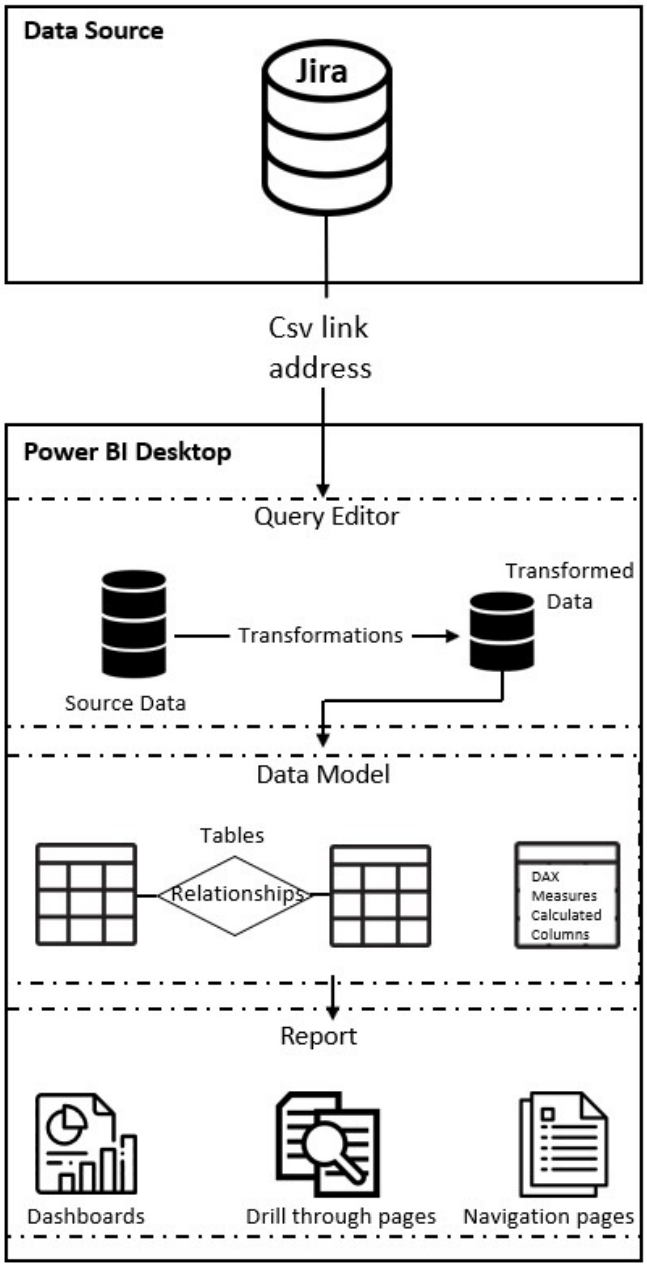

Figure 6.28: Process diagram of the developed BI solution

The report containing the dashboards and the data model is a Power BI file that was published in the Vestas intranet Microsoft Power BI website in order to be accessible to everyone in Vestas. The data model it forms consists of facts and dimensions, as well as other entities that contain no data but are used to organize the DAX measures containing the KPI calculations.

The final data model is illustrated in 6.29

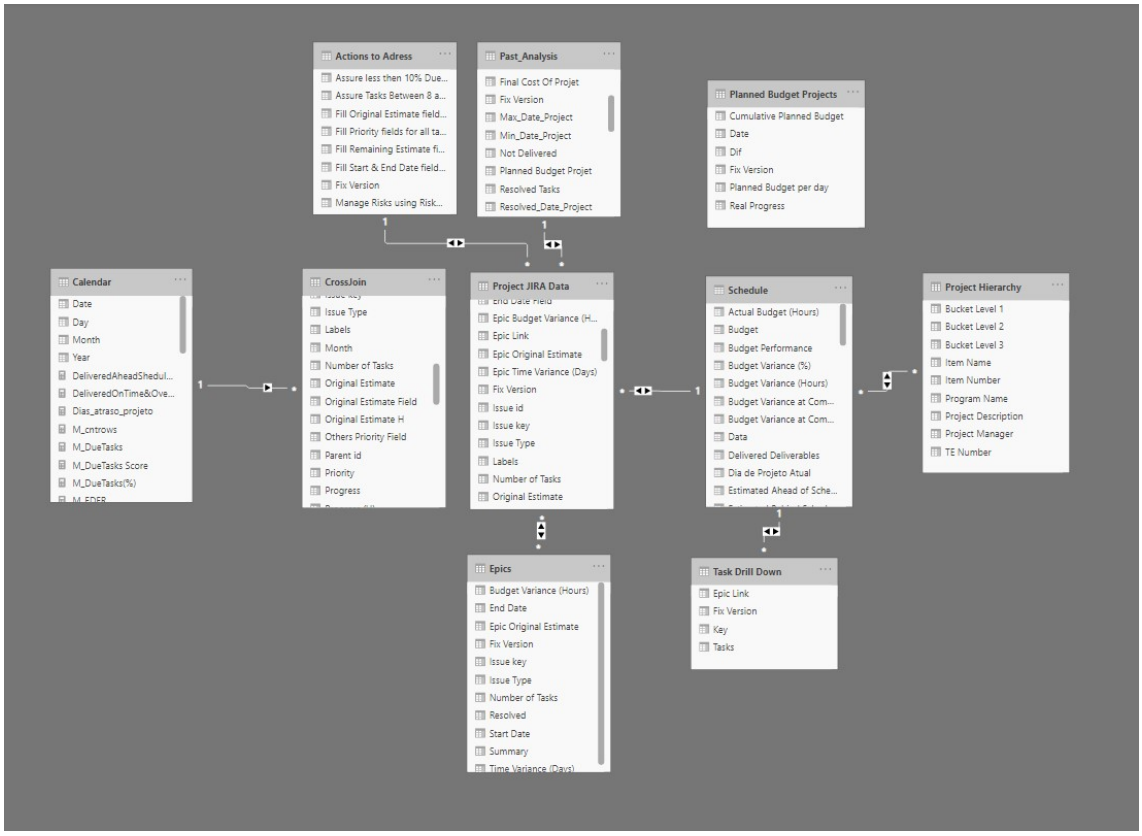

Figure 6.29: Final Data Model

Chapter 7

Validation Pilot

This chapter presents the pilot conducted over a three-weeks period, in order to test and validate the application proposed in the previous chapter so that it could be rolled over to another modules at the Porto Design Centre. After that, its organisational world-wide use can be implement.

In the first place, an outlined of the initial conditions of the pilot, such as the scope and the projects plans' it included will be provided. Afterwards, a results analysis is performed in order to understand the application impact in the organisation and to draw conclusions.

7.1 Nacelle Pilot

In order to validate the proposed application in the previous chapter, the Nacelle module was chosen to run the Pilot as it is the Vestas' module considered in this dissertation.

For this pilot two different project plans already in progress in the Nacelle module were selected. For each project, the analysis fell on the sixth stage plan of the project, the one currently in progress in the organisation.

The project plans under analysis are:

A) **Nacelle Covers (Stage 6)** : includes 7 Deliverables/Epics, which correspond to 72 tasks

B) **Nacelle Rear (Stage 6)** : includes 16 Deliverables/Epics, which correspond to 66 tasks

In order to track changes in the maturity and metric indicators, a picture of the first pilot day dashboards was taken for each one of the projects. Maturity indicators, actions and metrics indicators are presented in pictures 7.1 and 7.2 respectively.

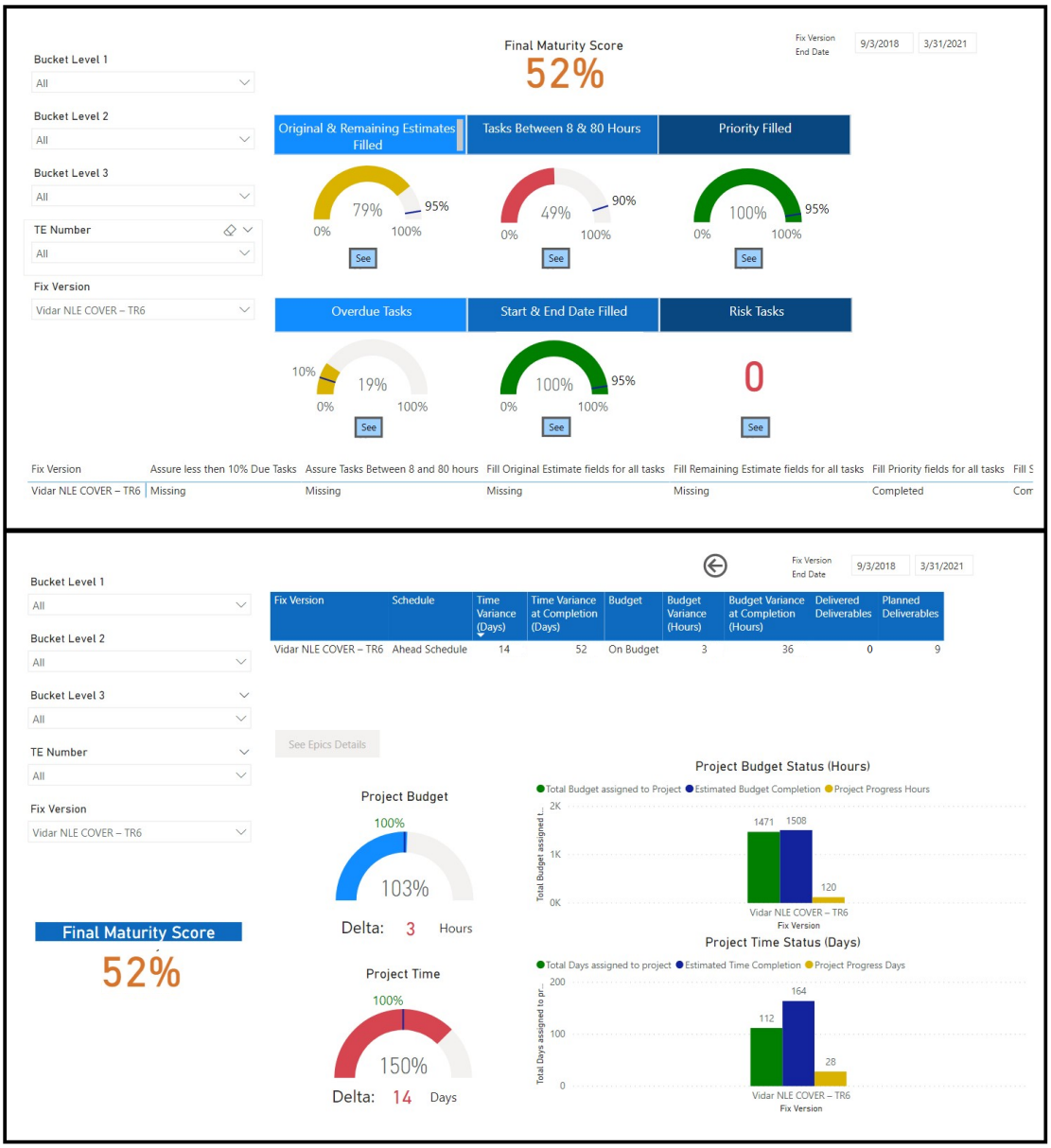

Figure 7.1: Nacelle Covers - first pilot day

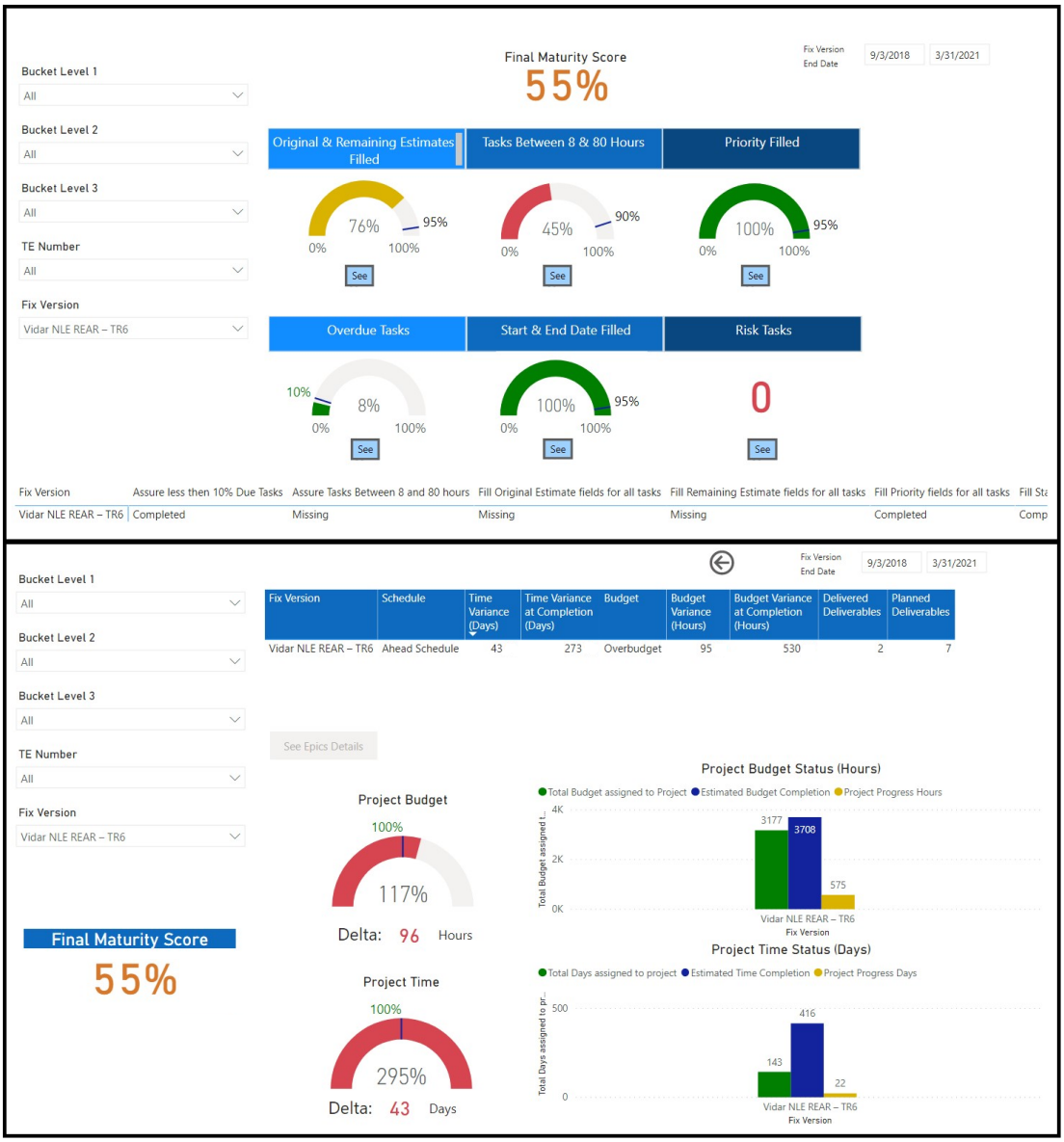

Figure 7.2: Nacelle Rear - first pilot day

During the pilot with the set duration of 3 weeks, weekly meetings between the technical leads of the project's plans and the project management team were scheduled, in order to track maturity and metrics indicators' changes and define actions for the tasks of the two plans. This maturity improvement process utilised:

- Six hours of Project Managers' work
- Four Hours of Technical Lead work

7.2 Analysis of Results

After three weeks of proactive management by the project management team based on the information provided in the application, the pilot ended. The last day of the pilot dashboards is illustrated in figures 7.3 and 7.4.

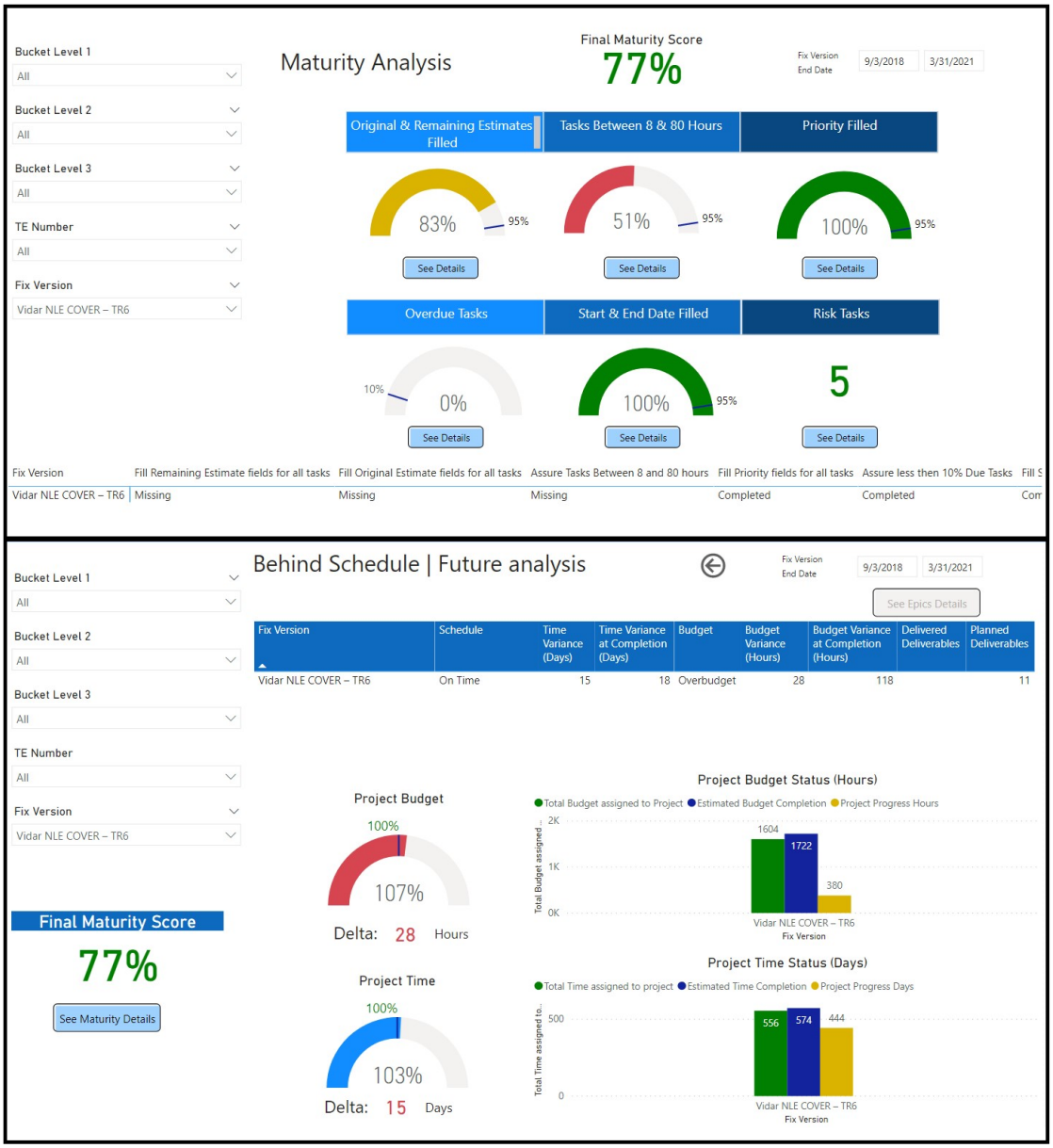

Figure 7.3: Nacelle Covers - last pilot day

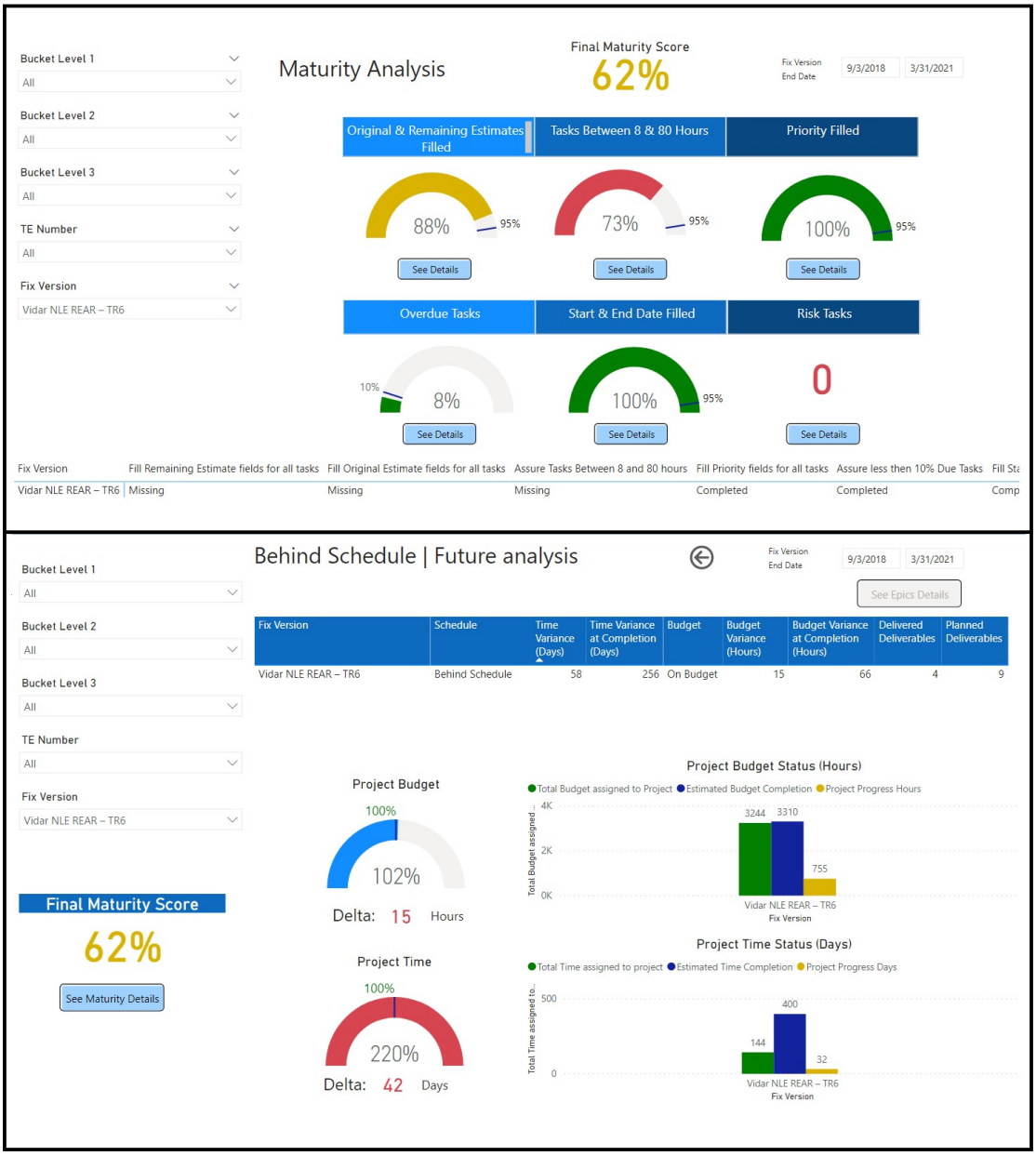

Figure 7.4: Nacelle Rear - last pilot day

The initial situation and the final situation for each project plan are summarised as follows: for project plan maturity in table 7.1, and for project plan metrics, in table 7.2.

Table 7.1: Final Pilot Day Maturity Dashboards Results

Stage 6 Plan	Maturity Indicator	Initial situation	Final situation	Difference
Nacelle Covers	Original & Remaining Estimates Filled	79%	83%	4%
	Tasks Between 8 & 80 Hours	49%	51%	2%
	Priority Filled	100%	100%	
	Overdue Tasks	19%	0%	-19%
	Start & End Date Filled	100%	100%	0%
	Risk Tasks	0	5	5
	Final Maturity Score	52%	72%	20%
Nacelle Rear	Original & Remaining Estimates Filled	76%	88%	16%
	Tasks Between 8 & 80 Hours	45%	73%	28%
	Priority Filled	100%	100%	0%
	Overdue Tasks	8%	8%	0%
	Start & End Dates Filled	100%	100%	0%
	Risk Tasks	0	0	0%
	Final Maturity Score	55%	62%	7%

Table 7.2: Final Pilot Day Metrics Results

Stage 6 Plan	Metrics	Initial Situation	Final situation	Difference
Nacelle Covers	Budget Variance	3%	7%	5%
	Time Variance	50%	3%	47%
Nacelle Rear	Budget Variance	17%	2%	15%
	Time Variance	195%	120%	75%

The key points of the performed analysis based on the project plans' pilot results are itemised for each plan.

A) Nacelle Covers (Stage 6)

1. **The Overdue Tasks indicator** were reduced from 19% to 0%. As "Deliver on Time" is the major objective of the company, this result was very important since the plan now is completely updated.

2. **The Original/Remaining Estimates Filled indicator** improved 4% after the app highlighted that some fields were not filled yet, so tasks' assignees corrected it. Moreover, a JIRA parameterisation feature was identified: original and remaining estimates fields of Epics/Deliverables should be automatically filled using the values of originals and remaining estimates fields from their composing tasks. However, JIRA parameterization is not allowing this process, so the original and remaining estimates fields of Epics/Deliverables show up as unfilled. This justifies the limitation in achieving 100% in the indicator.

3. **The indicator for tasks Between 8 & 80 hours** was improved in 2% after some tasks were broken down. The indicator value is still low and two reasons were found for that:

    - Tasks under 8 hours correspond to documents' reviews, approvals or updates, assigned to specific technicians and therefore, they cannot be aggregated.
    - There are some necessary risk mitigation tasks, which take more than 80 hours. At the moment, these tasks are decreasing the maturity of the project, which should not happen, creating uncertainty in this indicator.

4. **5 Risk Tasks** were identified for the plan after the app highlighted that the risk analysis was not performed for the project.

5. **Priority Filled and Start & End Filled indicators** were already fulfilled, so no actions were performed to address them.

6. **Final Maturity Score indicator** improved 20%, being now 72%. This value can be interpreted as the level of confidence for project plan's metrics.

Due to the proactive behavior of project managers and project stakeholders in updating JIRA data, the maturity for this plan was improved and the time variance could be reduced in 47%, being now lower than 5%. That value is is aligned with the organisational target proposed.

The budget variance increased 5% but is still under the 10% organisational target. Thus, it does not represent an alarming situation. Despite that, a close track of the plan budget should be conducted in order to prevent problems.

B) Nacelle Rear (Stage 6)

1. **Overdue Tasks indicator** could not be reduced because, in fact, there were no overdue tasks in the project plan. The 8% tasks shown as overdue, are tasks that have already been released, nonetheless, tasks' assignees did not update their status in the JIRA software. For that reason they are still set as "in progress" while their end date has already passed. The app alerted Project Managers to this issue and stakeholders were informed that they had to update the status of these tasks.

2. **Original/Remaining Estimates Filled indicator** improved 16% after the app showed that some fields were not filled yet, so tasks' assignees corrected it. Once again, the JIRA parameterisation feature was found: original and remaining estimates fields of the Epics/Deliverables should be automatically filled using the values of originals and remaining estimates fields from their composing tasks. This justifies the impossibility of achieving 100% in the indicator
3. **The indicator for tasks Between 8 & 80 hours** was improved in 28% after some tasks were broken down. The reason for not achieving 100% is the same as for the last plan:
    - Tasks under 8 hours correspond to documents' reviews, approvals or updates, assigned to specific technicians and therefore, they cannot be aggregated.
    - There are some necessary risk mitigation tasks, which take more than 80 hours. At the moment, these tasks are decreasing the maturity of the project, which should not happen, creating uncertainty in this indicator.
4. **Risk Tasks** were not identified for the plan. Indeed, this plan has no risk tasks which motivated a discussion about these maturity criteria. The real plan has no risks and its overall maturity, in the app, is being penalised due to the criteria in use, which should not happen.
5. **Priority Filled and Start & End Filled indicators** were already fulfilled so no actions were performed to address them.
6. **Final Maturity Score** improved 7%, having now reached 62%. This value can be interpreted as the level of confidence in the metrics of the project plan.

Due to the proactive behavior of project managers and project stakeholders in updating JIRA data, the maturity for this plan was improved and the time variance could be reduced by 75%. However, the time variance is above the 10% target, which constitutes a problem. This high value of time variance raised awareness for two points:

- There is a major organisational focus on the end date. However, time variance is also influenced by start dates. Assignees tend to set a start date while planning but the date is almost a guess, and if the task does not start in the set start date, the value of the start date is not updated (for the correct day) most of the times.
- The time variance indicator is being influenced by the 'fake' overdue tasks, which status is not correctly updated in JIRA.

These tasks not correctly reflected in JIRA are skewing the value of time variance and lowering the reliability of the value. Conversely, the budget variance was reduced by 15% now being within the organisational target.

Chapter 8

Conclusion and Future Work

The purpose of this chapter is to provides the main conclusions of this dissertation project, from the initial main objectives defined by the organisation, to the final Planning Maturity Framework and Power BI application developed to address them. Moreover, conclusions drawn from pilot results will be presented, and finally, a section regarding future work developments is presented.

8.1 Conclusions

The initial objective of this project was to improve the architecture of Vestas' project management system in order to turn it more effective in cross-sectional projects and for all types of projects, while ensuring uniformisation and a commom approach used and understood by all the company's stakeholders.

The path toward achieving this objective began with a literature review of important maturity concepts, project management tools and methodologies to approach this challenging project. Afterwards, identification and description of problems was conducted, and both an extensive and detailed maturity framework tailored to meet Vestas' organisational objectives was created. This framework addressed both the the organisational efficiency key points and the project pain points identified when assessing Vestas' actual project management system in chapter 4. The Planning Maturity Framework includes 3 main dimensions:

1. a **Maturity Model** with standard practices and common assessment criteria for every module across the organisation, so that performance indicators could be obtained to compare projects maturity of plans. This Maturity Model was tailored to address organisational pain points and included the criteria required to calculate project metrics.

2. a **Metric System** allowing the project managers to measure quantitatively how projects are performing and additionally forecast deviations based on the current status analysis. These metrics provided a quantified and reliable way to make informed management decisions, which was not possible before.

3. **Actions to Address** metrics' deviations and lack of maturity, meeting organisational targets, giving forewarning to Project Managers, so that corrective actions concerning the project could be performed on time.

The next step consisted in making the theoretical model 'Planning Maturity Framework' a functional tool. Therefore, a Power BI application was developed to make the framework available to every Project Manager in the organisation, in addition to meeting the organisational demands.

The organisation defined one key requirement for the application: it had to be fully automated. The Metrics and Actions to Address areas of the Planning Maturity Framework could be fully automated.

Regarding the Maturity Model, only part of the criteria could be implemented in the first version of the application because of the automation requirement. It is important to note that the criteria implemented do not provide the same feasibility for the 'final maturity score' indicator, as compared to the scenario where all criteria would be implemented.

However, achieving high levels of maturity is a long path and this application comprises the firsts steps into improving maturity in the organisation. Moreover, pilot results showed that with the implementation of the maturity criteria, huge improvements in projects' plans were achieved using only 10 hours of work (as stated in section 7.1), thus indicating an enormous potential when full maturity criteria will be included in the application.

The application was really valuable to the organisation and the full purpose of the **Planning Maturity Framework**, outlined in chapter 4, was achieved with it. The application presented the following advantages:

1. It allowed the clean up of data of project plans, as tasks not following the maturity criteria were displayed in the application.

2. It facilitated "Deliver on Time". This was the major point which motivated Vestas' focus to improve planning methods and the maturity of project plans. With the implementation of the application, not only were estimations and measurements for schedule introduced, but also a huge reduction in time variance was achieved using the application during the pilot. Hence, proving the value of the application.

3. It improved the way that planning, tracking and reporting are performed by project managers, allowing less time spent monitoring plans and faster decision-making. The application introduced an easier and more efficient way of performing these processes by automating the standard and common areas defined in the Planning Maturity Framework, using Power BI to model and transform data extracted from Jira.

4. The KPIs are updated using live data flow, and are included in dashboards accessible to every PM. Moreover, different colours were set depending on the indicator value to implement the alarm system proposed in the 'Planning Maturity Framework'. These indicators were displayed in a user-friendly way in the application, in a way that was not available before. This way of managing plans required less time, which has a direct impact, not only on the cost, but also in making time for other valuable activities available.

5. it helped Project Managers gather the most suitable people at meetings because by using the application they were able to identify maturity and metrics deviations at the task level and therefore, they could establish direct contact with the technician assigned to the task having an issue, instead of contacting the team technical leader, which would take more time.

6. it streamlined the way work is done and allowed flexibility. The app features a data slider system. Therefore, the high planning level and low planning level organisation can use the same app and select the relevant level of aggregation of the information, according to their interests.

The use of the **application** during the pilot also exposed weaknesses in Jira software features and in the indicators foundations:

1. Jira epic/deliverables feature, outlined in subsection 7.2, which were negatively influencing the tracking of project plans, providing misleading information for the original/remaining estimates filled indicator.

2. smaller tasks which cannot be aggregated and larger risk mitigation tasks which cannot be broken should not impair the indicator for tasks Between 8 & 80 hours.

3. plans that in fact have no risks are getting a lower maturity score, which should not happen.

4. The Maturity Model score system was built in such a way that a huge improvement in each criterion is necessary in order to increase its maturity score due to lack of staggering. Therefore, the final maturity score indicator, which is being used for comparison between plans, greatly increases by leps, rather than being more linear. The final maturity score indicator is the one considered for comparison between plans, thus the score system should be more staggered in order to fairly compare plans.

Besides that, the application pilot also exposed some incorrect procedures by project's stakeholders:

- some tasks shown as overdue have already been released, nonetheless, tasks' assignees did not update their status in the JIRA software, being still set as "in progress". The app alerted Project Managers to this issue and stakeholders were informed that they had to update the status of these tasks.
- tasks' assignees tend to set a start date while planning but the date is almost a guess. If the task does not start in the set start date, the value of the start date is not updated (for the correct day) most of the times, impairing maturity plan and the reliability of metrics.

Regarding the pilot results, it is important to note that although time and budget variance reduction is important, maturity increase is the priority as the confidence on the variance values depends on the project plan maturity. Therefore, the major point here is that the plan status analysis should not only rely on variances of percentages. First, it is necessary to have an increase of the plan maturity (confident) so that real values of variances are provided, and well informed actions can be performed.

The promising results achieved with this project led Vestas to proceed to the worldwide implementation of the application, and work on developing a new version, including the criteria that could not be automated for the first version of the application.

8.2 Future Work

Regarding future work, some possible improvements were highlighted during the project's execution and also exposed by the use of the application. These improvements could be grouped among: improvements for the planning maturity framework, improvements for the JIRA software and improvements for the Power BI application.

Regarding the **Planning Maturity Framework**:

1. The Maturity Model score system should be improved in order to be more staggered, allowing even fairer comparisons between plan, and having a more linear evolution rather than a evolution by leaps.
2. Rethinking the risk key point for maturity assessment should be considered.
3. A modification in the indicator for tasks "Between 8 & 80 hours" should be considered.

4. A lot of project plan's tasks were unassigned, therefore an assignee fill range criterion should be included for the assessment of the planning dimension maturity.

Regarding the **Power BI application**:

1. Vestas does not use any type of intermediary data modelling and storage processes, so the data were loaded directly into Power BI in order to be modelled. This process is not optimised and uses a lot of processing power from the computer running the application. Therefore, a Data Warehouse system could be implemented in order to have an intermediary data modelling so that Power BI measures and tables could be reduced, optimazing the overall BI system.
2. Vestas wants to automate all the Planning Maturity Framework criteria. Therefore, data from SAP, SharePoint and Microsoft Projects should be included in the data model of the next application, which would allow it.
3. Improvements on dashboards design based on users' feedback will be considered.

Regarding the **JIRA** software:

1. Create 3 extra fields in JIRA for start dates, end dates and original estimates in order to assure performance of 3 point estimations, would be valuable, as good estimations are the grounding for confident for metrics.
2. Introduce a routine in Jira which changes the start date of the project for the day in which the assignees start to work in it, in order to address the due dates tasks problems
3. Modified actual JIRA parameterisation in order to adress the Epics/Deliverables problem.

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