



Adaptation of Hitachi Solutions Europe intellectual property for Dynamics 365 Project Operations

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the requirements for the degree of Master of Science,
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Dedicatory

Dedicated to my family, friends, colleagues from both Masters and Hitachi and professors for all of the experience, support and help provided throughout this journey.

A special mention to my superior at Hitachi Solutions, Sandor Scsavinzski, and the rest of the team for all the good moments spent together.

Abstract

Microsoft Dynamics 365 Finance & Operations is one of the services that Hitachi Solutions Europe uses. It is a multi-company, multi-language and multi-currency enterprise resource planning (ERP) system by Microsoft that allows for organizations to be digitally transformed and enables them to monitor the performance of each company in real time, forecast results, and make data driven decisions to boost the growth of a company, regardless of its size and the industry in which it operates.

However, recently, Microsoft has planned to expand Finance & Operations features to Project Operations, a recent Microsoft application for project management, and further develop that product. As a first step of that said migration, Microsoft has decided to split two different Finance & Operations modules' (Project Management & Accounting (PMA) and Project Services Automation (PSA)) features between Finance & Operations and Project Operations.

Regarding Finance & Operations, it is used as a foothold in the Hitachi Essentials for Professional Services Intellectual Property, which is one of the many IP's of Hitachi Solutions Europe. As such, it had to be updated properly in order to keep on fulfilling most of its previously established requirements and implement new ones according to the new out-of-box Microsoft logic that came with the recent product release.

In the end, what was achieved was the adaptation of the Hitachi Essentials for Professional Services Intellectual Property with the new requirements implemented according to the Microsoft approach. To conclude, it is possible to infer that the work done in regards to both Finance & Operations and Project Operations managed to achieve all of the desired Hitachi custom features design, improving the user experience tied to these features.

Keywords: ERP, Upgrade, Microsoft, Finance, Project Operations, Project Service Automation

Resumo Alargado

O Microsoft Dynamics 365 Finance & Operations é um dos serviços utilizados pela Hitachi Solutions Europe. Este consiste num sistema ERP da Microsoft utilizado por organizações que possibilita a gestão de atividades de negócio no dia-a-dia, que suporta diversas empresas, idiomas e moedas. Adicionalmente, Finance & Operations permite que organizações sejam digitalmente transformadas e que estas possam também monitorizar o desempenho de cada uma das suas empresas em tempo real, prever resultados e tomar decisões orientadas por dados de forma a impulsionar o seu crescimento independentemente da sua dimensão e da indústria em que operam.

No entanto, recentemente, a Microsoft planeou a expansão de algumas funcionalidades de Finance & Operations para Project Operations, uma aplicação recentemente criada pela Microsoft para gestão de projetos, de forma a elevar o desenvolvimento da mesma. Numa fase inicial, a Microsoft decidiu dividir as funcionalidades de dois módulos diferentes relativos a Finance & Operations (Project Management & Accounting (PMA) e Project Services Automation (PSA)) entre Finance & Operations e Project Operations.

No que diz respeito a Finance & Operations, esta serve de base para o Hitachi Essentials for Professional Services Intellectual Property, uma das muitas propriedades intelectuais (IP) da Hitachi Solutions Europe. Como tal, teve de ser devidamente atualizada de forma a continuar a cumprir os requisitos previamente estabelecidos e implementar novos de acordo com a nova lógica da Microsoft proveniente da mais recente versão do produto.

De forma a compreender o processo de adaptação da plataforma IP às mudanças mais recentes da Microsoft, foi analisado o processo completo de criação de Project Operations e a influência que a existência de diferentes aplicações de negócios para projetos segregadas tiveram nessa decisão, o futuro da nova aplicação Project Operations e as diferenças que surgiram em FinOps comparativamente ao que existia previamente (tais como funcionalidade e esquemas de licenças).

As tecnologias envolvidas no decorrer do projeto e possíveis alternativas foram descritas no Estado de Arte e classificadas de acordo com três categorias: aplicações de negócio, de colaboração ou técnicas. Estas foram também classificadas de acordo com um critério simbolizado pelo grau de conhecimento prévio que o autor possui sobre as tecnologias. Desta forma, de acordo com o critério de classificação previamente definido, foi possível detalhar quais das tecnologias em estudo eram do conhecimento do autor.

No que se refere a possíveis alternativas ao trabalho efetuado, o autor tinha como possibilidades remover funcionalidades que deixaram de funcionar do sistema, remover tudo e tentar mover para Project Operations ou simplesmente adaptar as funcionalidades que deixaram de funcionar para Project Operations (decisão implementada). A análise de valor foi efetuada para estas alternativas, permitindo averiguar a melhor decisão foi a implementada.

Relativamente ao design, o esquema de licença inicial bem como os esquemas de licenças implementados pela Microsoft foram detalhados. Contudo, de momento, não existem possíveis alternativas de design. Porém, no futuro, caso a Microsoft migre todo o conteúdo associado a Finance & Operations para Project Operations, tornar-se-á possível a adaptação da solução da Hitachi completa para Project Operations. A arquitetura base da Microsoft está inacessível para edições, conseqüentemente forçando a utilização de ferramentas compatíveis com a mesma.

Posteriormente, o documento aborda os requisitos da trabalho, expondo as diferentes tarefas, pedidos de mudança e bugs pelos quais o autor foi responsável, classificando-os como funcionais ou não funcionais e providenciando as suas descrições.

Aquando o término da secção de design, foi possível averiguar qual o processo técnico e modelo de customização da solução, a qual se baseou em extensibilidade de código. Adicionalmente, foi possível verificar o funcionamento da integração entre Finance & Operations e Project Operations através de um exemplo dos critérios de aceitação de um requisito e respetivo resultado final.

De forma a avaliar a solução implementada foram utilizados os seguintes indicadores: um indicador relativo ao índice de aceitação dos requisitos implementados pelo autor; uma métrica referente à revisão da necessidade de esforço relativa à proporção da complexidade de requisitos. De forma a complementar os indicadores, foram levantadas as três hipóteses seguintes: validação do cumprimento de requisitos de acordo com os critérios predefinidos, bem como da entrega de valor; validação do cumprimento de requisitos de acordo com os critérios predefinidos mas não da entrega de valor; incumprimento dos critérios de avaliação. Para tal, foi redigido um questionário ao tester responsável pela avaliação dos requisitos implementados, como também foi executado um modelo de avaliação de qualidade (Quality Evaluation Framework), os quais corroboram o sucesso do trabalho efetuado pelo autor.

Finalmente, foi possível aferir que a adaptação do Hitachi Essentials for Professional Services Intellectual Property alinhada com a abordagem da Microsoft foi efetuada com sucesso. Desta forma, a propriedade intelectual da Hitachi foi atualizada, tendo compatibilidade tanto com Finance & Operations como Project Operations, mantendo o design personalizado pela Hitachi Solutions Europe.

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List of Acronyms

API	Application Programming Interface.
CRM	Customer relationship management.
DBaaS	Database-as-a-Service.
ERP	Enterprise Resource Planning.
FAT	Functional Acceptance Testing.
IaaS	Infrastructure-as-a-Service.
IDE	Integrated development environment.
OOTB	Out-of-the-box.
SaaS	Software as a service.
SLA	Service Level Agreement.
SQL	Structured Query Language.
T-SQL	Transact Structured Query Language.
TCP/IP	Transmission Control Protocol/Internet Protocol.

Chapter 1

Introduction

This chapter provides an overview of the document structure, the current context of this work, as well the basis of this dissertation. Lastly, there is the definition of the objectives, approach and development process.

1.1 Context

Hitachi Solutions Europe Ltd (from here on Hitachi) is a global consultancy firm working across the private and public sectors. It specializes in user-centred business applications based on the Microsoft cloud to digitally transform organizations by harnessing the power of the latest technologies and seamlessly integrating them into businesses.

For the year of 2021 the company has been named Microsoft Partner of the Year, which corroborates its familiarity and success with Microsoft services (Azure, Dynamics 365 business applications and SQL Server between others) throughout the last few years.

With a team of experienced industry professionals, consultants and technology experts, Hitachi Solutions has a wide range of capabilities, including digital transformation, CRM and FinOps implementation, data science & analytics and low code applications, having already proven its value with diverse clients in different markets, such as Central and Local Government, Construction, Housing, Insurance, Manufacturing, Retail and Professional Services (Hitachi Solutions Europe Ltd, 2021).

As such, it is inevitable for the company to have a set of reasonably complex intellectual properties that consist of both horizontal and vertical solutions.

Hitachi Essentials for Professional Services is one of many Hitachi Intellectual Properties (hereafter IP), a set of assets that is legally owned and protected by the company from outside use or implementation without previous consent.

The horizontal solution is Hitachi Accelerators. Being a horizontal solution means that it has the capability to serve a wide range of industries focusing on broad categories that cross industry boundaries such as electricity and software, for instance. In comparison, the vertical

solution is the core Project Service Automation (PSA), a solution that focuses on clients who operate in the professional services industry (Khillar 2020).

The author of this document has been a member of the Hitachi IP team since February 2021 in a technical consultant role and, as such, has been working on various activities pertaining to the IP.

1.2 Problem

The problem that will be addressed will focus on the Hitachi Essentials for Professional Services Intellectual Property, a solution based on the out-of-the-box (OOTB) FinOps platform (*Microsoft Dynamics 365 Fo* n.d.) that also becomes an integral part of the Microsoft ERP system. Being an add-on to the out-of-the-box solution, the Hitachi Essentials for Professional Services Intellectual Property comes with pre-designed, pre-packaged templates, forms and workflows, for instance. Already in place that are common to most users. It is “ready-made” for the required purposes and can be up and going in a short time (*Custom vs configured vs out-of-the-box solutions* 2021).

On a very high level, the Finance & Operations (hereafter FinOps) application is an extremely complex multi-language, multi-country, multi-currency enterprise resource planning (ERP) system. The system, on a very high level, integrates accounting, finance, customer and vendor management, fixed assets, manufacturing, project management and accounting, for instance. capabilities in a single package, on a modular basis. The following Figure 1.1 describes this system, addressing the complete business solution, including Finance and Operations.



Figure 1.1: Dynamics 365 Finance & Operations (*Microsoft Dynamics 365 Fo* n.d.)

The D365 FinOps based Hitachi Essentials for Professional Services IP solution is the culmination of decades of business experience in the professional services industry, addressing the most important functional gaps of the out-of-box ERP system for professional services organizations. The IP also adds various back-office quality improvements over the standard product, some of which are industry specific (professional services industry) while others are general, useful for any client of Hitachi who implement the D365 FinOps solution.

Recently, Microsoft has planned to move its clients to Microsoft Project Operations (hereafter ProjOps), which is a new Microsoft application based on the Microsoft Power Platform (making it compulsory starting from 2024). As such, Microsoft has brought drastic changes to the out-of-box D365 FinOps solution, having split Project Management & Accounting and Project Service Automation (PSA) features between D365 FinOps and ProjOps, where several of the FinOps features have been moved to ProjOps.

As the IP solution is built on the Microsoft default solution, the problem and the focus of this work consists of adapting the Hitachi Essentials for Professional Services IP to the recent segregation of features between D365 FinOps and ProjOps.

1.3 Objectives

As previously mentioned, the focus of this document is to show the process of adapting the Hitachi IP to the new application stack, in line with the recent changes implemented by Microsoft. The aim of the research is to re-implement all of the D365 FinOps based IP features in ProjOps where the underlying out-of-box D365 FinOps process/functionality has been refactored into ProjOps by Microsoft.

The Hitachi IP team have utilised Microsoft Azure DevOps to maintain their backlog and for version control purposes. The author's technical process was conducted as follows:

1. Analyse and reproduce each requirement work item to check if it is in fact something that required modification or was misunderstood by a tester previously. Essentially, this first step consists or re-testing the work packages in categories 1 and 2 (1. Works without changes with ProjOps; 2. Minor changes required for ProjOps).
2. If the requirement work item requires any changes, implement and test the developed solution and, after making sure it is working as expected, check in the code to the previously mentioned Azure DevOps repository.
3. Update the Azure DevOps respective work item with the adopted solution and assign it back to a tester. The tester will do the Functional Acceptance Testing (FAT), which is conducted to assess any discrepancies and non-conformities. Unexpected behaviours observed during testing are commented in the requirement work item repository and assigned back to the developer to be fixed.

4. Regression testing cycle is a type of software testing that is used to re-run functional and non-functional tests to ensure that no newly developed code causes bugs or breaks to any existing functionality in the software. This is regularly repeated and repeated before every code release (*What is regression testing? definition of regression testing, regression testing meaning* n.d.). This way, after the solution has been analysed, implemented and properly tested, it becomes part of a regression testing cycle from then on. Similar to the previous step, if it fails, it is assigned back to the developer to repeat the steps from point 3.

From all of those steps, the author must be responsible for all except the last one. Furthermore, the FAT is also something that should be done only by a tester, whereas the author focuses just on simple developer unit testing.

Essentially, the author is responsible for all of the process from analysis to implementation of each work item existing in the repository that he has been assigned to.

1.4 Work Approach

This topic will focus on the methodology for the work at hand. It will address Hitachi's IP and explain what and how does that relate with bespoke software and also address the Consensus methodology used. Since bespoke software refers to custom software and Consensus is a Hitachi-specific approach, both are part of a common practice for Hitachi D365 FinOps projects, and thus have been applied to other sets of IP beyond Hitachi Essentials for Professional Services.

1.4.1 Bespoke Software

Bespoke software is an ever-growing software trend that is directed to customers and companies' brand. It is also called custom or tailored software and, as the name implies, it means a software solution for a specific user or set of users, matching each one of their required specifications. It is a necessity to meet the complex demands of businesses and users (*What is bespoke software, and why should you go bespoke?* 2020).

The bespoke approach is used when the commercial off the shelf systems do not sufficiently support the required business processes. Some examples that make up the bespoke methodology from Stirk 2020 are:

- Purpose-built with the end product being fit-for-purpose;
- Future needs can be assessed as requirements gathering which enables features to be incorporated into the application to support the business;
- The IP (product) belongs to the company itself (Hitachi in this case), meaning that it owns the rights to use, sell, monetise or change the software as seen fit;

- The custom solution provides greater competitive advantage by differentiating the business, product offering or customer journey from competitors.

The only disadvantages of this approach are that it takes up a lot of time and resources. It is crucial to carry-out build versus buy analysis to check if there is already a software product that delivers the required functionalities. To be successful, it is also crucial to allocate dedicated talent to the bespoke team project and make sure to properly manage its resources and requirements.

Due to the reasons mentioned above, it can be noticed that they do apply to Hitachi's IP. However, even though the IP is bespoke, it is not a completely bespoke piece of software as it is more of an add-on to the out of box product and because of the foundation it is based on.

1.4.2 Work Methodology

Now, with the explanation of the bespoke software and how it relates to Hitachi's IP has already been addressed, it is time to focus on the work methodology.

Time and time again, organisations are experiencing the same issues when rolling out major projects that are intended to be transformational. In many businesses, IT and the business are leading separate lives and too often business and technology teams barely work together. Replacing or upgrading an organization's critical business applications is a challenge for most businesses.

Transferring a business to an entirely new unified business solution is not trivial. Add in the potential complexity of getting a supplier to work with a preferred project approach and the task ahead can seem monumental. It is important to walk through this hand-in-hand with an experienced implementation partner who understands both the technology and a business (*Consensus* n.d.).

Hitachi's bespoke Consensus project methodology can assist precisely with this. It helps businesses to progress past these issues, understanding what is the right technology and how to manage the project effectively. It provides a comprehensive approach to every stage in the lifetime of the project with the traits of being a comprehensive, flexible and proven methodology.

Consensus methodology delivers a repository of tools and documents that make it simpler to deliver complex projects and programmes on time and on budget. It embraces a range of established project approaches, which can range from Waterfall to Agile, and offers the Essentials option, centred on pre-configured solutions with rapid iterations of development, allowing businesses to go live with projects quicker and cheaper.

Consensus methodology objectives are:

- Provide certainty, based on previous experience and proven Microsoft Dynamics tools and techniques;
- Provide a level of rigour around project governance and control;
- Accelerate the implementation, reducing project timelines;
- Allow the client to have the option of a fixed price engagement through the certainty of a known outcome;
- Ensure that the delivered solution is robust and scalable, and meets the original requirements of the client;
- Ensure post go-live support of the client's Microsoft Dynamics solution.

Consensus methodology is a tried and tested framework that provides a comprehensive approach to every stage in the lifetime of a business project (inception, elaboration, construction, transition and operation).

1.5 Expected Results

As it was previously mentioned that the student has been working with a team upgrading the Hitachi Project Service Automation Intellectual Property, it is expected from him to be able to contribute to such a cause.

As the work consists of a sequential process using Consensus, the author should contribute to always have a work item at hand whenever possible and, upon completion, move on to a new one, thereby decreasing the amount of outstanding work items in the backlog that have yet to be checked and helping with the adaptation. This way, after his work ends, it is expected of the author to have managed to adapt multiple previous FinOps features to ProjOps.

1.6 Document Structure

The current report has a total of eight chapters: Introduction, Dynamics 365 Project Operations, State of the Art, Value Analysis, Analysis and Design, Implementation, Evaluation and Experimentation and Conclusion. Beyond Introduction they can be summarised as follows:

1. Dynamics 365 Project Operations - provides important context to ProjOps, the Microsoft roadmap and changes performed by Microsoft that is fundamental for the rest of the document.
2. State of the Art - describes the different technologies involved, the degree of knowledge that the author had about them and classifies the involved platforms and technologies

into three different categories (business, collaborative or communicative). It also addresses similar approaches and technologies.

3. Value Analysis - initially provides a description about value analysis then focuses on the innovation process and the theoretical concepts involved, the value which includes a value proposition and value map for this work where it describes some of the pains and gains of this adaptation project, a Canvas model that better describes the value scheme and, finally, the Technique for Order Preference by Similarity to the Ideal Solution (TOPSIS) methodology where different the most optimal alternative.
4. Analysis and Design - this chapter has two different subtopics: the problem domain and the requirements specification. The problem domain is where the initial, adopted and alternative licensing schemes are displayed and the requirements specification showcases the three different types of work items (task, bug or change request) and divides them into two different categories (functional and non-functional requirements).
5. Implementation - the implementation chapter focuses on the implementation process, describing what requirements the author was assigned to and describe them and the implemented solution. It will also explain step-by-step what was required for one of the existing requirements, starting by explaining what was initially planned, what was done and the user experience.
6. Evaluation and Experimentation - this chapter focuses on the evaluation indicators for this work and its assessment metrics, describe the hypothesis, evaluation methodology, the results and the assessment completion.
7. Conclusion - being the last chapter of the current report, it mentions the work contributions, the obstacles and limitations of the current work, achievements, what to expect in the future with this work and, finally, final considerations from the author.

Chapter 2

Dynamics 365 Project Operations

This chapter explains the approach in details that Hitachi Solutions Europe Ltd has taken in response to the changes implemented by Microsoft.

This chapter first provides the reader with explanation for the reason as to why the ProjOps application has been created by Microsoft, as well as it addresses the Microsoft roadmap for the PSA and ProjOps applications. It explains the fundamental structural and architectural changes the new application brings and the possible deployment types of the solution. Finally, it discusses the benefits of the new architecture as well as it explains what licensing changes the new infrastructure brings.

2.1 Creation of D365 Project Operations

Before explaining the Microsoft changes that instigated the subject of this document, the Hitachi initiative, it is important to first explain the reason why Microsoft decided to create ProjOps.

In what concerns project management tools, Microsoft has multiple, for example, Microsoft Planner, Microsoft Project, Microsoft Dynamics 365 Project Service Automation, among others. However, the fact that there were so many out there ended up causing some doubts to the users. Faced with so many opportunities, deciding on what to use and compare all of them to see what the best choice was proved to be a bigger of a challenge than it should be and also caused some organizations to use a mixture of different solutions, which also implied the existence of some duplicate features. This way, Microsoft planned to develop a solution that contained all of those other tools' key features and allowed to cover all of the stages of a project cycle (initiation, planning, execution, monitoring and closure) (Alam 2020).

The final product is the current ProjOps, which is a product management solution that can handle both the front-end functionality, as well as the back-end financials (Microsoft 2022).

It connects sales, resource management, project, contract and job management, and finance teams within one application to help win more deals and maximise contract profitability.

Besides, together with PSA, both are a part of Dynamics 365 Customer Engagement (CE), Power Platform based applications which help to improve the marketing capabilities of customer relationship management business solutions (Kvivek 2022).

Microsoft have clarified that they intend to combine Microsoft Power Platform as well as FinOps environments on the long run. The reasoning for such is due to the fact that Microsoft is standardising all other platforms into proper web-based services and will prevent users from acquiring new PSA licenses in the future, which proves that moving all users down the road of Power Platform and Dataverse will become the final goal from the author's perspective.

2.2 Project Operations deployment types

Microsoft recently implemented a set of enhancements in FinOps architecture to allow for a more cohesive integration with ProjOps (Power Platform).

Some of the changes can be seen in the roadmap changes for the wave 2 of 2020, (Krishna 2022) where Microsoft released features around Dual Write connection, an out-of-box infrastructure that provides near-real-time data interaction between FinOps and Microsoft Dataverse environment. It is important (as per the principles of Digital transformation shared by Microsoft) in any organization when data about people, products, operations, and customers goes beyond the boundaries of the individual line of business apps.

Project Operations deployment types

There are now three different types of approaches (designed as deployment types by Hitachi) in ProjOps:

1 - Legacy PSA (CE) or Project Operations #1

This deployment type supports resource based scenarios either without FinOps, with or without a third party ERP system. ProjOps is deployed in the Dataverse.

The features it includes are project sales, planning, resource management, time and expense entry and proforma invoice (Table 2.1).

Table 2.1: Type 1 - Legacy PSA (CE) features

Dataverse	Project Sales
	Project Planning
	Resource Management
	Time Entry
	Expense Entry
	Proforma Invoice
Finance and Operations	N/A

2 - Project Operations #2

This deployment type supports resource/non-stocked based scenarios where ProjOps is deployed in the Dataverse being backed by FinOps. Data flow between the two systems is orchestrated via Dual Write. Its features are present in the Table 2.2.

Table 2.2: Type 2 - Project Operations features

Dataverse	Project Sales
	Project Planning
	Resource Management
	Time Entry
Finance and Operations	Expense
	Invoicing
	Revenue Recognition
	Project Accounting

This deployment type is the one that had to be dealt with during the IP adaptation efforts. It is the most complex scenario as several features have a footprint in ProjOps as well as FinOps where the two applications have to seamlessly cooperate with one another in order to make such features work. Depending on the type of data, changes can be either saved in the source system (not interfaced), both systems in both ways (bi-directional data entities) or, in some cases, changes are only written from FinOps to ProjOps or vice versa but not both ways (unidirectional data entities).

3 - Legacy PMA (F&O) or Project Operations #3

It is the deployment type the IP had been written for, in lack of ProjOps, FinOps-only. It is a stocked/production-based scenario that is exclusive to FinOps, the opposite of the type 1 deployment type. The Table 2.3 mentions its features.

Table 2.3: Type 3 - Legacy PMA (F&O) features

Dataverse	N/A
Finance and Operations	Project Sales
	Project Planning
	Resource Management
	Expense
	Invoicing
	Revenue Recognition
	Project Accounting
	Time Entry

Overview

For a better overview of all the existing deployment types there is the following Figure 2.1.

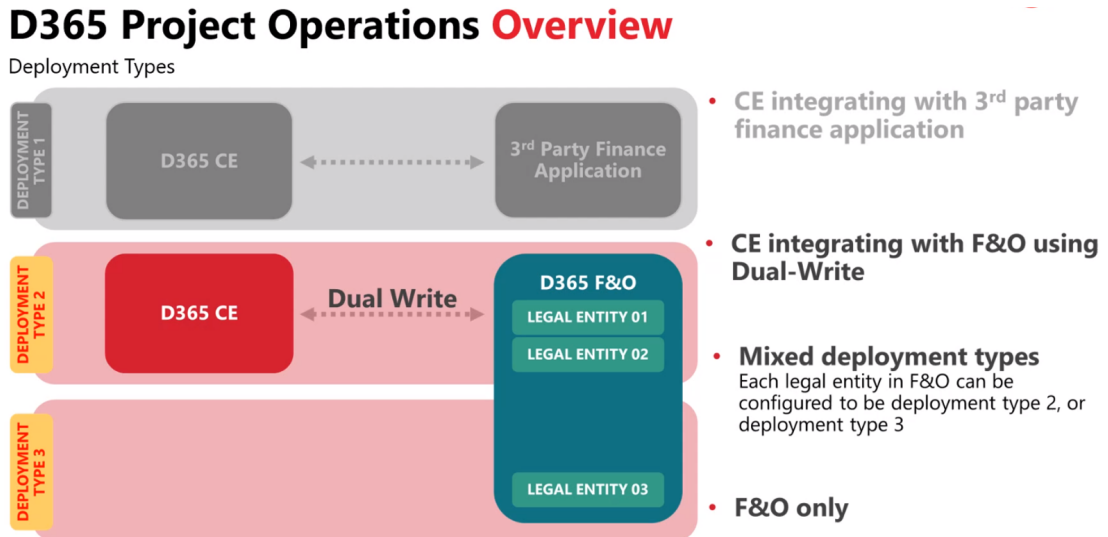


Figure 2.1: D365 Project Operations - Deployment Types Overview (Hitachi 2022)

Also, all of the strengths and weaknesses of each deployment type for each feature can be classified according to their performance and how they deal with a specific feature.

The following table summarizes all of that using a classification that ranges from one, the worst value possible, up to ten, the best. If a deployment type has a classification of one for a feature then it means that that feature does not apply for that deployment type. On the other hand, if a deployment type has a classification of ten for a feature, it means that the feature is implemented perfectly in that deployment type. ProjOps Deployment Types Classification per Features (Table 2.4).

Table 2.4: Project Operations Deployment Types Classification per Features

	Type 3	Type 1	Type 2
Project Sales	1	7	7
Project Planning	2	7	7
Project Resourcing	3	7	7
Time Entry	7	6	7
Expense Entry	7	4	7
Invoicing	7	2	7
Project Accounting	7	1	7
Total	34	34	49

2.3 Key differences

In what concerns the before versus after of the D365 PSA, both are end-to-end project automation and management tools. However, while D365 PSA revolves more around front-office project management, ProjOps covers both front and back-office, being a more complete solution that contains, for example, the planning and scheduling functionalities of Microsoft Project (previously not available in PSA), as well as some of the project management accounting and expense management features of FinOps (Table 2.5).

Table 2.5: Existing FinOps features in D365 Project Operations

Project Planning	Resource utilization and optimization
Forecasting (e.g., expected resources, time, expenses)	Time and expenses tracking
Project accounting	Business intelligence

Until Microsoft completes the work to merge FinOps into the Power platform, ProjOps is visible and manageable through the Power Platform Admin Centre (PPAC) and is only referenced on Lifecycle Services (LCS) when the integration is set up.

Microsoft has also notified that starting February 22nd, 2021, new FinOps environments created by customers will have a presence in both Lifecycle services (LCS) and Power Platform Admin centre (PPAC), automatically. In addition, Microsoft will be retroactively creating an environment in the Power Platform Admin centre (PPAC) for each FinOps environment that already exists in Lifecycle Services (LCS) today (Jimholtz n.d.) (not for tier one environments). This way, Sandbox and Production environments will be faced with another set of modifications, where each Sandbox or Production environment will receive an entry in the Power Platform Admin Centre (PPAC) and cannot be deleted independently from one another.

2.4 Benefits

The benefits that came with D365 ProjOps are many as it can be seen.

Simplified adaptation of Dual write

The adaptation of Dual Write is simple, allowing for a unified view of environments.

Dataverse data storage

All existing Power Platform based business applications utilise the Dataverse hence are accessible by PowerApps, Power Automate and to FinOps as well through Dual Write.

Required environments

Microsoft will automatically create the required additional environments in the Power Platform Admin centre (PPAC) for its customers (Jimholtz 2022).

Enhanced revenue recognition and improved cash flow

Enhance business performance through streamlined financials.

Reduced risks

Using always up to date key performance metrics to highlight danger signs on under-performing projects or contracts.

Tool for success

Unify cross-functional teams around project plans, scope, and budget while capturing conversations, having content, and using apps.

Optimised resource utilisation

Unify all resource management processes into a single connected solution to increase project efficiency.

Allows for an easier time and expense process for employees

For easier submissions and approvals anytime and anywhere.

2.5 Licensing & Costs

Historically, there used to be separate Power Platform application licenses as well as a single FinOps license (albeit with different levels and pricing for different usage patterns).

The Microsoft Dynamics 365 roadmap involves stopping users from purchasing new PSA licenses as of October 2020 while still supporting previously existing PSA users until October 2024. For those, Microsoft will also provide support until October 2024 and data migration tools to help in data migration from within PSA, but it will not add any new feature (Microsoft 2022).

A few years ago, Microsoft started to split FinOps licenses to key areas such as Finance (including PMA/PSA), Supply Chain Management and Retail. With this recent change, Microsoft has further split the Finance license to Finance (FinOps finance and ledger modules without PMA/PSA) and ProjOps (PMA/PSA in the FinOps and ProjOps applications). There is one license for ProjOps and there is another license for FinOps.

The fact that the licenses are split does not mean that one cannot do anything without having both of them. Supposing that one has a FinOps license for instance, while being able to post transactions in other modules like Accounts Receivable, Accounts Payable and General Ledger, the same does not happen in the Project Accounting module. By using a

ProjOps license, everything is posted in the background in FinOps but features bound to the finance license-only are not accessible.

Chapter 3

State of the Art

The state of the art will focus on addressing the technologies utilised on the described project. It will start with by describing the involved technologies and how they work followed by pointing out specific details and differences between those and other similar technologies. It will then provide a knowledge synthesis where each of such technologies are evaluated according to prior knowledge that the student has about them and discuss similar approaches to the implemented solution and, finally, specify possible alternatives.

3.1 Relevant Technologies

As previously mentioned, this chapter discusses the relevant technologies, providing an overview and some noteworthy details pertaining to them. Those technologies can also be divided into three different categories based on their purpose/nature:

1. Business applications.
2. Collaborative applications.
3. Technical applications.

3.1.1 Business Applications

Microsoft Dynamics 365 Finance & Operations

Microsoft Dynamics 365 for Finance & Operations is a Microsoft enterprise resource planning (ERP) system that is part of the group of Microsoft Dynamics 365 business applications, which also includes Microsoft Dynamics 365 Project Service Automation. It is a complex cloud hosted ERP software solution, one of the market leaders due to its quality of features, size and support provided to users by Microsoft.

It accelerates the speed and accuracy of doing business by providing a platform for digital transformation for organizations. It helps supporting the client's "unique requirements and helps them adjust to constantly changing business environments, without requiring that they manage infrastructure." (Higginbotham 2022).

It allows to enhance the financial decision-making of organizations, unify and automate business processes, to have a strategic impact, reduces costs and decreases the global financial complexity and risk. Due to these reasons among others, it is a successful product with a long history.

Microsoft Dynamics 365 Project Service Automation (Before ProjOps)

As discussed in the previous chapter, Microsoft Dynamics 365 Project Service Automation is a stale application which has been rebranded to Microsoft Dynamics 365 Project Operations.

It used to help with developing a more stable customer engagement and building a solid and trustworthy customer relationship by “developing credibility and increasing customer confidence through a responsive engagement model”, (Higginbotham 2022) all the while helping to manage priorities, innovation and investment in service offers based on actionable insight. Essentially, it helped organizations efficiently track, manage, and deliver project-based services, from the initial sale all the way to invoicing. In addition, it also empowered “professionals with a collaboration-rich experience, enabling transparency across the business and empowering them to use their expertise to increase project productivity with every customer.” (Higginbotham 2022).

Some of its features according to Microsoft were:

- Project planning, estimates and work schedules creation;
- Project cost and revenue tracking;
- Forecast resource requirements for projects in the pipeline;
- Project progress and cost consumption tracking;
- Quoting, pricing, and project billing management;
- Resources management.

Essentially, PSA was Microsoft refactoring some of the key project management related processes from FinOps into a standalone, Power Platform based application to provide a slicker, more refined user experience, however, at that point of time the PSA application did not replace any feature of the FinOps solution and it was not forced on clients.

Microsoft Dynamics 365 Project Operations

Microsoft Dynamics 365 Project Operations is a relatively new Microsoft Dynamics 365 application that has been released in October of 2020. It is the evolution of the existing project management and accounting (PMA) modules inside FinOps, as well as the previous Project Service Automation (PSA) solution from Microsoft.

It connects sales, resourcing, project management, and finance teams in a single application to maximize profitability and minimize project deadlines and also allows to flexibly manage projects with easy-to-use embedded Microsoft Project capabilities including Kanban boards and Gantt charts, improve contract management, have more accurate project quotes, forecasting, estimation, and scope and, finally, ensure that organizations have the right people on the right projects through resourcing insights, scheduling, governance, and skills matching (Sporen 2022).

According to Microsoft, ProjOps provides to its users:

- Leaders get business insights to increase visibility across all teams, data, and processes, plus AI capabilities for better and faster business decisions;
- Sales is enabled to win more deals and accelerate the sales cycle with fast and accurate quotes, flexible pricing, and seamless transitions from estimate to execution;
- Resourcing is set up to optimize resource use by aligning the right people, with the right skills, to the right projects. This alignment improves quality and helps to retain top performers;
- Project managers can accelerate project delivery with state-of-the-art, built-in project management that uses familiar, easy-to-use Microsoft Project capabilities;
- Team members can improve productivity, collaboration, and visibility with integration to Microsoft Teams, and submit time and expenses from anywhere;
- Finance can simplify project accounting with time and expense tracking governance, project costing, budgeting, invoicing, revenue recognition, compliance, and visibility into key business health metrics.

ProjOps is powerful by itself, but Microsoft also provides the opportunity for it to be expanded by customers who require more capabilities from other Dynamics 365 business applications, including Marketing, Human Resources, Customer Service, between others. Since all of the D365 business applications except for FinOps are built on the Power Platform, utilising Dataverse, ProjOps can seamlessly integrate with other functionalities of different Dynamics 365 applications or with the addition of a custom application built with Power Apps (Sporen 2022) (Figure 3.1).

Feature area	Reference number	Quality update
Planning and Tracking	2392596	Schedule APIs now allow updates to the Effort remaining , Effort completed , and % Complete fields.
Planning and Tracking	2478497	The Activity Number and Task ID fields for Schedule APIs can be blank on input because the system will populate them using automated numbering.
Time and Expense	2468135	The number of approval retries is reduced from five to three.
Time and Expense	2468188	Fixed the issue with log text exceeding the maximum length in the notetext attribute of the Annotation entity.
Billing and Pricing	2488698	Updated error message that occurs when the environment setup is missing Ledger entity records that are populated from Finance.

Figure 3.1: Microsoft Project Operations - Updates December 2021 (Sigitac 2022)

Also, one advantage of using ProjOps is that, in addition to being a recent application with some of the latest market features, it is also frequently updated by Microsoft, addressing issues as well as releasing new features. Its respective roadmap is also regularly updated by Microsoft to provide users with the best possible assistance and knowledge.

3.1.2 Collaborative Applications

Azure DevOps

Azure DevOps was officially launched at October 2018. However, it can be traced all the way back to Team Foundation Server, which was launched in 2006. “This is a mature product with a rich feature-set that has over 80,000 internal users at Microsoft.” (DevOpsGroup 2019). Not only that but it used to be one of the industry standard products, not only used by Microsoft but countless third-party companies too including Hitachi.

Azure DevOps is a SaaS platform that integrates with most leading tools on the market and provides an end-to-end DevOps toolchain for developing and deploying software. It is also great option for managing third-party tools.

Essentially, it is flexible, reliable, scalable and globally available, being backed by a SLA (service-level agreement) of 99.9% uptime and by 24×7 support. It is possible to adopt each of the services independently and integrate them, supports most popular tools (Jenkins for instance) and is also designed to work with any platform (Linux, MacOS and Windows) or language (including Node.js, Python, Java, PHP, Ruby, C/C++, .Net, Android and iOS apps). It supports continuous delivery to Amazon Web Services and Google Container Registry as well as to Azure.

DevOps is frequently updated by Microsoft with fixes and new features, which are available in a roadmap published by Microsoft. Also, for organisations running on-premises CI/CD (continuous integration/ continuous deployment) tooling, upgrades are a regular headache. By “moving to a SaaS model, you no longer need to worry about new patches or upgrades.” (DevOpsGroup 2019). It also comprises a range of services covering the full development lifecycle:

- Azure Boards: agile planning, work item tracking, visualisation and reporting tool;
- Azure Repos: provides version controlling capabilities ;
- Azure Pipelines: a language, platform and cloud agnostic CI/CD platform with support for containers or Kubernetes;
- Azure Test Plans: provides an integrated planned and exploratory testing solution;
- Azure Artifacts: provides integrated package management with support for Maven, npm, Python and NuGet package feeds from public or private sources.

The following Figure 3.2 further complements the information related with the Azure services described above.



Figure 3.2: Introducing Azure DevOps (*Microsoft Anunció La Disponibilidad de Azure DevOps Server 2019 RC2 2019*)

Moving on to the practical application of these services, during the work that is the subject of this document the IP team have utilised Azure Boards in DevOps for maintaining the work backlog, maintaining respective work items during the entire project lifecycle. This way, it contained all of the information that concerns the the full lifecycle, including specification writing, development, testing, among others. The Azure Repos, even though it contained Git repository, was not used and, instead, it was used TFVC repositories (Team Foundation Version Control). The Azure Pipeline hosted the automated build and deployment pipelines.

The Azure Test Plans had all of the test plans to be done by testers and hosted the regression test libraries and, finally, the Azure Artifacts were not used.

Microsoft Teams

Besides Azure DevOps, there was also another tool that was used to maintain contact with the team and share files pertaining to the upgrade of the PSA IP. That other tool was Microsoft Teams.

Microsoft Teams is a chat-based collaboration platform where one has the possibility of sharing documents through private chat or teams' groups, schedule and participate on online meetings, and many more extremely useful features for business communications. It has a user-friendly interface, requires little to no setup and can facilitate a work environment between remote users or within a large business. For businesses already using Skype for Business, the Microsoft Teams client will replace the Skype client, but all additional existing functionality will remain the same (*Microsoft teams n.d.*).

Some of its advantages are:

- Teams and channels;
- Conversations within channels and teams;
- A chat function;
- Document storage in SharePoint;
- Online video calling and screen sharing;
- Online meetings;
- Audio conferencing;
- Full telephony.

Teams can also be divided into three different parts from a logical architecture viewpoint: teams, voice and chats. For each one of those there is an interdependency with features, such as contacts, messages, among others.

Its logical architecture is described in the Figure 3.3.

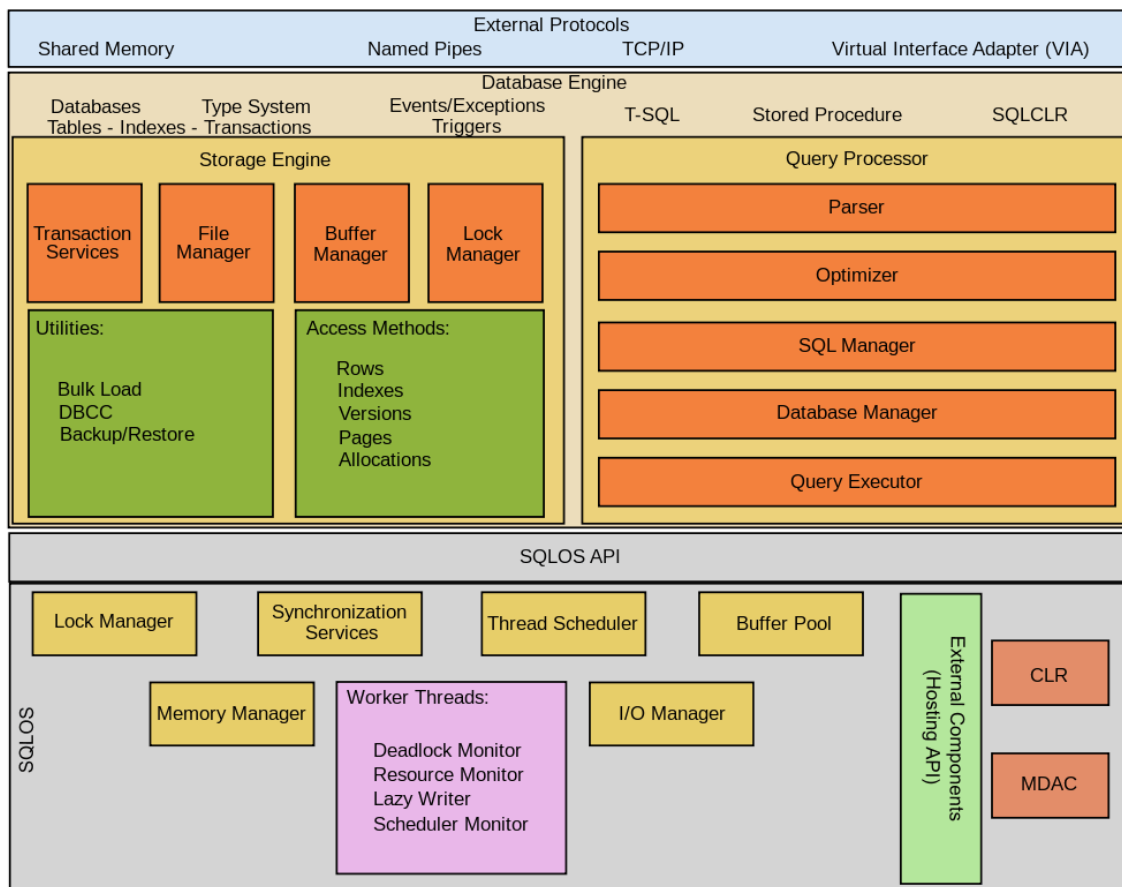


Figure 3.4: SQL Server Architecture

The virtual machines used throughout the work discussed utilised Microsoft SQL Server (on-premise) as the data storage platform.

Azure SQL

The other important database tool is Azure SQL.

Azure SQL is an extension of the Microsoft On-Premise SQL Server into the cloud. It is a Microsoft’s cloud always-up-to-date relational database service and also a part of the Azure SQL Family (Figure 3.5).

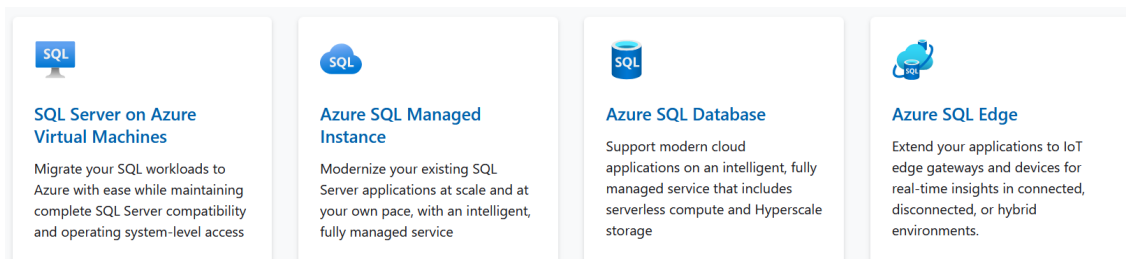


Figure 3.5: Azure SQL Family

It is a fully managed SQL database that automates updates, provisioning, and backups so that the user can focus on application development, its flexible and responsive serverless compute and Hyperscale storage allow to rapidly adapt to changing requirements, provides layers of protection, built-in controls, and intelligent threat detection keep the data secure and has built-in AI and high availability which maintain peak performance and durability with an SLA (Service Level Agreement) of up to 99.995 percent (*Azure SQL database – managed cloud database service: Microsoft azure n.d.*).

Any existing multi-tiered environments (not specific to Hitachi only), such as, the production environment, uses Azure SQL.

How does SQL Server compare with Azure SQL?

Azure SQL offers Database-as-a-service (DBaaS-PaaS). With SQL Database, there is no access to the machines that host databases. In contrast, Azure Virtual Machine offers Infrastructure-as-a-service (IaaS). Running SQL Server on an Azure VM is similar to running SQL Server in a On-Premise datacenter (Patel 2022).

The following Table 3.1 further mentions their differences.

Table 3.1: Azure SQL vs SQL Server

Azure SQL	SQL Server
Can host databases from various clients who use the service	The database only holds instances from the on-premises setup
Only uses TCP/IP to talk to the Azure gateway through the internet	Uses LAN and Tabular Data Stream protocol instead of HTTP or TCP/IP to allow applications to talk to the server
Is a subset of SQL Server (doesn't have several features SQL Server has)	Has more features (more difficult to set up and manage than Azure SQL)

Microsoft SQL Server Management Studio

In terms of accessing data stored in Microsoft SQL Server or Azure SQL databases, the team have used Microsoft SQL Server Management Studio for the most part.

Microsoft SQL Server Management Studio (SSMS) is an integrated environment for managing any Microsoft SQL infrastructure, on-premise SQL as well as Azure SQL servers. SSMS provides tools to configure, monitor, and administer instances of SQL Server and databases. It can be used to deploy, monitor, and upgrade the data-tier components used by applications, and build queries and scripts (Ghanayem 2022).

The data in FinOps is saved in data tables. As PSA IP is an integral part in FinOps, its data is saved in data tables in the same database too as the IP is built upon the core product so its data is saved in the same database that the core product uses. By using the Microsoft

SQL Server Management Studio, one is able to easily access and filter all of the desired data using SQL statements. Of course, to be able to do so, having knowledge about SQL is a must.

Microsoft Visual Studio

Microsoft Visual Studio is an IDE (Integrated Development Environment) whose first version was Visual Studio 97 and the newest one is Visual Studio 2022. It allows developers to write and edit their code (or others') and its UI (User Interface) allows for editing, debugging and building of code among others.

Visual Studio 2015 and then later on 2017 has been used throughout the work that this document discusses, starting with the 2015 version and, later on, upgrading to the 2017. The reason why only previous versions were used when there was one more recent is due to the FinOps Visual Studio development add-on (a software program that expands the capabilities of the core product). For instance, the version 2022 is out now but at the time of writing this document FinOps development was officially stuck on Visual Studio 2017.

Visual Studio is mainly used for different types of software development (computer programs and websites, for instance). Some of its advantages are, according to Incredibuild 2021, the following:

- It is one of the best IDE's and it supports many other different languages;
- Has a lot of extensions free in the marketplace;
- Has a free version with no costs included.

In terms of FinOps development Visual Studio has a number of other traits, as follows:

- Is the essential (and the only) tool for FinOps development, Visual Studio is the compulsory development toolset for customising FinOps;
- Can directly change the code to test in local environment;
- It is not free of charge, need to have license subscription to be able to access the code repository;

X++

The programming language that was used for Dynamics development in Visual Studio was the official development language for FinOps development (X++) and, together with a FinOps Visual Studio add-on, it was possible to effectively add X++ code customisations to Visual Studio. As it has become part of Visual Studio through the FinOps add-on, it is not a standalone technology.

X++ is an object-oriented, application-aware, and data-aware programming language used in ERP programming and in database applications. It provides system classes for a broad range of system programming areas, highlighted in the following table.

It is Microsoft's own bespoke development language, which is a mixture of C++/C#, Java and T-SQL, being the default language for FinOps development (Table 3.2).

Table 3.2: X++ Language Reference (Reynolds-Haertle 2022)

X++ language feature	Description
Classes	In addition to system classes, there are also application classes for managing many types of business processes. Reflection on classes is supported.
Tables	X++ programmers can access the relational tables. X++ includes keywords that match most of the keywords in standard SQL. Reflection on tables is supported.
User interface	Manipulation of user interface items, such as forms and reports.
Best practice checks	X++ code is checked for syntax errors during compile time. The compile process also performs best practice checks. Violations of best practices can generate compiler messages.
Garbage collection	The X++ runtime execution engines have automatic mechanisms to discard objects that are no longer referenced, so that memory space can be reused.
Interoperability	Interoperability between classes written in X++ and in C# (or other .NET Framework languages) is supported.
File manipulation	File input and output are supported, including XML building and parsing.
Collections	Dynamic arrays are supported and the X++ includes several collection objects.

When comparing X++ with, for instance, C#, some of its similarities are:

- Single line (//) and multi-line (/* */) comments;
- == (equal) operator for determining whether two values are equal;
- != (not equal to) operator for determining whether two values are not equivalent;
- + (plus sign) operator for string concatenation.

On the other hand, some of its differences can be seen in the Figure 3.6.

Feature	X++	C#	Comments
<code>if</code> and <code>else</code> conditional statements	The <code>if</code> statement accepts any type of expression that it can automatically convert to a Boolean. Common examples include an <code>int</code> for which 0 means false, or an object for which null means false.	The <code>if</code> statement requires a Boolean expression.	The syntax structure regarding curly braces and parentheses is exactly the same between X++ and C#.
Literal string	A literal string can be delimited by either of the following: <ul style="list-style-type: none"> • A pair of double quotation mark (") characters. • A pair of single quotation mark (') characters. 	A literal string must be delimited by a pair of double quotation mark (") characters.	For X++, the double quotation mark characters are usually used to delimit strings. However, it is convenient delimit a string with single quotation mark characters when your string must contain a double quotation mark character.
<code>char</code> type	There is no <code>char</code> or character type in X++. You can declare a <code>str</code> of length one, but it is still a string: <code>str 1 myString = "a";</code>	There is a <code>char</code> in C#. You cannot pass a <code>char</code> as the parameter to a method that inputs a <code>string</code> parameter, although you can first explicitly convert the <code>char</code> to a <code>string</code> .	For more information about X++ data types, see Primitive Data Types.
Output of messages	X++ delivers messages to the user in the Infolog window. Common methods include the following: <ul style="list-style-type: none"> • The <code>print</code> statement: • static methods on the <code>Global</code> class: <ul style="list-style-type: none"> ◦ <code>Global::info</code> ◦ <code>Global::warning</code> ◦ <code>Global::error</code> 	For a command line program, messages can be delivered to the console. Common methods include the following: <ul style="list-style-type: none"> • <code>Console.Out.WriteLine</code> • <code>Console.Error.WriteLine</code> 	

Figure 3.6: Microsoft Power Platform (Peart 2022)

Microsoft Power Platform

Power Platform is a Microsoft cloud platform on which Microsoft and third parties can create applications. It was created by Microsoft to develop and build complex business solutions, analyse, and draw data visualizations, automate a business process, or build virtual agents for communication. All included products provide a base that does not require code to build applications and have a simple user interface which can be used by any business users or developers, thus helping to reduce the need for IT in the organization (Data and Engineer 2020). Some of the most important Power Platform based Microsoft products are as follows:

- Power BI;
- Power Apps;
- Power Automate;

- Power Virtual Agents.

Dataverse

Being a part of Microsoft Power Platform, Dataverse, previously known as Common Data Service (CDS), is an Azure SQL based database (Enric S 2022) that provides a cloud-based storage for D365 Power Platform based business applications. Figure 3.7 displays the Power Platform products, backed by Dataverse.

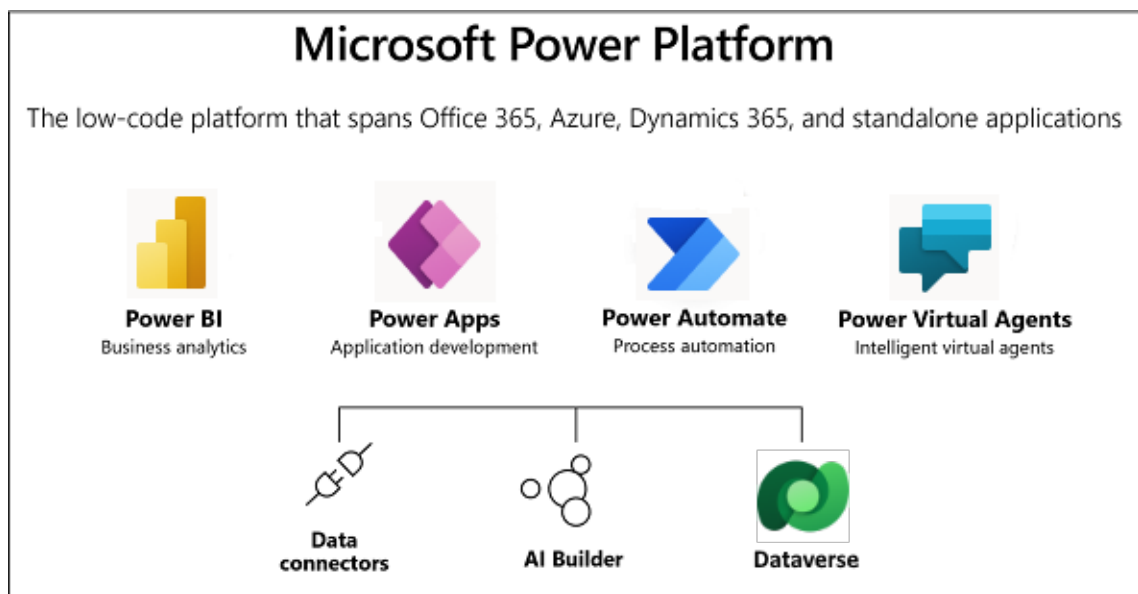


Figure 3.7: Microsoft Power Platform (Peart 2022)

Dataverse works as an API and makes it possible for Power Apps or Power BI to interact with it. Data can be integrated with Dataverse either directly or via the use of connectors.

Pre-built connectors such as the Dynamics 365 Connector or the Common data Service Connector can access Dataverse (Peart 2022).

FinOps/ProjOps Dual-Write

Also a part of Dataverse, there is Dual-write, which is a recent tool that has been introduced by Microsoft fairly recently.

Dual-write is an out-of-the-box framework that allows customer engagement apps and FinOps apps to interact in near-real time. It enables Dataverse and FinOps apps to communicate in a bidirectional, strongly connected manner. Any data change in FinOps apps triggers Dataverse writes, and any data change in Dataverse triggers FinOps app writes. This automated data flow ensures that users have a consistent experience across all apps (Krishna 2022).

According to Microsoft, some other advantages of using Dual-write are:

- Data from customers, products, operations, projects, and the Internet of Things (IoT) automatically flows to Dataverse through dual-write. This connection is useful for businesses that are interested in Power Platform expansions;
- The dual-write infrastructure follows the no-code/low-code principle. Minimal engineering effort is required to extend the standard table-to-table maps and to include custom maps;
- Dual-write supports both online mode and offline mode. Microsoft is the only company that offers support for online and offline modes.

Postman

Postman is an API (Application Programming Interface, a set of definitions and protocols for software building and integration) platform for building and using APIs. Essentially, Postman simplifies each step of the API lifecycle and streamlines collaboration so that API's can be created faster and better (Postman n.d.).

It is used for API testing, simulating an HTTP client that tests HTTP requests, utilizing a graphical user interface, through which can obtain various types of responses by sending requests, such as get, post, put, delete, etc. (Romero 2021) (Figure 3.8).

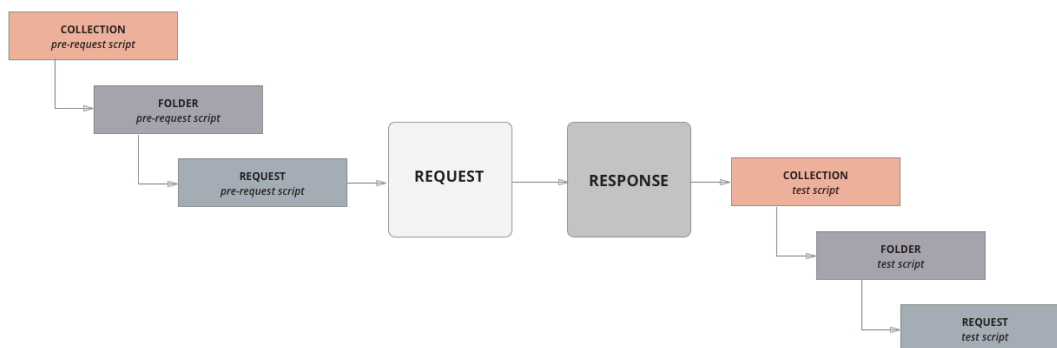


Figure 3.8: Postman Process (*Testing an API with Postman - Adexin 2020*)

Its usage throughout this work was extremely specific and not too relevant. It was also non-mandatory, as it should only be used for some exceptions where the developer wants to test and create something in the ProjOps but does not have access to it directly from his own virtual machine.

3.2 State of the Art in similar initiatives

Now that the state of the art has already been fully addressed, this topic will focus on addressing the state of the art on similar approaches.

3.2.1 Solution and existing Approaches

The solution at hand (Hitachi Essentials for Professional Services solution) is something that required some modifications. However, it must be noticed that, even though some features required modifications (Table 2.5), there were also plenty that did not require any changes, as they were not affected by the Microsoft modifications.

As for the possible alternatives for the solution, there are three:

1. Adapt previously existing features that do not work with ProjOps.
2. Hide/remove previously existing features that do not work with ProjOps.
3. Hide the entire IP and move it to ProjOps.

By hiding or removing previously existing features that have stopped working with ProjOps, the solution would keep on working without problems but, however, it would result in a loss of the IP. The same applies, even though in a bigger scale, to hiding the entirety of the IP and moving it to ProjOps, as there are some features that are specific to FinOps only and, this way, they would end up being discarded. The first one, adapting previously existing features that have stopped working due to ProjOps, seems to be the most plausible approach, as it does not require discarding IP features.

A more detailed analysis for all these approaches will be addressed in the value analysis to confirm what exactly would be the best proven approach.

3.3 Knowledge Synthesis

As the technology required for this project has already been described, now it is time to synthesize its features and capabilities.

From all the tools and programming languages involved, it can be said that the author has an average knowledge about how they work and operate. The referenced tools and technologies can be classified into the following three categories based on the author's prior experience with them:

1. The author has never used it before.
2. The author has a small amount of knowledge about it or only knows about some tool or programming language it uses.
3. The author has experience using it.

To better understand this, the following Table 3.3 was created.

Table 3.3: Technologies Knowledge Synthesis

Technology	Description
Microsoft Teams	Used a lot during the curricular internship and master's degree classes
Microsoft Visual Studio	Used for master's classes
Postman	Used for multiple subjects for testing projects
Microsoft Power Platform	Had some previous knowledge from the curricular internship
Dataverse	Had some previous knowledge from the curricular internship (as CDS)
Azure DevOps	Only used for implementing some project's pipelines
Microsoft SQL Server Management	This specific tool was never used but there is knowledge about SQL
X++	This specific programming language was never used but it has some similarities with C# and SQL, which were both learnt and used at ISEP
Microsoft Dynamics 365 Project Operations	No previous knowledge
Microsoft Dynamics 365 FinOps	No previous knowledge
Microsoft Dynamics 365 Project Service Automation	As this is part of FinOps, there is also no previous knowledge for this one
Dual-write	No previous knowledge

Even though there were some technologies that the student had experience on, there were also others he did not. This means that, for those he did have a little or no experience working with, he had to learn how they worked and how did they fit in the work on hands.

This was a progressive and sequential experience, as the know-how had to be acquired throughout the course of the developed work, according to each work item at hand. Of course, there could also be the possibility to have learnt everything beforehand however, learning all of the involved technologies before the project would have been impossible as the knowledge could only be acquired through prior work experience.

3.3.1 Similar projects and technologies

In what concerns similar projects, there is no public information concerning similar initiatives. There is, of course, always the chance that competitors of Hitachi working in the Microsoft space go through the same process with their PSA IP products, but, as one can imagine, such projects should also be confidential.

In what concerns technologies which are similar to ProjOps, from the vendor's (Hitachi) point of view there were no alternatives to the utilised business applications (them being a Microsoft value added reseller). This means that there were no other alternative technologies that could be used that had the same features ProjOps currently has. However, the comparison, first and foremost, should be based on the features the pieces of software provide. If the comparison was done from that perspective, there could possibly be viable alternatives as follows in the Table 3.4:

Microsoft Dynamics 365 Finance & Operations

Table 3.4: Finance & Operations Alternatives (Gartner n.d.)

Technology	Alternatives
D365 FinOps	Sage Intacct
	Workday Financial Management

As the possible alternatives for FinOps, the alternatives mentioned were the ones that had a user classification higher than 4.3 out of 5 with a minimum of 150 evaluations (Gartner n.d.).

What will be compared are four different categories:

1. Overall Rating.
2. Evaluation & Contracting.
3. Integration & Deployment.
4. Service & Support.

Starting with Sage Intacct, it is an alternative that is generally very usable and has an intuitive and easy-to-learn navigation. It has good customer service but, however, could be improved. The key categories where it has higher evaluations is for the Integration & Deployment, which includes ease of deployment, ease of integration using standard APIs and tools and quality of end-user training. The remaining categories have similar evaluation values.

Workday Financial Management is an alternative which, even though has similar ratings, has a critical review that mentions the lack of cutting-edge features, compared to FinOps, where the critical review is that it is difficult to use and extend code. The key categories where it is higher evaluated are Evaluation & Contracting and Service & Support, as it has a better pricing flexibility, ability to understand needs and timeliness of vendor response.

In conclusion, even though there are a few alternatives that seem to have higher evaluations for some categories, FinOps is the only ERP where some of its features from a single module have been refactored into a standalone product, interfacing the ERP. Besides, no other alternative provides a connection with the other Microsoft services at the same level.

Microsoft Dynamics 365 Project Operations

For ProjOps, some alternatives are present in the Table 3.5.

Table 3.5: D365 Project Operations Alternatives (Sourceforge n.d.)

Technology	Alternatives
D365 Project Operations	MavenLink
	FreshBooks
	BQE Core Architect

MavenLink was founded in 2008, which means it is also recent. When compared with ProjOps, one major flaw is that it does not support Windows. However, it also supports SaaS and even has 24/7 live support. It is cheaper (39\$ / month / user vs 95\$ / month / user) and includes a free trial version. The main difference is that it supports a lot more integrations, such as APIANT, Expensify, BugHerd, etc.

FreshBooks was founded in 2004, which means it is older than MavenLink however, like it, also does not support Windows. However, it does support SaaS and other platforms, such as iPhone, iPad, and Android. It targets self-employed professionals, agencies, and firms. As ProjOps, it also provides support for business hours via online. It is a lot cheaper (6\$ / month / user) and includes a free trial version but does not provide in person training.

Finally, BQE Core Architect, founded in 1995, provides support to the same platforms as FreshBooks, targeting more professional services firms. Has 24/7 support and has a close price range to FreshBooks (7.95\$ / month / user), including, besides a free trial, a free version. The key difference is that it lacks quite a few project management features, such as Agile methodologies, client portal, Kanban board, etc., and some integrations with Microsoft services for example.

With what has been mentioned in the two previous comparisons of the FinOps and ProjOps alternatives, it can be assumed that there are some similar technologies to the ones that are related with the Microsoft PSA platform. Of course, this is the case if it is compared one-by-one. If what was desired was an alternative to the current PSA platform, there would be no specifically good choice over this.

Visual Studio, DevOps & SQL

Concerning both Visual Studio and SQL, there are some competitors for them however none of them could possibly be used in this case. As the IP is not built from scratch but, instead, is based on Microsoft default product, these are a given, there is not any other alternative technology that could be utilised.

For DevOps version control system (Team Foundation Version Control), the same does not apply. A viable alternative would be Git, which uses Distributed Version Control System.

It could also have been used in DevOps, as it can actually utilise git repositories (every DevOps project can have a single TFVC repository and an infinite number of git repos) but was not due to company requirements. The following Table 3.6 was created to compare both options.

Table 3.6: Azure DevOps (TFVC) vs Git (DVCS) (MaximMalygin 2022)

Azure DevOps (TFVC)	Git (DVCS)
Centralized version control system: Each code check-in pushes code changes to everyone else	Distributed version control system: clone the entire repository to local machine. Advantage of being able to work completely offline if needed. Disconnected from any central hosting server
Only commit when online	Commit while disconnected
Makes copies of the parent from which it branched	Branches are just pointers to a commit
Allows for branching and merging, although not as good as git	Best at branching and merging

Postman

As for the last remaining tool, Postman, there were a lot of possible alternatives but only two have been analysed as follows because this was the less relevant tool and just it was just required something simple (Table 3.7).

Table 3.7: Postman Alternatives (G2 n.d.)

Technology	Alternatives
Postman	Mulesoft AnyPoint
	Azure API Management

AnyPoint Platform is a complete integration platform that lets companies realize business transformation through API-led connectivity. It is simple to use, includes prebuilt connectors, which simplifies the process of integrating tools with Mulesoft, is easy to integrate and manage. Some parts where it could be improved would be that the IDE is eclipse based and heavy, taking too much time to load and Enterprise Edition has costs involved.

As for Azure API Management, it is a hybrid, multi-cloud API management system for all settings. It consists of a stable system that helps users publish, maintain and transform their APIs securely, monitoring its health easier. The problem with this tool is that as it is planned for developers to build APIs, it is costly for small teams and organizations, lacking awareness about how the Azure software works, with costs that are difficult to sustain over a long period of time, primarily monthly.

To summarize, Postman was chosen because it was only required for simple testing and did not involve any costs, something that cannot be said to the other mentioned tools.

Chapter 4

Value Analysis

The current topic will start by providing an overview of the value analysis, as well of what it contains. For example, this will start with a value analysis specification, address the value proposition, which includes a customer profile and value map, and the Canvas model together with its respective segments, such as key partners, activities and resources, between others.

4.1 Specification

In short, value analysis consists of an analysis and evaluation process that focuses on identifying a way to increase the value of an item or service without the need to sacrifice anything, such as quality. It does an examination of a product to reduce the cost or improve its performance.

In more detail, it can be said that value analysis is a systematic process of analysis and evaluation which requires planning, control and co-ordination, so as to be able to properly analyse the capacity of a product to achieve the requirements and demands of a customer. For this, a proper understanding of the product is crucial, as without so an assessment about the product and its derived value by the customer would not be achievable. Without these functional specifications and performance criteria, providing value to that said customer would prove to be impossible. Lastly, the review process involved needs to be the result of a sequential process of design improvements the focus on reducing the costs involved while maintaining its value so as to yield benefit for the organization.

The value analysis in question will be done within the business for an existing product that has to be upgraded, as this requirement consists of an opportunity for the business to keep up with the latest technology advances.

4.2 Innovation Process

The innovation process is a process that defines the management of an idea from the strategic search to the successful market launch and its transfer to the operative management. It describes the path of translating new and/or existing knowledge into marketable

solutions. Companies that pursue a successful innovation process have something decisive that puts them ahead of others - they have designed the path of an idea from generation, through development, to market entry (GmbH n.d.). However, before doing so, it must be clear within the company what is meant by the process itself.

It can be divided into three different areas: the fuzzy front end (FFE), the new product development (NPD) process, and commercialization (Figure 4.1).

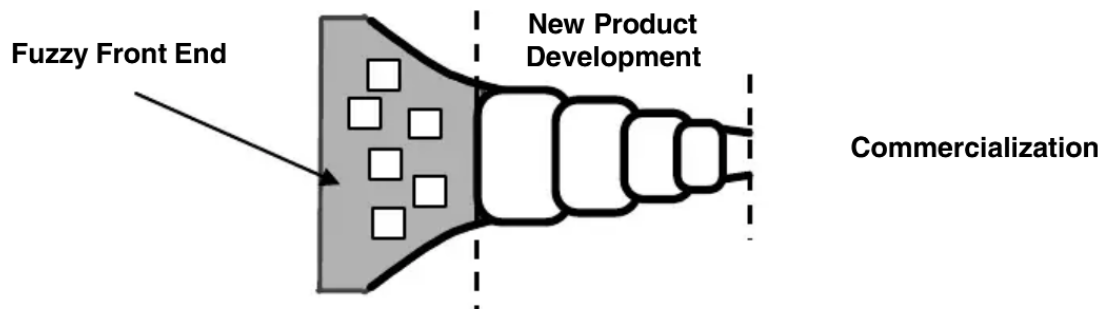


Figure 4.1: The entire innovation process may be divided into three parts: fuzzy frontend (FFE), new product development (NPD), and commercialization (Koen et al. 2002)

Proceeding to the analysis of the Figure 4.1, starting from the left to the right side:

1. The Fuzzy Front End is, as the name self implies, fuzzy. That is due to companies lacking critical information or something in their process has made it needlessly complex, or perhaps both (Schade 2018). However, if ones manages to fix these things, the front-end should be clear and actionable. Besides, within the innovation process, it is what has the highest impact on the whole process, as it affects the following steps;
2. Following the Fuzzy Front End is the New Product Development (NPD). It is a process of taking a product or service from conception to market. The process sets out a series of stages that new products typically go through, beginning with ideation and concept generation, and ending with the product's introduction to the market (*Research and develop ideas, new products and services* n.d.).
3. Lastly, there is the Commercialization. Being the last step concerning the innovation process, it aims to the commercialization of a product after it has reached the last stages.

The innovation process has had all of its parts addressed but, according to Koen, there is a problem with the innovation process in general, and that is the comparison of Fuzzy Front End practices across different companies. Doing a comparison was complicated. There was a lack of common terms and definitions for key elements of the Fuzzy Front End and, without having a common language and vocabulary, knowledge transfer is ineffective if both parties mean different things when using the same terms.

This is what led to the belief that the understanding of the Fuzzy Front End could be improved by describing it using terms that mean the same thing to everyone. To address this shortcoming, it was developed a theoretical construct, the New Concept Development (NCD) model (Koen et al. 2002).

4.2.1 New Concept Development

As just mentioned above, the New Concept Development is a model that is intended to provide insight and a common terminology for the Fuzzy Front End.

It consists of three key parts:

1. **Engine (Center)** - The engine or bull's-eye portion is the center part of the NCD model. IT consists of leadership, culture, and business strategy of the organization that drives the five key elements that are controllable by the corporation;
2. **Wheel (Inner)** - The wheel is the inner spoke area, where the five controllable activity elements (opportunity identification, opportunity analysis, idea generation and enrichment, idea selection, and concept definition) of the Fuzzy Front End are defined;
3. **Rim (Exterior)** - The rim part, consisting of the exterior part of the NCD model, is where the influencing factors are. They consist of organizational capabilities, the outside world (distribution channels, law, government policy, customers, competitors, and political and economic climate), and the enabling sciences (internal and external) that may be involved. These factors affect the entire innovation process through to commercialization. These influencing factors are relatively uncontrollable by the corporation (Koen et al. 2002).

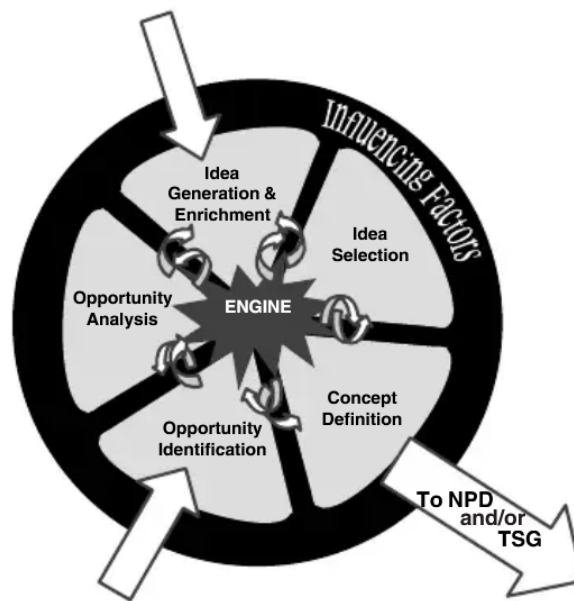


Figure 4.2: The new concept development (NCD) construct is a relationship model, not a linear process (Koen et al. 2002)

The fact that the model shown in Figure 4.2 is in a circular shape is to demonstrate that ideas flow among the five elements. The arrows pointing into the model represent the possible starting points for projects, which can be either the Opportunity Identification or the Idea Generation & Enrichment. The arrow pointing out of the model represents the projects that leave through the NPD or the Technology Stage Gate processes (*Peter Koen n.d.*).

4.2.2 Opportunity Identification

Opportunity identification is typically driven by the business goals. For example, the opportunity may be a near-term response to a competitive threat, a “breakthrough” possibility for capturing competitive advantage, or a means to simplify operations, speed them up, or reduce their cost. It could be an entirely new direction for the business or an upgrade to an existing product. It could also be a new product platform, a new manufacturing process, a new service offering, or a new marketing or sales approach. Overall opportunity identification defines the market or technology arena the company may want to participate in (Koen et al. 2002).

The opportunity for the current work consists of, as mentioned above, an upgrade to an existing product.

4.2.3 Opportunity Analysis

Opportunity analysis consists of an assessment to confirm that an opportunity is worth pursuing. Additional information is needed for translating opportunity identification into specific business and technology opportunities.

SWOT Analysis

To better analyse the opportunity, a SWOT analysis is performed. It is a tool to help with the development of a business strategy. Its acronym stands for Strengths, Weaknesses, Opportunities, and Threats.

Strengths and weaknesses are internal to a company — things that the company has some control over and can change. Examples include who on a team, patents and intellectual property. Opportunities and threats are external — things that are going on outside the company, in the larger market. Companies can take advantage of opportunities and protect against threats, but cannot change them. Examples include competitors, prices of raw materials, and customer shopping trends (Parsons 2021).

- **Strengths** - Strengths are things that a company does particularly well, or in a way that distinguishes them from competitors;
- **Weaknesses** - Characteristics of a business that gives disadvantage relative to others. Everything that a company does that does not perform well;
- **Opportunities** - External factors that a company can capitalize on or use to its advantage;
- **Threats** - External factors that can affect the entity's success.

The following Table 4.1 describes the SWOT analysis to the current work.

Table 4.1: SWOT Analysis

Strengths	Rapid time value implementation Reduced total implementation cost Reduced ongoing cost of ownership Reduced project duration Increased project certainty
Weaknesses	Requires more than one license for full feature access Complex upgrade process
Opportunities	Bring alignment with the latest Microsoft approach Microsoft support as the solution is according to the latest versions Improved solution
Threats	Clients may not like new solution

The most important strength involved in this adaptation is the fact that it brings a rapid time value implementation. By doing the adaptation, the total implementation and ongoing ownership costs have the possibility to be reduced and it also allows for a reduced project duration and increased project certainty, as the implementation becomes easier to do and requires not as much effort as before.

The weaknesses related to this are that, instead of having only one license, two are required to be able to have access to all of the existing features and the fact that the upgrade process is complex.

As for the opportunities, the main one is that it brings alignment with the latest Microsoft approach. Also, as the solution is being upgraded according to the most recent Microsoft versions, the solution overall becomes improved and there is also support by Microsoft, something that would not happen if the solution was related with older versions.

Finally, the only threat possible for this adaptation is that there is a possibility that clients may not like the new solution as is.

4.2.4 Idea Generation and Enrichment

The idea generation and enrichment is an evolutionary process evolutionary which concerns the birth, development, and maturation of a concrete idea. An idea may go through many iterations and changes, as it is studied, discussed, and developed with other elements of the NCD model. Direct contact with customers and users and connections with other cross-functional teams or collaborations with other companies and institutions often enhance this activity.

Idea generation and enrichment may be a formal process, including brainstorming sessions and idea banks, to provoke the organization into generating new or changed ideas for the identified opportunity. It may also emerge outside the bounds of any formal process. It can feed opportunity identification, demonstrating that the NCD elements often proceed in a nonlinear fashion, advancing and nurturing ideas wherever they occur (Koen et al. 2002).

For the current work, there were three main ideas that could have been applied to the solution adaptation:

1. To perform the solution adaptation and modify the previously existing features in a way that they would be able to also work as before or, at least, not too far off from that. This would make the newly upgraded solution better, as, besides getting access to the latest Microsoft features, would even allow to keep some custom Intellectual Property;
2. To perform the solution adaptation but, concerning the features that existed before, they would end up being removed in the case they caused errors or had integration problems with the new default platform. This would also allow to have access to the latest Microsoft features and work without errors, reducing also the total investment cost and time. However, it would also imply that there would inevitably be a possible loss of Intellectual Property, losing some custom features that existed before;
3. To move the entirety of IP to ProjOps. This would allow for everything to be at the same place but, however, would also require in-depth knowledge pertaining ProjOps

and would also cause some features to be dropped, as some of them are specific for FinOps only.

4.3 Value proposition

The value proposition can be explained simply. It is a promise of value made by the company that summarizes the process related with the benefits of that company's product. It is what makes the product attractive to customers and how it distinguishes itself from others.

The value proposition which was used as basis for this report is the upgrade of the Hitachi Essentials for Professional Services Intellectual Property, more specifically the Project Service Automation Intellectual Property (PSA IP). It is a unique product as it includes decades of sector business experience into one single solution that also has the perk to be closely related with Microsoft.

The main targets are the current client organizations that already have implemented the solution and future client organizations, which can range from small to big sized companies, that will desired for it to also be implemented for them.

The value incoming from this solution can be divided into two different levels: as level one value there is the delivery outcome and, as level two, there is the solution/business outcome, which strengthens the Dynamics proposition by itself and, together with the level one value, differentiates Hitachi from the competition.

Besides, for the solution delivery to be successful, there are also three key value measures that are essential. Those, which are directly influenced by the PSA IP, are the financial, timescale and risk impacts (Table 4.2).

Table 4.2: Key Value Measures

Financial Impact	Reduced total implementation cost
	Reduced ongoing cost of ownership
	Reduced internal resource cost for implementation
Timescales Impact	Reduced internal resource cost for implementation
	Reduced project duration
Risk Impact	Reduced project duration
	Increased project certainty

As this upgrade is a full packaged deal, in what concerns that Hitachi Essential Intellectual Property, that focuses on a rapid time value implementation, the financial impacts it has are the reduction of costs, more specifically the total, ongoing ownership and internal resource implementation costs. The timescales impact concerns both the internal resource cost for

implementation (which is also a financial impact) and the overall project duration (which is a risk impact). As for the last impact, risk impact, it increases the project certainty while diminishing the project duration.

Before proceeding to the customer profile, it is important to mention here in the value proposition that there are two key values in what pertains this project:

1. Bringing alignment with the latest Microsoft approach;
2. Rapid time value implementation.

These are the core values related to the solution upgrade and which should have a special mention to properly showcase their importance.

4.3.1 Customer Profile

On one hand, as part of the value proposition, there is the customer profile, where the customer's gains, jobs and pains can be found. The gains describe some of the outcomes that customers want to achieve or some concrete benefits that they seek, customer jobs describe what customers try to get done with their work and pains are some bad outcomes, risks or obstacles related to customer jobs (Table 4.3).

Table 4.3: Customer Profile

Gains	What do customers want?
	- Increased confidence in delivery;
	- Reduced project duration;
	- Reduced overall time to value through reduced project timescales;
	- Reduced risk through reduced project timescales and level of customisation;
	- Reduced internal costs through shortened project timescales;
	- Reduced ongoing cost of ownership through reduced level of customisation of the base platform;
	- Improved solution quality, driven by a standardised, mature and established solution, which translates into having the latest Microsoft features without the need to sacrifice the previous solution features;
	- Bug fixing or some specific modifications for existing requirements.
Pains	What are the bad outcomes and risks?
	- The maintenance may surpass the initial deadline;
	- The new upgrade may cause dislike to some users.
Jobs	What are customers trying to achieve with their work?
	- Customers have the need to properly specify features and other requirements they want to have in their services;
	- Customers should also provide current feedback so as to maintain and achieve the desired results.

4.3.2 Value Map

On the other hand, the other part concerning the customer profile is the value map. It has the gain creators, pain relievers and products and services.

The gain creators are used to describe how the product and related services create customer gains, the pain relievers describe how the product and related services alleviate some customer pains and, lastly, the products and services is the list of all the products and services which the value proposition is built around (Table 4.4).

Table 4.4: Value Map

Gain Creators	The product and related services create customer gains by:
	- allowing for the customer organization to manage its resources more efficiently;
	- storing all the data in the same place, which makes it easier to access;
	- providing trustworthy data, which allows to focus more on key performance indicators;
	- providing compatibility with ProjOps;
	- bringing alignment with the Microsoft approach.
Pain Relievers	The product and services alleviate some customer pains by:
	- for new customers, no more trouble sorting out all the data;
	- for new customers, everything is done digitally, there is no need for physical storage unless wanted;
	- key enhancements drawn from real implementations;
	- fully SAT tested solution with regular architectural support from Product Group;
	- enhanced data model and library of visualisations by using Power BI;
Products and Services	The products and services the value proposition is built around:
	- Microsoft Dynamics 365 FinOps (includes Microsoft Dynamics 365 Project Service Automation);
	- ProjOps.

4.4 CANVAS Model

The Canvas model is a business tool that is used to be able to easily visualize all of the building blocks when one wants to start a business. Some of the block it includes are the lay partners, activities and propositions, besides the customer relationships and value propositions, for example.

The CANVAS model that has been created for the PSA IP upgrade is as it follows (Figure 4.3).

Key Partners	Key Activities	Value Propositions	Customer Relationships	Customer Segment
Microsoft	Maintain and upgrade the Hitachi Solutions Europe - PSA IP platform Support clients	Organizations have an up-to-date platform with the latest Microsoft features Organizations have reduced implementation costs and duration Bring alignment with the new Microsoft approach	Brand through Social Media Hitachi Solutions Europe website Promotion of Hitachi and client organizations through reviews Personal assistance through email and videocalls	Organizations that want to digitally transform their business Organizations that want to change to Hitachi Solutions Europe services
	Key Resources Microsoft D365 Finance & Project Operations Team Microsoft D365 Finance & Project Operations licenses Virtual Machine	Rapid time value implementation	Channels Hitachi Solutions Europe website	
Cost Structure Fixed (associated with Microsoft D365 licenses and the team's licenses and salary)			Revenue Streams Sales of the Intellectual Property	

Figure 4.3: CANVAS Model

Pertaining to the costs, they mostly derived by employing the team (team members, IP director and project managers), licenses (Microsoft D365 Finance, ProjOps and VM) and the revenue streams are incoming from the direct sales of the Hitachi PSA IP custom features.

The main value brought by this is the fact that this will bring alignment with the new Microsoft approach while also providing the client organizations with the latest version of the Microsoft modifications and respective features.

The key activities involve maintaining the PSA IP platform, whether it is by analysing, implementing, and testing already known tasks or finding unexpected behaviours, such as bugs, and providing to the existing clients. As key partners, there is Microsoft, having the perk of expanding its influence by supporting one of its biggest customers (Hitachi Solutions

Europe) and that helps Hitachi Solutions Europe by providing custom assistance to issues that may eventually arise.

The key resources consist of FinOps Team, licenses and VM to be used by the student and rest of the technical part of the IP team for development.

There is a customer segment which benefits with this work: the organizations that want to digitally transform their business, moving a step further into the current technology standards and the organizations that want to change from another company's services to Hitachi Solutions Europe services. The customer relationships are brand through social media, the Hitachi Solutions Europe website page, the promotion of Hitachi and client organizations through reviews and the personal assistance that can be done whether it is through email or videocalls.

4.5 TOPSIS

TOPSIS, known as Technique for Order Preference by Similarity to the Ideal Solution, is a multi-criteria decision analysis method that compares a set of alternatives based on pre-specified criteria/attributes that can be divided into three different types:

1. Qualitative benefit attributes/criteria;
2. Quantitative benefit attributes;
3. Cost attributes or criteria.

As part of the set of alternatives there are two that are mandatory: an ideal alternative, which is the one that has the best level for all attributes considered and a negative ideal alternative, which has the worst attribute values. For all of those, TOPSIS selects the alternative that is the farthest from the negative ideal alternative and has the closest value to the ideal alternative by employing reliable metrics.

It assumes that there are m alternatives (options) and n attributes/criteria and that it is required to have the score of each option with respect to each criterion.

4.5.1 Setup

What has been considered for the analysed variables was the following:

- $m = 3$ alternatives:
 - Adapt previously existing features that do not work with ProjOps;
 - Hide/remove previously existing features that do not work with ProjOps;
 - Hide the entirety of the IP and move it to ProjOps.
- $n = 3$ attributes/criteria. The attributes and their respective weight:

- Functionality – 0.6, it is the most important attribute for this work;
 - Product awareness - 0.2, as it is relatively important for Hitachi to have a team that knows what it is working with;
 - Cost – 0.2, also relatively important.
- x_{ij} = score of option i with respect to criterion j ;
 - $X = \{x_{ij}\}$ 3x3 score matrix;
 - J = set of benefit attributes: Functionality & Product Awareness (more is better);
 - J' = set of negative attributes: Cost (less is better).

4.5.2 Step 1

Construct a normalized decision matrix.

It is in this step that occurs a transformation of various dimensional attributes into non-dimensional attributes, allowing for a comparison across criteria. It normalizes scores or data as it follows in the Table 4.5:

$$r_{ij} = x_{ij} / (\sum x_{ij}^2)^{1/2} \text{ for } i = 1, \dots, m; j = 1, \dots, n \quad (4.1)$$

Table 4.5: Evaluation Matrix

Weight	0,6	0,2	0,2
	Functionality	Product Awareness	Cost
Adapt conflicting features	9	8	7
Remove conflicting features	5	8	5
Move everything to ProjOps	6	6	8

4.5.3 Step 1(a)

Calculate $(\sum x_{ij}^2)^{1/2}$ for each column (Table 4.6).

Table 4.6: TOPSIS - Step 1(a)

	Functionality	Product Awareness	Cost
Adapt conflicting features	81	64	49
Remove conflicting features	25	64	25
Move everything to ProjOps	36	36	64
$(\sum x_{ij}^2)^2$	142	164	138
$(\sum x_{ij}^2)^{1/2}$	11.92	12.81	11.75

4.5.4 Step 1(b)

Divide each initial column by $(\sum x_{ij}^2)^{1/2}$ to get r_{ij} (Table 4.7).

Table 4.7: TOPSIS - Step 1(b)

	Functionality	Product Awareness	Cost
Adapt conflicting features	0.75	0.62	0.60
Remove conflicting features	0.42	0.62	0.42
Move everything to ProjOps	0.50	0.47	0.68

4.5.5 Step 2(b)

Multiply each column by w_j to get v_{ij} (Table 4.8).

Table 4.8: TOPSIS - Step 2(b)

	Functionality	Product Awareness	Cost
Adapt conflicting features	0.450	0.124	0.120
Remove conflicting features	0.252	0.124	0.084
Move everything to ProjOps	0.300	0.094	0.136

4.5.6 Step 3(a)

Determine the ideal solution A^* and negative ideal solution A' (Table 4.9).

Table 4.9: TOPSIS - Step 3(a)

	Functionality	Product Awareness	Cost
Adapt conflicting features	0.450	0.124	0.120
Remove conflicting features	0.252	0.124	0.084
Move everything to ProjOps	0.300	0.094	0.136

As such, there is:

- $A^* = 0.450, 0.124, 0.084$
- $A' = 0.252, 0.094, 0.136$

4.5.7 Step 4(a)

Determine separation from ideal solution: $A^* = 0.450, 0.124, 0.084$ (Table 4.10).

Do $S_i^* = [\sum (v_j^* - v_{ij})^2]^{1/2}$ for each row.

Table 4.10: TOPSIS - Step 4(a)

	Functionality	Product Awareness	Cost
Adapt conflicting features	$(0)^2$	$(0)^2$	$(0.120 - 0.084)^2$
Remove conflicting features	$(0.252 - 0.450)^2$	$(0)^2$	$(0)^2$
Move everything to ProjOps	$(0.300 - 0.450)^2$	$(0.094 - 0.124)^2$	$(0.136 - 0.084)^2$

Determine separation from ideal solution S_i^* (Table 4.11).

Table 4.11: TOPSIS - Step 4(a)

	$\sum(v_j^* - v_{ij})^2$	$S_i^* = [\sum(v_j^* - v_{ij})^2]^{1/2}$
Adapt conflicting features	0.0013	0.036
Remove conflicting features	0.0392	0.198
Move everything to ProjOps	0.0261	0.161

4.5.8 Step 4(b)

Determine separation from negative ideal solution: $A' = 0.252, 0.094, 0.136$.

Do $S_i' = [\sum(v_j^* - v_{ij})^2]^{1/2}$ for each row (Table 4.12).

Table 4.12: TOPSIS - Step 4(b)

	Functionality	Product Awareness	Cost
Adapt conflicting features	$(0.450 - 0.252)^2$	$(0.124 - 0.094)^2$	$(0.120 - 0.084)^2$
Remove conflicting features	$(0)^2$	$(0.124 - 0.094)^2$	$(0)^2$
Move everything to ProjOps	$(0.300 - 0.252)^2$	$(0)^2$	$(0.136 - 0.084)^2$

Determine separation from negative ideal solution S_i' (Table 4.13).

Table 4.13: TOPSIS - Step 4(b)

	$\sum(v_j^* - v_{ij})^2$	$S_i' = [\sum(v_j^* - v_{ij})^2]^{1/2}$
Adapt conflicting features	0,0414	0.2035
Remove conflicting features	0,0009	0.0300
Move everything to ProjOps	0,0050	0.0707

4.5.9 Step 5

Calculate the relative closeness to the ideal solution: $C_i^* = S_i' / (S_i^* + S_i')$, $0 < C_i^* < 1$ (Table 4.14).

Table 4.14: TOPSIS - Step 5

	$S'_i / (S_i^* + S'_i)$	C_i^*
Adapt conflicting features	(0.2035 / 0.036 + 0.2035)	0.85
Remove conflicting features	(0.0300 / 0.198 + 0.0300)	0.13
Move everything to ProjOps	(0.0707 / 0.161 + 0.0707)	0.31

As it can be seen from the obtained results, when faced with three different alternatives: adapting previous features that do not work with ProjOps, removing them or hiding all the IP and moving it to ProjOps, the best proven alternative is to adapt the previous features.

As proved above, the only attributes that contribute positively are the Functionality and Product awareness while the Cost is a negative attribute. As the adaptation has an overall higher value, it is proven as the best alternative possible for this scenario.

Chapter 5

Analysis & Design

Having addressed the value analysis for the developed work, this chapter will provide an overview regarding the analysis and design. It will start by focusing on the problem domain, giving an overview about the previous and new licensing schemes, as well as possible alternatives and restrictions involved. Finally, it will address the requirements (functional and non-functional) involved throughout this work and provide some descriptions for the reader to have a better understanding.

5.1 Problem Domain

A licensing scheme refers to a scheme formulated by one or more licensing bodies setting out the classes of cases in which they are willing to grant licenses and the charges (if any) to a set of users/buyers (Insider n.d.).

5.1.1 Initial Licensing Scheme

Initially, the licensing scheme was simple (Figure 5.1). There were three different licenses: Supply Chain Management, Retail and Finance (including PMA/PSA). However Microsoft started to split the app in terms of licenses - functionality (which did not affect the background as the application and database remained the same) which influenced the users directly, as they could see different interfaces in FinOps depending on the licensing schemes owned.

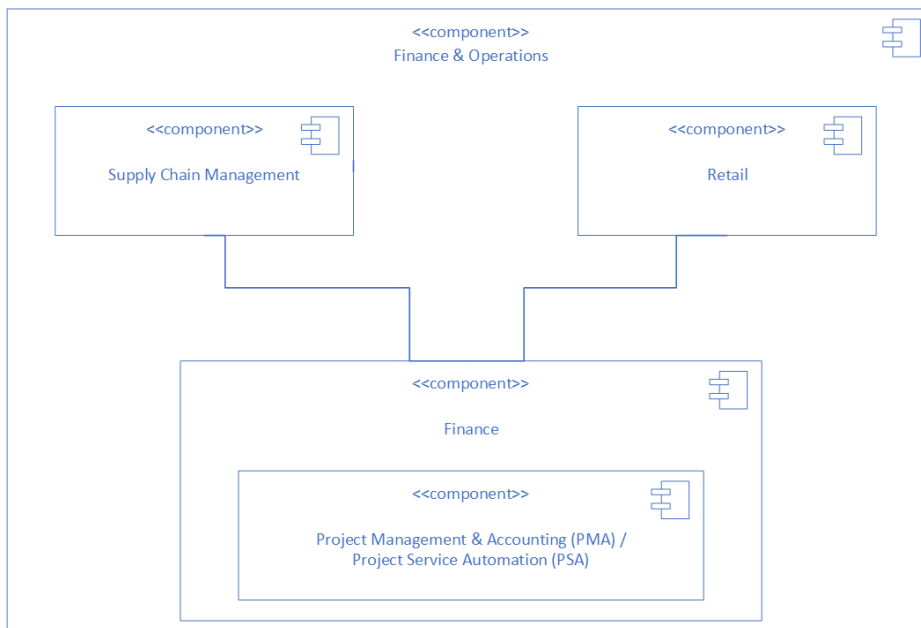


Figure 5.1: Initial FinOps licensing scheme

5.1.2 New Licensing Schemes

With the creation of ProjOps three different types of approaches (designed as deployments by Hitachi) emerged:

1. Legacy PSA (CE) or Project Operations #1;
2. Project Operations #2;
3. Legacy PMA (F&O) or Project Operations #3.

For each one of those deployment types, there is a different licensing scheme that can be applied.

Deployment type 1

The deployment type 1, also known as Legacy PSA (CE), is a deployment type that works only for Power Platform (Figure 5.2).

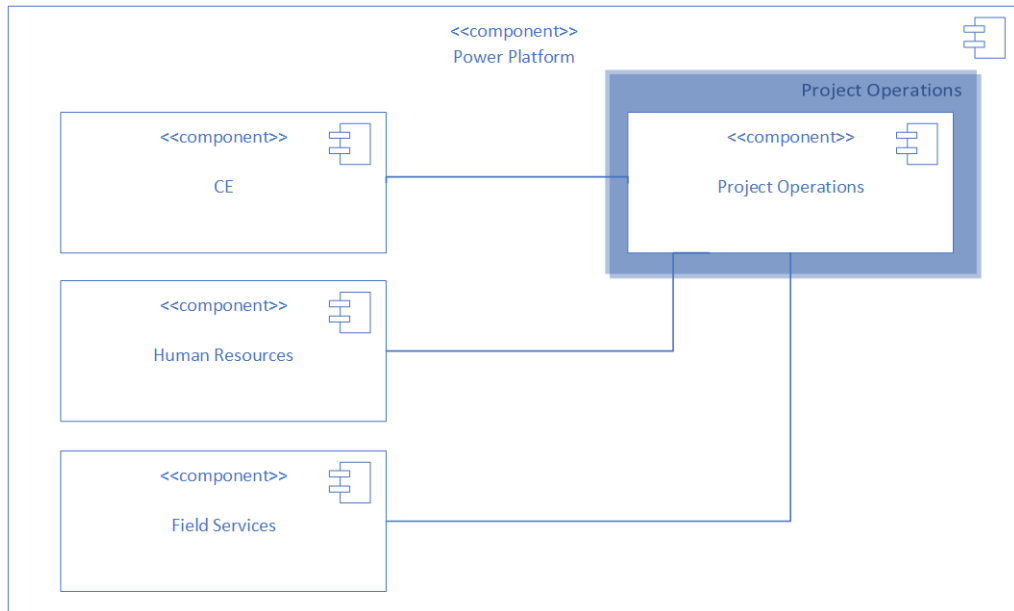


Figure 5.2: Power Platform Licensing scheme

Power Platform has a new licensing scheme which includes four licenses: CE, Human Resources, Field Services and one also for the recently created ProjOps.

Deployment type 3

If compared with deployment type 1, this deployment type can be considered as the complete opposite. Instead of being included in Power Platform, deployment type 3, also known as Legacy PMA (F&O), is part of FinOps (Figure 5.3). This is the traditional FinOps-only deployment type, without Power Platform.

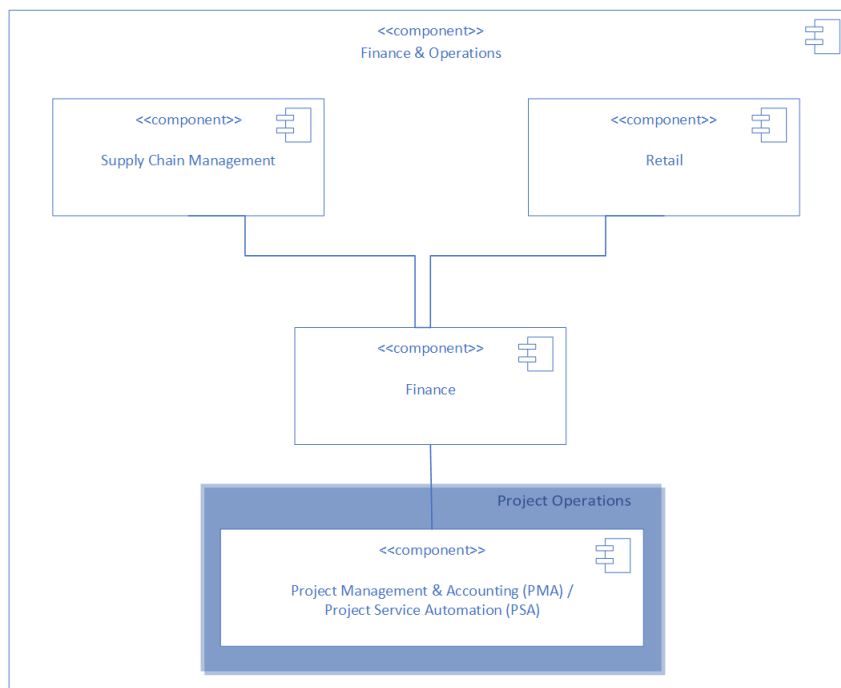


Figure 5.3: FinOps Licensing Scheme

Comparing with the initial FinOps licensing scheme, both include the Supply Chain Management, Retail and Finance licenses. The difference, however, is that the PMA/PSA license has been segregated from Finance, being a new different license that is part of FinOps, which is responsible for the connection with ProjOps in Power Platform.

Deployment type 2

Finally, there is the deployment type 2 and it is the most important from all the existing three deployment types in what concerns this work as this is the one that the work this document was based on. Every single IP feature that required adaptation for ProjOps was done in this environment because this is also the only one which concerns both FinOps, as well as Power Platform. Its licensing scheme, due to these reasons, is the most complex one (Figure 5.4).

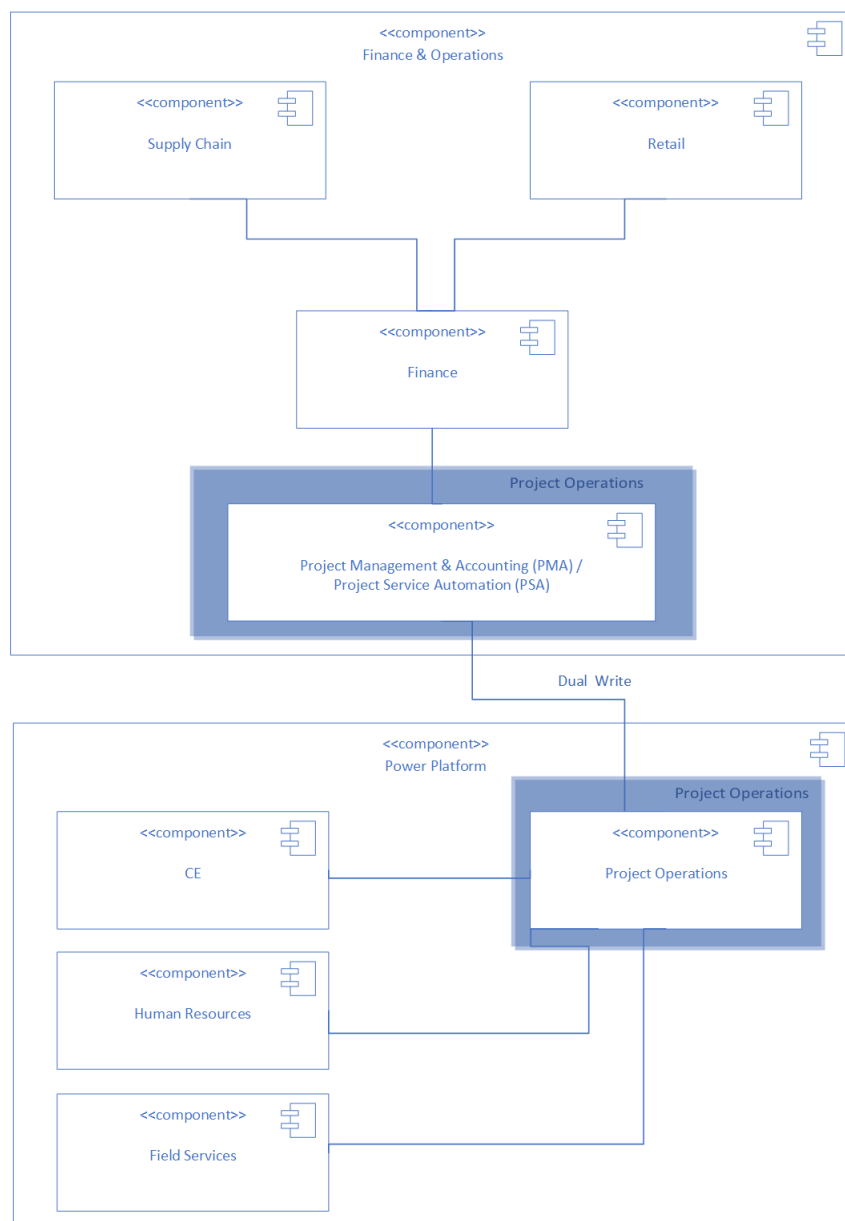


Figure 5.4: FinOps & Power Platform Licensing Scheme

For this deployment type, instead of having all of the previous PSA features as part of FinOps, some of them have been hidden in the FinOps side and moved to Power Platform and

renamed as D365 Project Operations (previously PSA). So, some features have a footprint in both FinOps and ProjOps and they communicate with each other through Dual Write.

5.1.3 Alternative Design Approach

To summarise, the implemented changes were part of the Project Operations licensing scheme, which includes PMA/PSA in FinOps and ProjOps in Power Platform.

As the bespoke IP solution is built on the default Microsoft product, currently there is no other possible alternative in what concerns the base default architecture. However, one possible alternative approach, in fact, would be porting everything project related to the Power Platform, into ProjOps, although that would only be possible if Microsoft decided to migrate everything from FinOps into Power Platform.

5.1.4 Restrictions

Taking into consideration what has been addressed above, the main restriction concerns Microsoft. As the IP is a bespoke solution that is based on the default Microsoft product, most of the tools and technologies are restricted to that basis.

The architecture involved is one of those examples. Being based on Microsoft, it is not something that can be modified. Of course, there can be some modifications but the base itself is not editable.

5.2 Requirements Specification

Requirement engineering is the process of gathering software needs from clients, analysing and documenting them (Point 2022).

User's expectations or the product are represented through user stories (which the IP does not work with, but it is an agile concept). Instead, the IP uses requirement type work items in DevOps to express feature GAP's (which describes the differences between expected and current behaviour).

As for the author's software requisites throughout this work, there were three different types of work items in the PSA IP Azure backlog:

- Task;
- Change Request;
- Bug.

Due to confidentiality purposes, only a few work items are described. However, it is important to notice that some of the examples that follow are samples and that the author had a bigger involvement beyond what is described:

Tasks

- Task 1 - Project Operations Modifications (allowing expense entries on projects);
- Task 2 - Clean up UI and background processes for out of scope and roadmap items;

Bugs

- Bug 1 - Warning message: Accounting distribution form is not available because there are no amounts to distribution;
- Bug 2 - Hour and Expense Forecast - Line property is not updated correctly to Fixed Price project;
- Bug 3 - Resolving a project line property for mismatching billing type;

Change Requests

- CR 1 - Resolving project line property on project operation integration journal lines using existing logic;
- CR 2 - Configured Invoice fields on Project Contract;
- CR 3 - Vendor's integration - Dual Write;

5.2.1 Functional Requirements

Functional requirements are product features that focus on user demands and describe what a software system must accomplish and how it must work (Jafari 2021).

All of the previously mentioned work items are all requirements or a result of the delivered work not meeting the requirements. This way, two sample requirements will be described to allow the reader to have a better understanding.

Task 2 - Clean up UI and background processes for out of scope and roadmap items

Description: From a technical standpoint, the aim of the ProjOps initiative is ensure that the IP code as-is remains completely intact in FinOps-only implementations.

Process: There is a file provided to the IP team which details features that do not work with ProjOps. The student is responsible for choosing one at a time and implementing a validation that it should only work if ProjOps integration is not enabled. It is best practice to leave a comment above the code explaining what the new piece of code does.

After completion: When the list has been completed, search for all done implementations to check if they have been commented and, if not, do so.

Bug 2 - Hour and Expense Forecast - Line property is not updated correctly to Fixed Price project

Description: When the "Enable project group/line property" is set to "No", then system should update the Line property based on the Billing type. At present for Fixed price project, system is updating Hour and Expense Forecast as "Bill".

Expected: System should update Hour and Expense Forecast as "NonBill".

Process: Perform the required setup in the development Virtual Machine and reproduce the steps to see if it also occurs locally. If so, fix it. If not, then proceed to discover why and discuss the findings with the tester or with the rest of the team during the daily meetings to analyse the best approach.

CR 3 - Vendor's integration - Dual Write

Description: ProjOps enables vendors creation from both ends, FinOps and Dataverse. However, our custom solution only supports vendor creation in FinOps. This is to prevent the creation of vendors without the necessary information being catered. Therefore, a decision has been taken to disable Dataverse vendor creation via security.

Nonetheless, not all vendors are required to be integrated with CE through Dual Write, especially if employees are considered. Therefore, a decision has been taken to condition Dual Write to only include the vendor groups: Vendor Groups A, B and C.

Eventually, it has been clarified that it is not desired to hardcode these vendor groups but, instead, it should be created a solution that would not need any configuration to follow-up work once new vendor groups are created that would need to be interfaced between FinOps/Dataverse. Vendor creation in Dataverse would still be disabled via security, so would changing vendor groups be on existing records.

Therefore the following changes are required:

- A new no/yes enum field to be added to the Vendor Group table:
 - New field is active only when ProjOps is enabled;
 - Create a new enum for the field that extends No/Yes with:
 - * Label: 'Project Operations enabled';
 - * Help text: 'Interface vendors/suppliers with this vendor/supplier group id to Project Operations?' - be mindful about label translations. EN-US: vendor(s), EN-GB: supplier(s);
- If the Vendors Group table is not a data source at present on the Vendors data entity in FinOps, add it there and add the new vendor group field to the data entity fields;

- The modified data entity needs to be further modified by removing the Vendors Group filters and instead filter for new field = Yes;
- The same filter needs to be added to the Vendors Group entity too, only want to have the eligible Vendors Group in CE;

The reason why it is not desired to modify the FinOps data entity directly (by adding a range to it for the new field) is because, that way, the entity would not be suitable for exporting/importing non-applicable vendor data anymore.

5.2.2 Non-Functional Requirements

Non-functional requirements are requirements that specify constraints that influence how a software system should perform. While a functional requirement focuses on the "What to do?", a non functional requirement focuses on the "How to do?" (Rome 2020).

Through requirements analysis and discussing with the IP team, the non-functional requirements were found and will be further analysed using the FURPS+ quality model.

FURPS+ Quality Model

The FURPS+ is a quality model that stands for Functional, Usability, Reliability, Performance and Supportability (FURPS) and also includes design, implementation, interface and physical constraints (+) (Al-Obthani and Ameen 2018) (Figure 5.5).

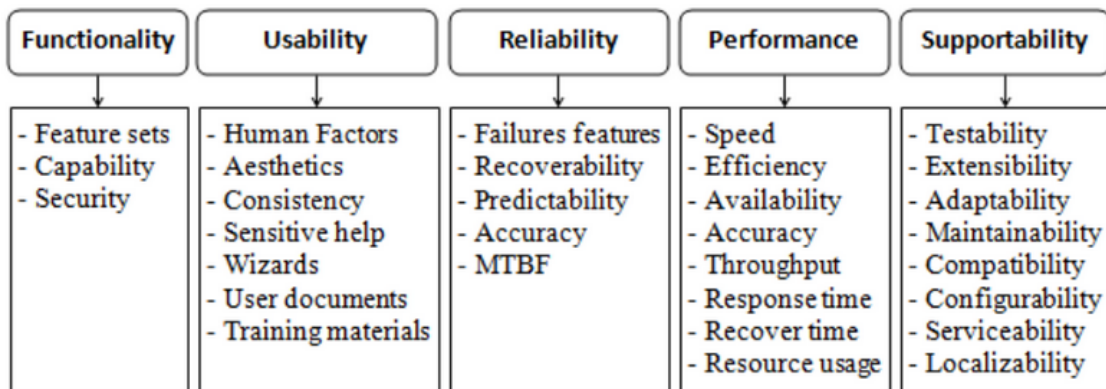


Figure 5.5: Detailed contents of the FURPS quality model (Al-Obthani and Ameen 2018)

Functionality

The features, capabilities, security are the three main categories of functionality non-functional requirement.

None of the non-functional requirements fit this attribute.

Usability

The usability is centered around interface aesthetics and consistency within the user interface, human factors and also help and documentation.

None of the non-functional requirements fit this attribute.

Reliability

Frequency of failure, availability, recoverability and predictability are some of the aspects included in reliability.

None of the non-functional requirements fit this attribute.

Performance

Performance involves aspects such as system response time, recovery time, start-up time.

None of the non-functional requirements fit this attribute.

Supportability

Supportability is related with testability, adaptability, maintainability and other similar aspects.

None of the non-functional requirements fit this attribute.

+

- **Design constraints:** Adapt the requirements to ProjOps while maintaining their previous planned design;
- **Implementation constraints:** The entire Microsoft application landscape is provided with all of its details (FinOps, Visual Studio, x++, SQL, Dataverse, ProjOps).
- **Interface constraints:** Dual Write;
- **Physical constraints:** N/A.

Chapter 6

Implementation

This chapter focuses on explaining how the implementation process works, referencing the related DevOps work items. The chapter also discusses the way that the DevOps work items have been structured for this project.

6.1 Implementation Process

The PSA IP update work is done by a team consisting of both technical and functional members, as well as a project manager, who conducts usual daily meetings during the morning and assigns tasks to each team member as one would expect. The requirement work items that each team member should work on are managed through Azure DevOps, where it can be seen who is working on what, what has been done for a specific work item. Any update to the work item is saved to the related DevOps work item(s).

Work items have been created based on the following classification of IP work packages:

1. Works without changes with ProjOps.
2. Minor changes required for ProjOps.
3. Roadmap items.
4. Out of scope for ProjOps.

Above classification was vital in order to plan for the initial phase of the IP adaption work.

Hitachi have had regular meetings with Microsoft about the ProjOps product and, by being up to date about the recent process and system changes and roadmap, had been able to make sure that it aligned the IP to the new Microsoft approach, managing to identify most of the problematic areas and saved them in Azure DevOps.

As this new platform may have given way to unexpected behaviour, it was important to raise such issues during meetings with Microsoft to gain clarity and understand the best approach possible. In such cases extra internal change requests were raised which manifested in their separate new DevOps work items.

Pertaining to the solution, as it was just mentioned, it was based on multiple features and those features and their related tasks and issues (bugs) were represented by DevOps work items.

The following flowchart summarizes the process for each one of those Azure DevOps requirement work items that had been created to simplify its understanding (Figure 6.1).

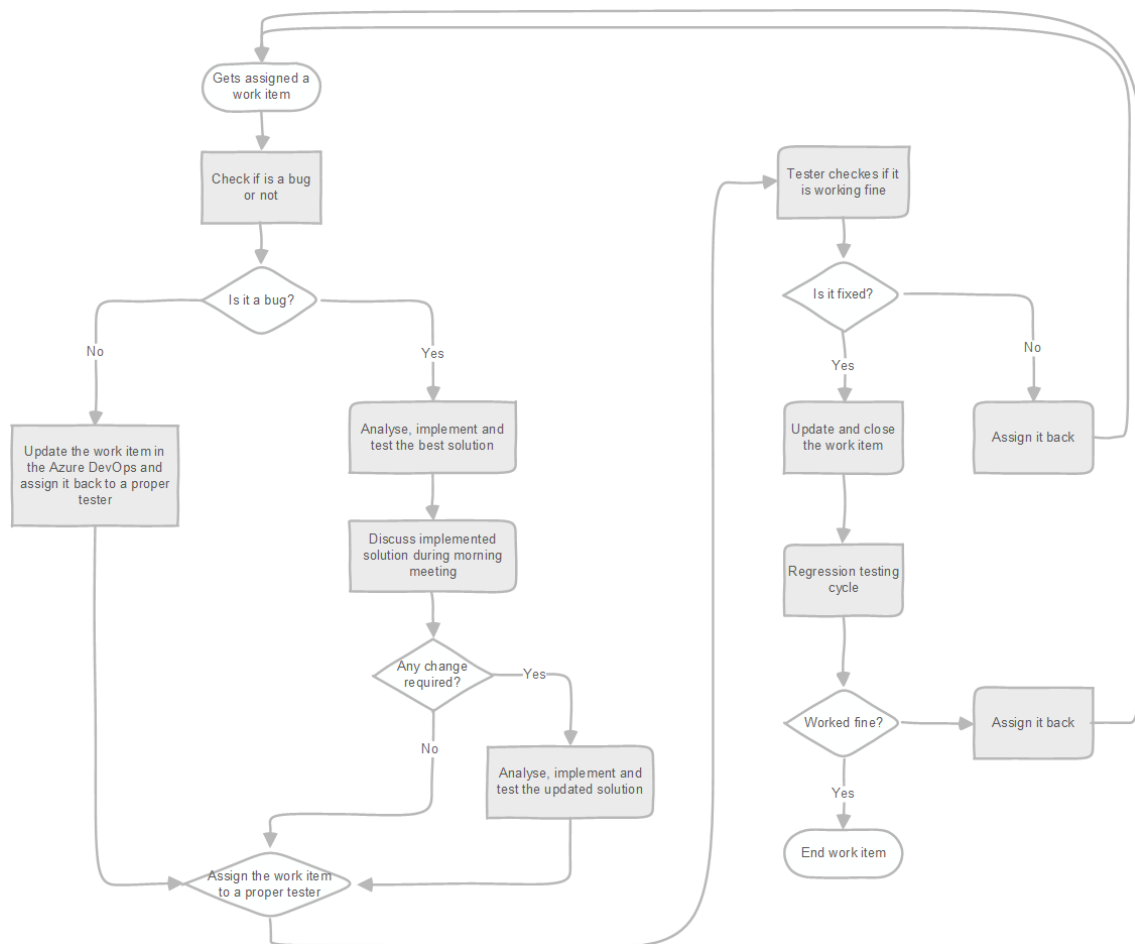


Figure 6.1: Work Item Flowchart

This way, it can also be said that the entire implementation was an iterative process where each applicable feature is validated, re-developed or updated and properly tested.

6.2 Implemented Solution

As far as the architecture is concerned, its implementation was done according to the Microsoft best practices, as previously described in the Analysis and Design chapter.

In FinOps, the Finance and Supply Chain Management, for instance, are extensively customised by partners and even also by customers. A product customisation ability is a strength that has historically been supported through over-layering of the application code. However,

moving to the cloud required a less intrusive customisation model so that updates were less likely to affect custom solutions. This way, Microsoft has replaced over-layering by adopting the extensibility customisation model (hereafter extension) (FrankDahl 2022).

Extension allows to extend existing artifacts in a new model and is easier to maintain. It is the only customization framework in Finance (Pvillads 2021). This way, it was the used approach because by doing so, it was also guaranteed that the default Microsoft modules remained untouched and it ended up being possible to add custom code to override the default one but without affecting the base architecture's layout.

In ProjOps, the implemented changes involved creating a single new solution (designed as solution per CE standards, not equivalent to IP solution) on the Power Platform where all Hitachi modifications and feature changes were gathered.

6.3 Work Item Example

To better understand the effort involved in the development of the requirement (which is represented in DevOps as a work item) - taking confidentiality into consideration - one example of a requirement will be provided so that the reader is able to have a general idea about the overall process.

CR #3: Vendor's integration - Dual Write

User Story

To better describe the software requirement, an user story was created. Considering Emma as an user, the user story is as follows:

"Emma is an Accounts Payable administrator who has to record a new vendor group in the system. Emma also has to create vendor records for the new vendor group. Some of the vendors Emma creates will only be used in Finance, others will be referenced in ProjOps as well."

Sequence Diagram

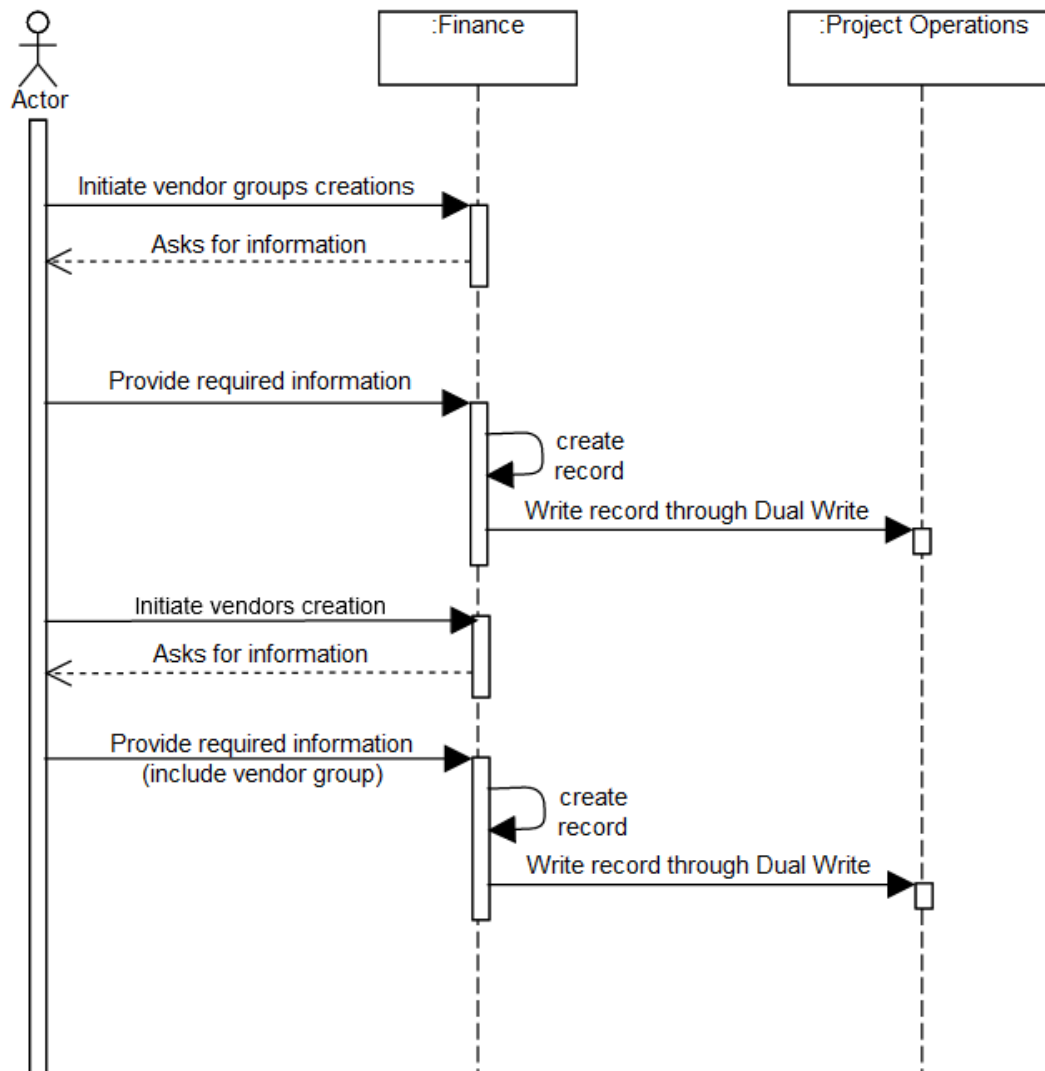


Figure 6.2: Change Request #3 Sequence Diagram

Described above (Figure 6.2) is the sequence diagram which explains how and in what order a group of objects related with the change request number three, a work item related with the integration between FinOps and Dataverse work. There, it can be seen that the use case starts with the user initiating the process by creating a vendor group in FinOps. FinOps asks for required information to create the record, the user provides it. Thereafter the record gets created in FinOps and is synchronised into Project Operations.

In the end, the user can access the vendor group-record they created in both FinOps and Dataverse and also edit it however it is desired.

6.3.1 FinOps changes

1. New data field

First and foremost, a new boolean data field (a field which can only be set to either Yes or No) was created to indicate if Project Operations was enabled. As the implemented fix was required for a deployment type 2, a feature class (a property that ensures that pieces of metadata are only visible to users when the corresponding feature has been enabled) was also used in that field so that it was only available when ProjOps was enabled. It was a generic Microsoft ProjOps Integration Feature Helper class.

2. Vendor groups user form change

For the existing vendor group form, as the default Microsoft object could not be directly modified, it was extended to an Hitachi model (Hitachi PSA Extension, for instance) and modified after. This way, the new field could be added to the form.

3. Vendor groups data entity change

A data entity is an abstraction from the physical implementation of database tables. For example, in normalized tables, a lot of the data for each customer might be stored in a customer table, and then the rest might be spread across a small set of related tables. In this case, the data entity for the customer concept appears as one de-normalized view, in which each row contains all the data from the customer table and its related tables (Peakerbl 2022).

By default, the data import and export process also creates a staging table for each data entity in the target database. Staging tables allow to validate, clean up, or convert data before moving (import/export) it (Sunil-Garg 2022).

Similar to the previous customer data entity example, the vendor group also had a data entity. For that data entity to work as planned with DIXF (configuration data import/export) and Dual Write (ProjOps integration), it required the addition of the previously created field.

As the data entity has an associated staging table, changes were also mandatory so that both ran smoothly. This way, the same field was also used to the respective vendor groups data entity staging table.

4. Vendors data entity change

The vendor data entity, identical to the vendors group entity, also required the addition of the boolean data field for Dual Write (ProjOps integration) to fetch the new field from the related vendor group record. Furthermore, it was also necessary to establish a relation between the vendors and the vendors group data entity, where the vendors data entity data-source vendor group field corresponded to the vendors group field in the respective vendors group table.

Finally, the same field was also added to the respective vendors data entity staging table.

6.3.2 Dual Write changes

As far as Dataverse is concerned, the changes were simpler in comparison with the ones in FinOps. To do so, it was required to first go to the Data Management module inside FinOps and, there, access the Dual Write.

After accessing Dual Write, the user was faced with was all of the tables and respective mappings that are used to synchronize FinOps and Dataverse. From there, it was necessary to find the ones related with vendors and vendor group that were being used by the system, this is, the ones which were in an active status.

1. Extend Vendor Groups Dual Write integration map with the new field

The first change in Dual Write is related with the recently created data field. After accessing the Dual Write, it was required to access the vendor groups Dual Write integration map and create a new version which included the recent data field.

2. Filter the Vendor Groups Dual Write integration map

After extending the vendor groups Dual Write integration map, the following step involved filtering the vendor groups Dual Write integration map so that the records that were enabled for ProjOps integration were synchronised. To do that, a filter had to be manually inserted into the vendor groups Dual Write integration map filter parameters which checked for the new field value. This way, records which were not enabled for ProjOps integration were excluded from the Dual Write synchronisation.

3. Extend the Vendors Dual Write integration map with the new Vendor Group field

Similar to the vendor groups Dual Write integration map, there was the need to extend the vendors Dual Write integration map with the new field.

4. Filter the Vendors Dual Write integration map

Finally, the last step comprised filtering the vendors Dual Write integration map so that only the vendors whose vendor group record was marked for ProjOps integration were interfaced. To achieve that, it was necessary to manually add a filter that checked the new field in the vendors Dual Write integration map filter parameters.

6.3.3 Practical Showcase

The requirements for this work item is to have vendor groups created in FinOps written into Dataverse through Dual Write.

Having already completed the implementation process for the vendor groups dual write change request, as described previously, a custom field to check for ProjOps integration was added to the Vendors Group (Figure 6.3).

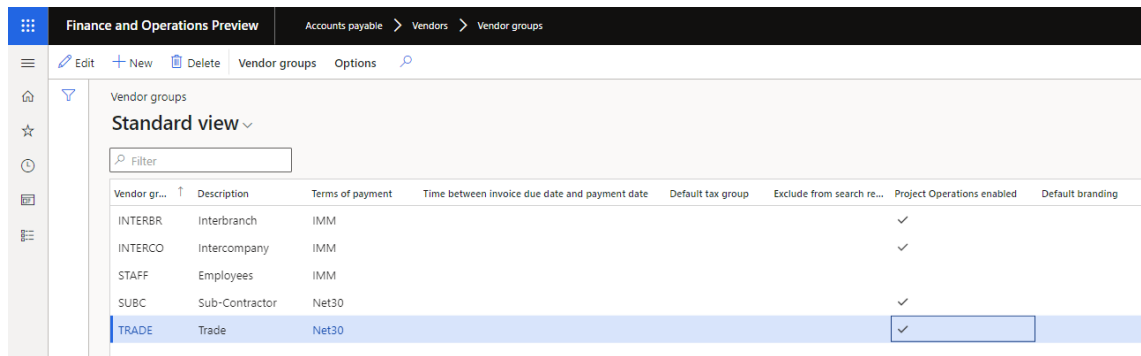


Figure 6.3: Vendor Groups - custom ProjOps checkbox example

In this case, it can be seen that the TRADE vendor group has ProjOps enabled set to Yes.

This way, any vendor which has a TRADE vendor group is used in Dual Write so that it is written to ProjOps. The following Figure 6.4 showcases one such vendor record (ASUS FR).

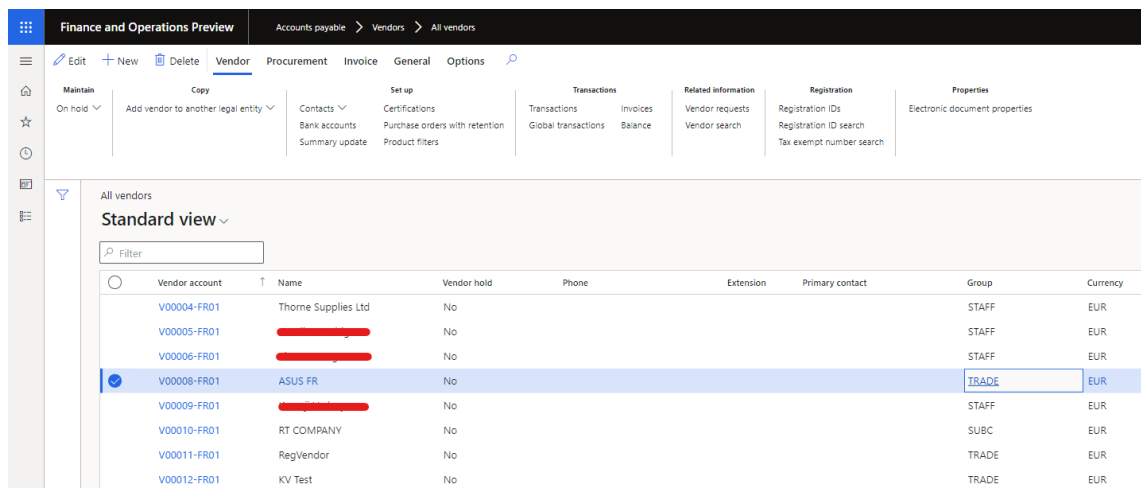


Figure 6.4: Vendor Groups in Vendors table example

So, having already a vendor record (ASUS FR) which is associated with a vendor group that has ProjOps custom field enabled (TRADE), it becomes available in ProjOps for the user as displayed in the Figure 6.5.

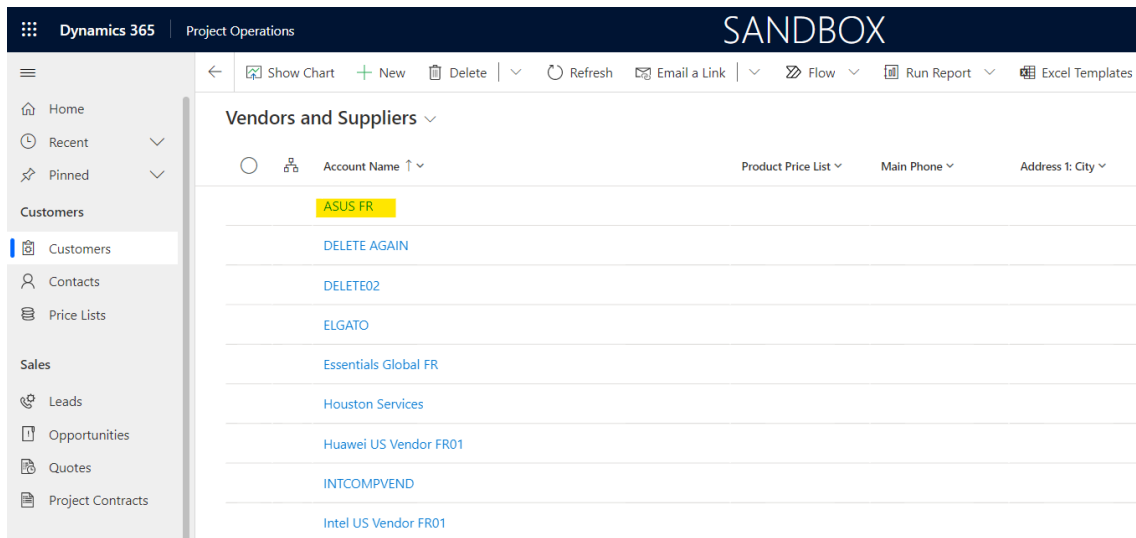


Figure 6.5: Vendor Groups in Dataverse

Chapter 7

Evaluation & Experimentation

The Evaluation & Experimentation chapter will address the evaluation indicators, the assessment metrics used (including dimension and criteria) in this project and hypothesis. Finally, the evaluation methodology (which includes the functional acceptance testing, quality evaluation framework and test considerations), results and assessment completion.

7.1 Evaluation Indicator

Evaluation indicators are indicators used to evaluate the developed work. What has been considered as evaluation indicator for this work is the system functionality.

The evaluation indicator set for this work was for the requirements completion, being essential to validate if the work items that the author has been assigned to were, in fact, successfully implemented.

7.2 Assessment Metrics

Assessment metrics are metrics that are used to ensure that a developed product manages to achieve the desired criteria. For this work, there was one assessment metric stipulated:

- The assessment metric considered is a metric that applies to more complex work items. For those, there should be an extra validation performed by a superior (above senior role), so as to make sure that the logic planned or implemented for the work item does not stray from the overall product roadmap and is in conjunction with the design of the requirement represented by the work item.

This way, whether a work item is simple or complex, there is always, at least, one evaluation performed. In addition, in case of more complex work items, a senior team member performs a double check.

7.2.1 Dimension

Pertaining to the dimension related to the metric mentioned, it can be said that it is specific and of decent size. As the metric involves testers or superiors with highly important roles, depending on the work item complexity, it can involve from only one to multiple testers. In the most complex cases the dimension can involve up to nearly ten people.

7.2.2 Criteria

The assessment metric that can range from simple to complex as mentioned in the previously. It may sometimes involve different factors and a bigger scope. For instance, a work item that only requires a modification in a form and respective table is something usually verified by a single tester. However, a requirement that involves different modules and features is something that, besides the initial tester, could also involve up to ten people so as to diminish the chance of an unexpected behaviour in some other part of the solution.

7.3 Hypothesis

Involved with the adaptation to ProjOps work, there are three different possible hypothesis for each work item:

- The performed work manages to fulfil the criteria successfully (works fine without affecting other features);
- The performed work follows the criteria but does not deliver the desired initial result (works fine but affects other features or were bad design that the author had to implement);
- The performed work does not follow the criteria (does not work as intended).

The first hypothesis focuses on successfully achieving the required criteria specified for the work, when everything works as planned and does not affect any other feature. The second hypothesis consists of following the initially specified criteria but not delivering what was desired, as it affects other features. As the last hypothesis, the third one is not following the criteria, when a work item does not work as expected.

The hypothesis results are displayed in the Results section, where an evaluation form for all existing requirements fulfilled by a tester is analysed.

7.4 Evaluation Methodology

As it is usual for features to be implemented but having some problems that the developer did not notice, it is always essential for software to have some evaluation methodologies

implemented so as to ensure that everything is working as planned and that it does not stray from the initial plan.

For the current work, there were two evaluation methodologies used to ensure that the developed work manages to fulfill its requirements successfully. Those two evaluation methodologies were Functional Acceptance Testing (FAT) and Quality Evaluation Framework (QEF).

7.4.1 Functional Acceptance Testing

Functional Acceptance Testing (FAT) consists of functional testing to assess the acceptance of one or multiple features/requirements. It is conducted to check if there are any discrepancies and non-conformities.

In addition to the student conducting development unit tests, functional acceptance test has been performed by an experienced functional consultant team member on work items. In case any unexpected behaviour was observed, the work item would be updated in the repository and assigned back to the developer to be fixed.

This allowed for the progressive improvement of the solution, besides increasing the overall solution quality and confidence.

7.4.2 Quality Evaluation Framework

A quality evaluation is the process of classifying the level of quality or standards.

The Quality Evaluation Framework (QEF) is a simple and useful way to see if the solution takes into account all the criteria that were initially agreed upon. It identifies weaknesses, allowing for the development team to focus on fixing them, improving the product.

This framework will aid in determining whether the solution is progressing in the proper direction in relation to the defined metrics during the development process (Bidarra and Escudeiro 2008).

7.4.3 Test considerations

As the IP solution is later going to be used by clients of Hitachi, supposedly they should be the ones to also have the opportunity to evaluate what has been implemented. However, as throughout this work there was no direct contact with any customer, the intermediary for such affairs was an internal tester, who was responsible for raising the work items in question.

After the work item was developed and unit tested, it was, it was assigned back to the respective tester, who would then re-assign it to another tester if they were busy or, last resort, to the project manager for the work item to be assigned.

7.5 Results

To assess the requirements completion, a form has been created and assigned to the tester for fulfillment. The results are displayed as follows.

Requirements	Requirement Fulfillment Status			
	Not Applicable	Badly Implemented	Partially Implemented	Implemented
Task 1 - Project Operations Modifications (allowing expense entries on projects)	-	-	-	✓
Task 2 - Clean up UI and background processes for out of scope and roadmap items	-	-	-	✓

Figure 7.1: Tester Evaluation Form - Tasks

As can be seen in the Figure above (Figure 7.1), both existing tasks related with the ProjOps expense entries modifications and UI cleanup for out of scope and roadmap items were evaluated as successfully resolved by the tester.

Bug 1 - Warning message: Accounting distribution form is not available because there are no amounts to distribution	-	-	-	✓
Bug 2 - Hour and Expense Forecast - Line property is not updated correctly to Fixed Price project	-	-	-	✓
Bug 3 - Resolving a project line property for mismatching billing type	-	-	-	✓

Figure 7.2: Tester Evaluation Form - Bugs

All of the bugs (Figure 7.2) were also successfully resolved. The only noteworthy detail is that the second bug (Bug #2: "Hour and Expense Forecast - Line property is not updated correctly to Fixed Price project") did not require any implementation, as the author noticed that the issue was due to missing setup. So, it was resolved outside of development but still successfully resolved.

CR 1 - Resolving project line property on project operation integration journal lines using existing logic	-	-	-	✓
CR 2 - Configured Invoice fields on Project Contract	-	-	-	✓
CR 3 - Supplier's integration - Dual Write	-	-	-	✓

Figure 7.3: Tester Evaluation Form - Change Requests

The change requests (Figure 7.3) were all completely implemented without any any issue involved.

Adapt the requirements to Project Operations while maintaining their previous planned design	-	-	-	✓
Specific implementation language (X++) and database tools (default from Microsoft)	✓	-	-	-
Dual Write	-	-	-	✓

Figure 7.4: Tester Evaluation Form - Constraints

Finally, the constraints (Figure 7.4) had two which the tester could evaluate as successful ("Adapt the requirements to ProjOps while maintaining their previous planned design"

and "Dual Write") and a different one ("Use specific implementation language (X++) and database tools (default from Microsoft)") which the tester could not evaluate as successful due to not having access nor knowledge from the technical side of the development.

7.6 Assessment Completion

Taking the tester's evaluation form into consideration, this topic will now focus on the Assessment Completion. It will show what has been achieved as the final results of the Quality Evaluation Framework (Figure 7.5).

The final results can be divided into three different categories:

- **Functionality:** addresses the functional requirements of the work items that have been implemented by the author;
- **Design:** focuses on the design constraints of the work;
- **Implementation:** related with the implementation constraints;
- **Interface:** related with the interface constraints.

The evaluation metrics used for each of those categories are also present in the appendices chapter, where the evaluation metrics for Functionality (Figures A.1, A.2 and A.3), Design (Figure A.4), Implementation (Figure A.5) and Interface (Figure A.6) are showcased with further detail.

The following Figure 7.5 summarizes the final overall results achieved.

q	D	qi	Dimension	Qj	Wij (Factor Weight j in Dim i) [0,1]	Factor	rvjk (requirement weight k in Factor j) {2, 4, 6, 8, 10}	Requirement	wfk % requirement fulfilment k)
100%	0,00	100	Functionality	100,00	0,25	Task	10,00	Task 1 - Project Operations Modifications (allowing expense entries on projects)	100
							10,00	Task 2 - Clean up UI and background processes for out of scope and roadmap items	100
							10,00	Bug 1 - Warning message: Accounting distribution form is not available because there are no amounts to distribution	100
				100,00	0,38	Bug	10,00	Bug 2 - Hour and Expense Forecast - Line property is not updated correctly to Fixed Price project	100
							10,00	Bug 3 - Resolving a project line property for mismatching billing type	100
							10,00	CR 1 - Resolving project line property on project operation integration journal lines using existing logic	100
				100,00	0,38	Change Request	10,00	CR 2 - Configured Invoice fields on Project Contract	100
							10,00	CR 3 - Supplier's integration - Dual Write	100
							10,00	Adapt the requirements to Project Operations while maintaining their previous planned design	100
		100	Design	100,00	1,00	Design Constraint	10,00	Specific implementation language (X++) and database tools (default from Microsoft)	100
		100	Implementation	100,00	1,00	Implementation Constraint	10,00	Dual Write	100
		100	Interface	100	1,00	Interface Constraint	10,00		100

Figure 7.5: QEF Final Results

The QEF performed an assessment two tasks, three bugs and three change requests as a part of the functional requirements (Functionality), one design constraint (Design), a implementation constraint (Implementation) and a interface constraint (Interface), reaching

a total of twelve requirements. For all of those, every single requirement managed to reach a completion status of 100%, having been successfully fulfilled and tested by the tester.

With this, it is also possible to conclude that the quality of the developed work has been highly successful with a 0% deviation (maximum evaluation score).

7.7 Obstacles and Limitations

Trough this work, the author has faced many adversities and limitations which affected the developed work and its related effort in order to be concluded.

Obstacles

Starting off with FinOps, it was a technology that the author had some prior experience working with but not yet remotely close to the current knowledge he currently has now that the work has been completed. For every work item he was assigned to, he had to first learn together with the rest of the IP team how everything worked for that scenario and, just after doing so, would he be able to fix it. With this, and also taking into consideration that the PSA IP is an intellectual property which involves an huge amount of bespoke features and customizations, the main adversities for FinOps consisted of low knowledge about the technology and the product and most of the work items were related with features that the author had never previously seen nor worked with.

As for ProjOps, its adversity was that, as it was something new, the student and the rest of the IP team had no prior knowledge about how it worked and had to learn everything through working and researching.

Limitations

Concerning limitations, there were two involved in this work:

1. the first one was that the default Microsoft objects could not be directly edited. This applied to all out of box modules' objects, such as classes, forms and tables, for instance.
2. the second and last limitation was related with ProjOps. It does not provide the same freedom of customization as FinOps. Some of the features that had to be adapted to ProjOps were either modified or could not be adapted to the limitations in what could be customized in ProjOps.

Chapter 8

Conclusion

The current topic will focus on addressing the conclusion of the thesis. Starting with the work's contributions, together with the obstacles and limitations throughout this journey, it will also be mentioned what the achievements were, how it is envisioned for a near future and, finally, conclude after providing some final considerations.

8.1 Work Contributions

This document provides an overview to the previously existing FinOps and to the recently created ProjOps.

Containing information from multiple sources in a single document, this document allows the reader to have an easier perception about the whole Microsoft timeline (the beginning of FinOps, the Microsoft roadmap and the creation of ProjOps) as well as what was required to be done in order to adapt the Hitachi intellectual property to that said changes (how the architecture was initially in comparison to after ProjOps was implemented, what were the technologies involved and what were the required changes).

Furthermore, the adaptation work has also been successfully implemented and managed to get a positive approval from the tester and achieve the planned objectives.

8.2 Achievements

All of the initial requirements have been successfully achieved and an overview for one of the most complete examples has also been showcased, providing the reader with a small insight of the effort involved throughout this work. The document also described how the recent changes implemented by Microsoft changed the involved licensing schemes and technologies. Furthermore it explained the reasons that lead Microsoft to implement said changes.

8.3 Future Work

Even though FinOps is a business application with quite a long history, ProjOps is a recent business application. Being created by Microsoft and also a part of the Dataverse, it has a lot of potential for future growth.

Currently, Hitachi is still implementing/re-implementing IP features for deployment type 2 in line with the Microsoft roadmap and the team's availability.

As it has also been mentioned in the Microsoft roadmap, it is expected that, in the future, Microsoft will migrate all clients to the ProjOps license scheme meaning that clients will have to, sooner or later, utilise deployment type 2 systems (FinOps+ProjOps). However, it is yet uncertain if it will be required to completely adapt the IP to ProjOps because Microsoft has still yet to decide if they want to remove (or completely hide) PMA/PSA in FinOps and re-implement everything in ProjOps. In that case, the complete solution will have to be re-implemented in ProjOps only. Nonetheless, by then, it should have become an easier process, as some current adversities and limitations may be improved with time.

8.4 Final Considerations

As final thoughts go concerning the process of writing this document, it has been a positive experience overall. It contains very important information that is scattered throughout the internet and difficult to find in a single document and addresses two predominant business applications: FinOps and the recently created ProjOps.

The solutions' initial requirements and respective design have both been successfully achieved. The customisation model and every single requirement implemented by the author had a very positive feedback from the tester, which means that the author did manage to contribute to the IP team and that the solution has been successfully adapted to the latest Microsoft changes and is now aligned with the Microsoft roadmap. Still, as the Microsoft roadmap is frequently updated, it will be required to keep on working on this adaptation, meaning that there is also the possibility for future improvements.

Despite the demanding work and research involved, it was also a good experience to work out of the author's comfort zone that allowed him to grow professionally and academically.

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Appendix A: Quality Evaluation Framework Evaluation Metrics

Dimension		Functionality				
Factor		Task				
		Wfk - Fulfillment (%)				
Requirement	Metric Evaluation	0	25	50	75	100
Task 1 - Project Operations Modifications (allowing expense entries on projects)	Expenses are allowed entry on projects	Not implemented	-	Implemented with Bugs	-	Display all the available options and settings
Task 2 - Clean up UI and background processes for out of scope and roadmap items	Cleanup of all existing warnings from custom code	Did not clear any warning nor document anything	Did not clear a reasonable amount of warnings and documentation is lacking	Half of the warnings were not clean and documentation is lacking	Most of the bugs were cleanup and documented the ones that could not	Every change is commented perfectly and cleanup all possible warnings

Figure A.1: Functionality Evaluation Metrics - Tasks

Factor		Bug				
		Wfk - Fulfillment (%)				
Requirement	Metric Evaluation	0	25	50	75	100
Bug 1 - Warning message: Accounting distribution form is not available because there are no amounts to distribution	Accounting distribution is available to access	Not implemented	-	Implemented with Bugs	-	Implemented
Bug 2 - Hour and Expense Forecast - Line property is not updated correctly to Fixed Price project	Line property is correctly updated for Fixed price projects	Not implemented	-	Implemented with Bugs	-	Implemented
Bug 3 - Resolving a project line property for mismatching billing type	Fixed mismatching for project line property with billing type	Not implemented	-	Implemented with Bugs	-	Implemented

Figure A.2: Functionality Evaluation Metrics - Bugs

Factor		Change Request				
		Wfk - Fulfillment (%)				
Requirement	Metric Evaluation	0	25	50	75	100
CR 1 - Resolving project line property on project operation integration journal lines using existing logic	Fix the project line property on project operation integration journal lines	Not implemented	-	Implemented with Bugs	-	Implemented
CR 2 - Configured Invoice fields on Project Contract	Display the configured invoice fields on a project contract	Not implemented	-	Implemented with Bugs	-	Implemented
CR 3 - Supplier's integration - Dual Write	Expand the vendor groups to Dataverse through Dual Write	Not implemented	-	Implemented with Bugs	-	Implemented

Figure A.3: Functionality Evaluation Metrics - Change Requests

Dimension Design						
Factor Design Constraint						
		Wfk - Fulfilment (%)				
Requirement	Metric Evaluation	0	25	50	75	100
Adapt the requirements to Project Operations while maintaining their previous planned design	The requirements have been implemented while respecting the previous design	None of the requirements fulfilled the previous planned design	Almost none of the requirements fulfilled the previous planned design	Half of the requirements fulfilled the previous planned design	Most of the requirements fulfilled the previous planned design	All of the requirements fulfilled the previous planned design

Figure A.4: Functionality Evaluation Metrics - Design Constraints

Dimension Implementation						
Factor Implementation Constraint						
		Wfk - Fulfilment (%)				
Requirement	Metric Evaluation	0	25	50	75	100
Specific implementation language (X++) and database tools (default from Microsoft)	System only uses X++ as the programming language and the default database tools are the default ones from Microsoft	3rd party database tools and a different implementation language are used	-	-	-	Only uses X++ as the programming language and the database tools are the default ones from Microsoft

Figure A.5: Functionality Evaluation Metrics - Implementation Constraints

Dimension Interface						
Factor Interface Constraint						
		Wfk - Fulfilment (%)				
Requirement	Metric Evaluation	0	25	50	75	100
Dual Write	System uses Dual Write	Does not use Dual Write	-	-	-	Uses Dual Write

Figure A.6: Functionality Evaluation Metrics - Interface Constraints