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BENEFITS AND OPPORTUNITIES OF IMPLEMENTING PLANT DIGITAL TWIN PLATFORM IN SUMITOMO SHI FW

AUTHOR/S Md Rifat Monjur Khan

SAVONIA UNIVERSITY OF APPLIED SCIENCES

THESIS
Abstract

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Abstract

The purpose of this thesis was to investigate the benefits and opportunities Sumitomo SHI FW (SFW) can have by implementing Cadmatic eShare as a plant digital twin platform. SFW is a global organization with a vision to power a decarbonized world through their advanced technological solution in energy industry. Cadmatic eShare is a plant digital twin platform that can integrate, visualize and share information in a singular web-based platform.

This thesis explains the concept of plant digital twin and how it can be integrated in Sumitomo SHI FW. This thesis was written under the Global Engineering IT(EIT) department of SFW and the role of the candidate was Thesis student/Application Support. The engineering applications and tools of Sumitomo SHI FW are explained in this thesis incorporated with EIT department. The Cadmatic eShare application environment setup was carried out during this thesis. Throughout the eShare environment setup, potential capabilities of the platform were identified. These capabilities enable eShare to be considered as a plant digital twin platform. Cadmatic eShare offers features and tools that are specially tailored for plant digital twin platform. Throughout the process of this thesis those features and tools of eShare were tested and modified according to the requirement of SFW. Both SFW proposal and execution projects were configured in eShare during the environment setup. As SFW projects were configured in eShare, interviews were conducted with the potential users for feedback and comments to identify the benefits and opportunities eShare brings in SFW. Also, a field test was carried out in one of the SFW project site during this thesis to test the features and tools of eGO (Tablet version of eShare).

The thesis evaluates the potentiality of eShare to be considered as a plant digital twin. During the thesis process prospective benefits of using eShare in SFW were identified by demonstrating the application to the users. And this thesis also points out the future development roadmap of eShare under SFW that will unfold the full potential of eShare as a plant digital twin platform.

Keywords
Digita Twin, Industry 4.0, Cadmatic, eShare, eGo, IOT, Data flow, Adapter, Database

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1 INTRODUCTION

1.1 Client Organization

Sumitomo SHI FW (SFW) is a global leader in the energy and environmental technology solutions with vision to provide sustainable energy solutions through decarbonization, decentralization and digitalization of the energy industry. Sumitomo SHI FW have roots in Finland from A. Ahlström Oy whose core business started with ship building and boiler manufacturing. Current SFW is associated with two leading industrial corporation Sumitomo heavy industries Ltd. and Foster Wheeler. Sumitomo heavy industries started its journey through mining operations back in 1888. Foster Wheeler started the production of industrial boilers in 1940s and acquired Ahlstorm Pyropower´s boiler business in 1995. By obtaining Amec Foster Wheeler´s fluidized bed business in 2017, Sumitomo heavy industries constructed **Sumitomo SHI FW,** a global pioneer in the sustainable energy technology. Now in SFW there are 1500 talented people who is providing a wide range of technological solutions in different energy sectors.

Sumitomo SHI FW is the global provider of energy and environmental technologies with focus on high efficiency and flexible energy generation for the following industries:

- Utility Power
- Industrial Steam Power
- Combined Heat & Power
- Waste to Energy

As a part of the new strategy, SFW took the initiative to power a decarbonized world for everyone (Sumitomo SHI FW, 2022). To take the strategy in action SFW has broadened its business portfolio which includes:

- Energy Generation
- Waste to Value
- Energy Storage
- Services
- Carbon Capture

1.2 Background

Sumitomo SHI FW (SFW) operates as a global organization with facilities all around the globe. For successful execution of SFW projects, co-operation is required from different facilities of its global network. Sumitomo SHI FW (SFW) holds the largest global delivery network for fluidized bed technology. Maintaining such global network means continuous cooperation among the manufacturing sites, engineering offices, customer sites and additional services involved in the global network. SFW have demonstrated the competence of its global network by delivering a great deal of successful projects and providing high quality service to the respected customers. SFW have set their vision to be a leading technology provider of integrated solutions for decarbonized energy (Sumitomo SHI FW, 2022). As SFW is in the frontier of developing innovative solutions in the field of clean energy and constantly cooperating with the industry and utility power services, the advanced technological

product range is getting immense. Innovation in clean energy technology means new projects, customers, and servicing. Subsequently, there are unique challenges emerging in the maintenance of global network. To overcome these possessed challenges, strategical and technological development of the global network is compulsory. As the fourth industrial revolution is taking place, it is high time for the industries to re-evaluate their policies and strategies to identify whether they are on the right path to join in the industry 4.0 movement. Industry 4.0 is the latest industrial revolution which is changing the way how technological organizations are operating. Industry 4.0 is constructed on the following core design principles (RMIT University):

- Interoperability
- Virtualization
- Decentralization
- Real-time capability
- Service orientation
- Modularity.

SFW has always been pioneer of innovation and technological advancement in energy industry. From the industry 4.0 design principles and SFW strategy, it is clearly understandable that SFW strategy is aligned with the core principles of industry 4.0. Considering both aspects, the emerging challenges in maintaining large global network and industry 4.0, SFW is moving forward by implementing advanced data driven information sharing portal (Plant digital twin) that directly incorporates with the core principles of industry 4.0 such as virtualization. Virtualization is the ability to create digital copy of equipment, operation, and processes to enhance the digital capability.

1.3 Objectives

SFW is implementing Cadmatic eShare as a standard portal for plant and project information to integrate, visualize and share engineering, design, construction and operation information in a unified platform. SFW is taking a significant step towards digitalization/industry 4.0 by implementing eShare in its operation. One of the core objectives of the implementation of eShare is to acquire a common virtual platform where information from different aspects of a project: 3D model of the plant, 2D diagrams and drawings, engineering data, and relevant external systems is accessible to the authorized personals under SFW global network regardless their location.

This thesis was written under the Global Engineering IT department of Sumitomo SHI FW. Engineering IT provides technical software tools and solutions that enables SFW to develop advanced technological solutions. Engineering IT performs development and support tasks on the technical software solutions that increase productivity of the technological operation in SFW. Engineering IT also develops in house software solutions that improves the technical competence of SFW. As a global department, Engineering IT provides support and services across the SFW global network. Engineering IT plays significant role in the transformation and adoption of new technical software solutions and tools in SFW. Accordingly, in the implementation of Cadmatic eShare (plant digital twin platform), Engineering IT is making sure the successful development and operation of eShare across the SFW global network.

This thesis topic originated regarding the implementation of the Cadmatic eShare application. The objectives of this thesis are as follows:

- Cadmatic eShare environment setup.
- Data integration into eShare from other SFW engineering applications.
- Visualizing data in a user friendly and meaningful way in eShare.
- Identifying the benefits SFW can have by implementing eShare.
- Evaluation of eShare as a plant digital twin platform in SFW.
- Research on potential future development of eShare under SFW vision and strategy.

2 DIGITAL TWIN

2.1 History of Digital twin

Digital twin is one of the major industry 4.0 trends which is driving the digital transformation of different industries. The current digital twin concept what we see is not the same as when it was first introduced. The idea of digital twin technology was first voiced in 1991, with the publication of Mirror Worlds, by David Gelernter. However, Dr. Michael Grieves (then on faculty at the University of Michigan) is credited with first applying the concept of digital twins to manufacturing in 2002 and formally announcing the digital twin software concept. The concept had three components: real space, virtual space and linking mechanism of the information between two spaces (Scholarly Community Encyclopedia, 2021). Ultimately, NASA's John Vickers introduced a new term "digital twin"in 2010. (IBM). With the advancement of data science and innovation of IOT and cloud computing, the term digital twin can convey a wide concept in the technology industry. Now the digital twin technology have evolved in different industries and each application of digital twin technology have their own definition.

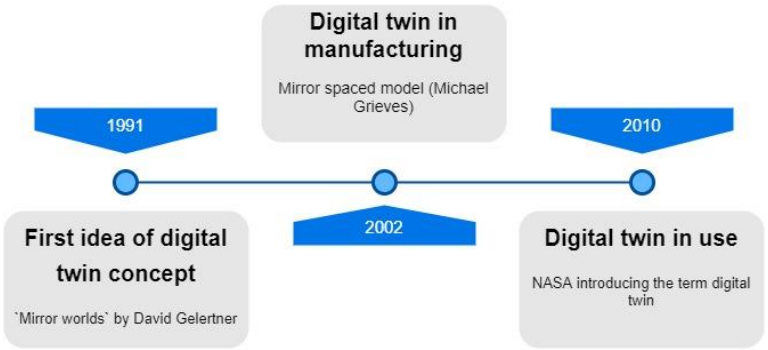

Figure 1: Brief history of digital twin (Scholarly Community Encyclopedia, 2021)

2.2 Explanation of digital twin concept

A digital twin is a virtual representation of a physical object, asset, process or arguably anything. The virtual replica incorporates with the physical object throughout its lifecycle. Anyone who have the access to the digital twin of the physical object can see the actual state of the object in a virtual model. The key in the term digital twin that separates it from a normal simulation of an object is real time communication between the physical system and the virtual replica. Simulations usually

focuses on singular process where digital twin is a whole environment that combines multiple processes. With the constantly updated data from different sources and leveraging the power of cloud computing and information flow digital twin environment can give a deeper insight into the operation of products and processes which ultimately improves the quality of the products and processes. (IBM). The concept of digital twin varies a lot depending on the use of digital twin. Different industries have different implementation of digital twin according to their need. So, to make it more understandable digital twin can be classified into several categories.

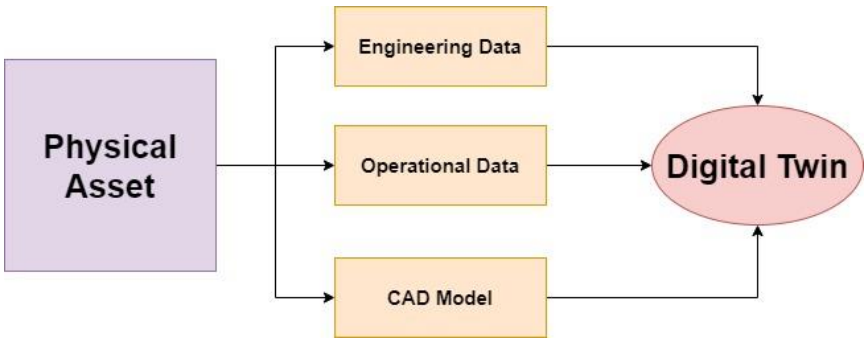

Figure 2: Simple digital twin model

- **Descriptive twin –** The descriptive twin is the virtual representation of the physical object with design, engineering and construction data including 3D models and 2D drawings.
- **Informative twin –** The informative twin uses sensors and operation data to give real time information of the physical object.
- **Predictive twin –** Predictive twin utilizes the real time data and analytics to identify future potential issues.
- **Comprehensive twin –** The comprehensive twin leverages advanced modeling and simulation for potential future scenarios as well as prescriptive analytics and recommendations.
- **Autonomous twin-** Autonomous twin has the capability to learn and make decisions through artificial intelligence alongside advanced simulations and 3D visualization. (Autodesk, 2021)

3 DIGITAL TWIN IN SUMITOMO SHI FW

As it is obvious that the term digital twin varies to a great extent depending on the industry and the use cases, it is logical to investigate what digital twin can mean for Sumitomo SHI SFW. SFW operates as a project-based organization which means the lifecycle of a project starts with the proposal phase of the project and it continues with execution and servicing of the project. In terms of SFW to acquire a digital twin platform, it requires that the system provides support in each phase of the project and reflects the actual state of the project virtually. Cadmatic eShare platform possesses the capability to assist SFW in the digital twin solution by providing support in each phase of SFW projects. With the implementation of eShare at this stage SFW is moving forward to acquire the **Descriptive** and **Informative** digital twin. As we are turning our focus of digital twin concept that

integrates with SFW, we can introduce the term **Plant digital twin.** Plant digital twin platforms are developed considering the special need of the process industry. Plant digital twin is tailored with features and tools that provides support in the successful execution of plant projects. eShare represents the plant digital twin of individual projects under same template or individual configuration. Plant digital twin will improve the collaborative design, engineering and construction of projects by leveraging the shared and easily accessible information from different departments. The eShare platform will act as the base digital twin model for the next level digital twin integration in SFW. The first steps towards the implementation of digital twin involves digitalization of information sharing and management system of the organization. The eShare digital twin platform provides the ideal solution for SFW's first step towards the implementation of digital twin. As SFW operates globally and possess wide range of functionality from engineering to servicing of the customer sites, there is ample scope for the development of digital twin. eShare as a plant digital twin platform have the potentiality for next level of digital twin (**comprehensive** and **predictive)** integration in SFW.

4 ESHARE (INFORMATION INTEGRATION, PUBLISHING AND DISTRIBUTING PLATFORM)

eShare is the ideal information sharing platform for the industries that enables integration, visualization and sharing of information in a unified web portal that can be accessed with eShare application and eGo (Windows tablet version). With its advanced connectivity to the different data sources and ability to function as a common digital platform, eShare provides a greater accessibility to the relevant information. eShare gives the opportunity to build a more transparent information portal from which all the stakeholders can be benefitted.

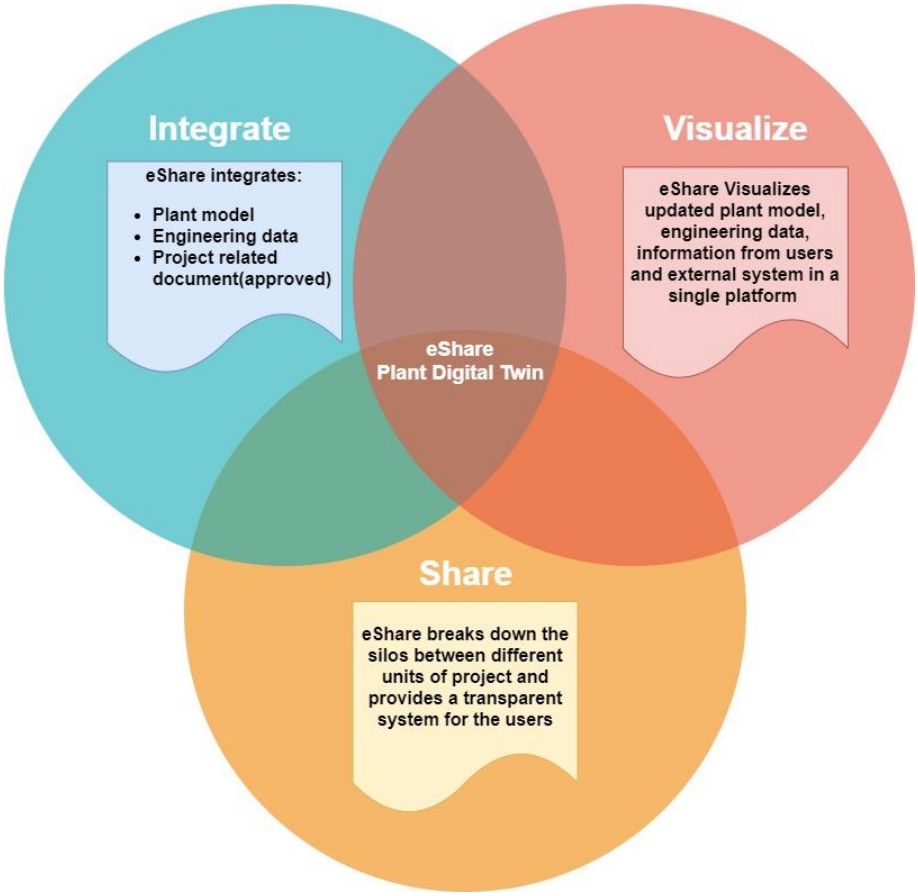

Figure 3: eShare as a plant digital twin

One of the key aspects of the eShare is the user interface which visualizes the 3D model, engineering information and project related documents in a user-friendly way. This unique way to represent all the information increases the user´s daily productivity. eShare provides special tools and features like smart points, markups, different visual styles that makes project collaboration and information sharing among the project participants much simpler.

4.1 eShare User Interface

eShare model view

The 3D model viewer in eShare is enriched with useful tools and features that makes model review and design collaboration process smoother for the users. The available tools in the eShare model view enhance the data visualization in user friendly way which makes it easier for the users to get their hands on to the application and start using eShare in their tasks.

The combination of different visual styles, object hierarchy and model tree in the eShare model view offers user to visualize the model according to their need. User can save specific views of the plant model and directly come back to that section without navigating from the main model.

The ability to see the plant model alongside the model and Comos (Process engineering software) attributes in a same window gives user more informative experience.

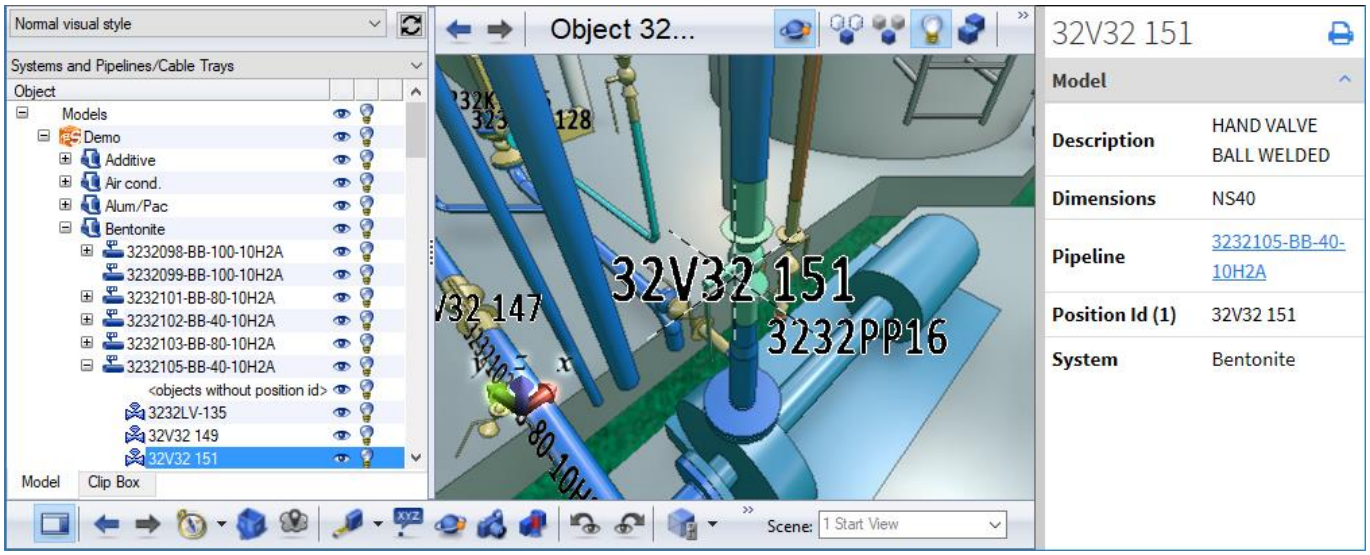

Figure 4: eShare user interface (Cadmatic eShare, 2022)

4.2 eShare environment setup

As of any other software implementation eShare also requires a comprehensive environment set up before taking it into use. One of the main goals of eShare implementation is the integration of information from different sources that directly refers to the other engineering applications in use at SFW.

SFW owns the following applications from where eShare will be integrating data:

- COMOS (Process Engineering Software)
- CADMATIC Plant Design (3D Modelling)
- M-Files (Document Management Software)
- ESTEN (Estimation Tool)

eShare environment setup includes two levels of administration.

- System Administration
- Project Administration

System level administration sets up the projects and manages the users and user groups. Project administration sets up individual projects in eShare. Cadmatic eShare stores data in Microsoft SQL server database. There is main database for running the server and individual database for each project/plant. Thus, eShare also requires database administration to set up the environment.

COMOS (Process Engineering Software)

Comos is the ultimate plant engineering and management platform from Siemens that SFW uses throughout the entire lifecycle of a project. Both proposal and execution projects start in Comos (Senior Application Specialist, 2022). To obtain a plant digital twin platform it is vital to have the necessary plant engineering information in the system. Thus, it is important to have the access to Comos data from eShare. KKS code which defines the product structure is the key attribute in object linking with the model and documents. And Comos owns the KKS code. In process industry, Piping and instrumentation diagram (P&ID) describes piping and process equipment including instrumentation and control device in detail. In SFW, P&ID diagrams are generated in Comos. Comos updates the piping and instrumentation design documents to the M-files vault.

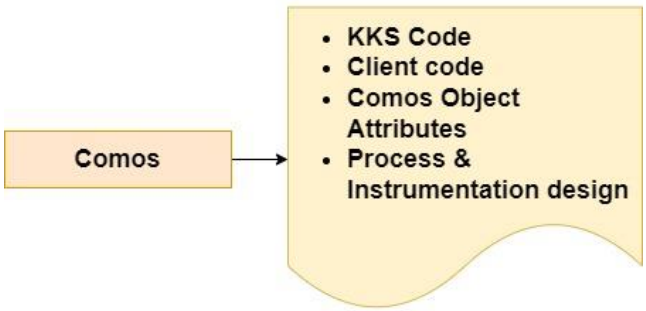

Figure 5: Comos (process engineering software)

CADMATIC Plant Design

Cadmatic 3D plant design software is a 3D modelling solution particularly focused on the plant emgineering industry. The solution offers a great opportunity for collaborative design works in multinational organizations. Project distribution system enables users to collaborate on design project despite their location. Dedicated products of Cadmatic for distributed engineering makes it easier to distribute the design project among different personals and locations. Cadmatic 3D plant design benefits eShare by providing 3D models of the project. As both softwares are part of the same ecosystem, the transfer of data is straightforward. Design updates in plant modeler are aligned with the eShare and that gives the user the latest design to work with.

Figure 6: Cadmatic CoDesign (Cadmatic, 2022)

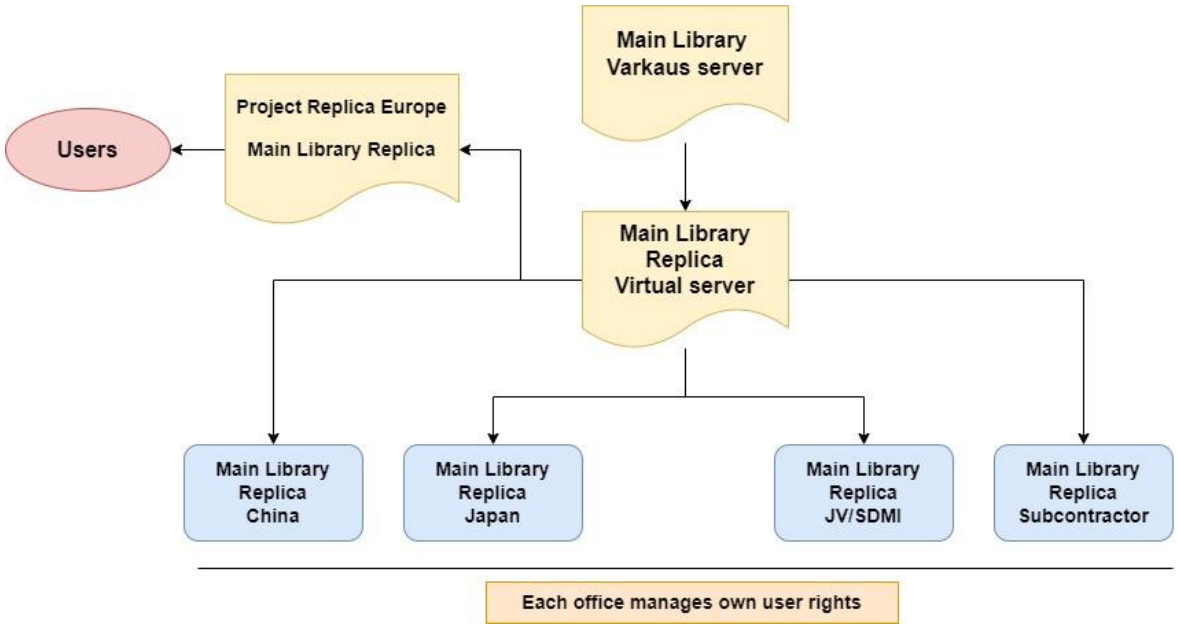

Figure 7: SFW Cadmatic CoDesign (Global Engineering IT, 2021)

M-Files

SFW uses M-files as the document management system. M-files have separate document vaults depending on the classification of the documents. Both execution and proposal projects have their individual document tree where documents related to the project are stored. There is available sorting and searching features to find the correct documents from M-files. With the document handling, eShare gains access the approved M-files documents and links them to the model objects.

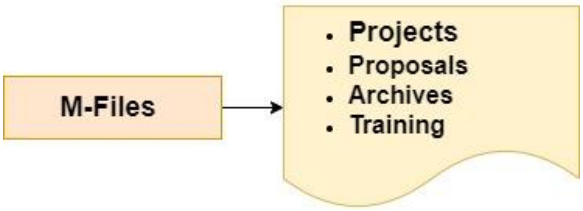

Figure 8: M-Files in SFW

ESTEN

Engineering operation in SFW is vastly distributed among different disciplines. And these disciplines generate a great deal of data from the engineering applications in use. In certain situation data input is also manually handled. And there is available history data that can be taken into consideration for quantity estimation. ESTEN application process can be described in two steps: Quantity estimate and Cost estimate. ESTEN is the estimation management application that takes input data into consideration and performs data validation and highlights changes. ESTEN publishes the quantity that is required for cost estimation. Cost estimation can be exported to various analyzing tools via queries, database connection and excel export. (Senior Application Specialist, 2022)

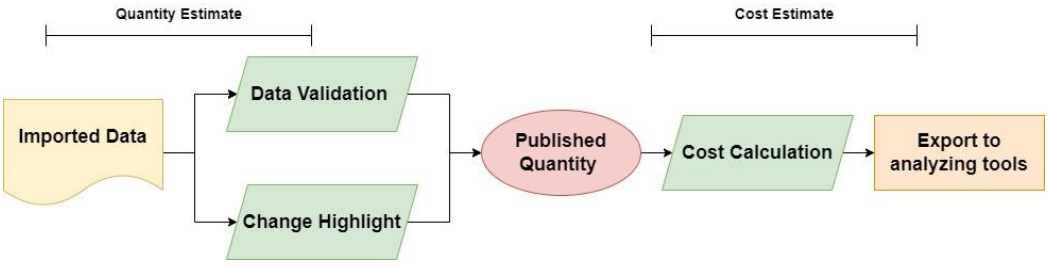

Figure 9: ESTEN process

Currently ESTEN uses local file systems and database to access the imported data. With the development of engineering data hub, ESTEN will be able to access the M-Files and the engineering data hub.

4.2.1 System Administration

User and Group management

eShare is a versatile application which is not only based on specific users. eShare serves users from different departments of SFW. Some of the current users of eShare are as follows:

- Boiler Design Engineers
- Structural & Civil Engineers
- Project managers

With the future development of the eShare platform, it will be able to provide support to more departments inside SFW e.g. Construction, Service, Sales etc and also to the customers. Therefore, the range of eShare users will also expand. It is essential to manage this huge group of users smartly. eShare have special features and tools that not all users need access rather particular user groups benefits from those features. eShare provides the tools for admin to manage the users and groups in eShare. With the eShareAdminTool (command line interface) it is possible to import and synchronize organizational Active Directory groups in eshare which omits the manual work in user management. It is also possible to configure special groups in eShare with users who have similar requirements and access.

4.2.2 Project Administration

Model Configuration

One of the main objectives of implementing eShare is the ability to view and inspect the 3D model of the plant in easy way so that it is not required to use the CAD software every time. Cadmatic plant designer can directly send 3D model of a design project to eShare. eShare model export can be configured at the time of Cadmatic project creation or it is also possible to configure it afterwards. Admin can define how frequently the Cadmatic model should export the model to eShare. In eShare, it is also possible to import 3D models in various formats. eShare uses model importers to import 3D models of different formats. There is separate import configuration available for different 3D model formats.

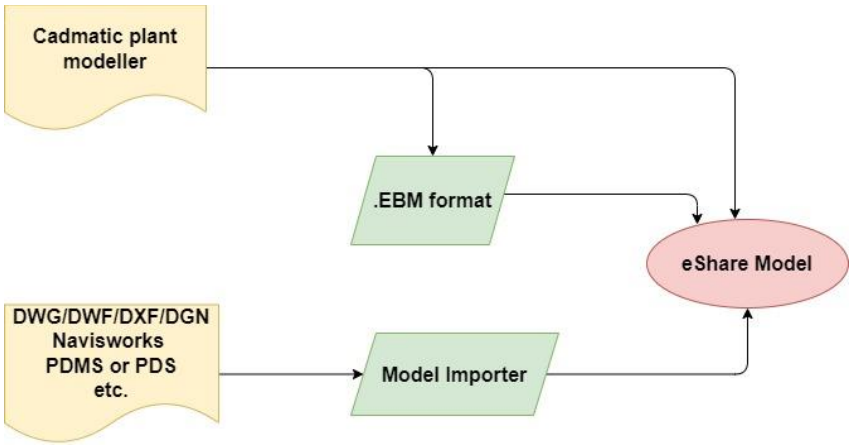

Figure 10: Model configuration in eShare

After the model is imported administrator can publish the model in eShare. When publishing the model admin can define the settings of the attributes from the model file. Attributes illustrates the properties of model objects.

Adapters and Data Sources

The ability to connect and integrate to both internal and external systems provide a platform with opportunity to be developed as a smart system that can bring values to the organization. Cadmatic eShare platform supports integration with numerous data sources such as relational database management systems, file systems, internal and external online services, which allows projects to retrieve data from multiple sources in the same window as the interactive model of the project. One of the key features of eShare is that it allows data to be retrieved from different sources in various ways such as model object information, smart points and object attribute. The adapters and data sources in eShare are used to retrieve data from other SFW engineering applications like process engineering software COMOS via integration database. The eShare platform offers a wide range of data adapters that can be used smartly to visualize and share information.

The common data adapters available in eShare:

- Database adapter
- REST API adapter
- File system document adapter
- Hyperlink adapter
- CMIS document adapter
- Excel adapter

Here is an example of the general working principle of adapters and data sources in eShare. eShare can retrieve information from external sources into smart points and model objects.

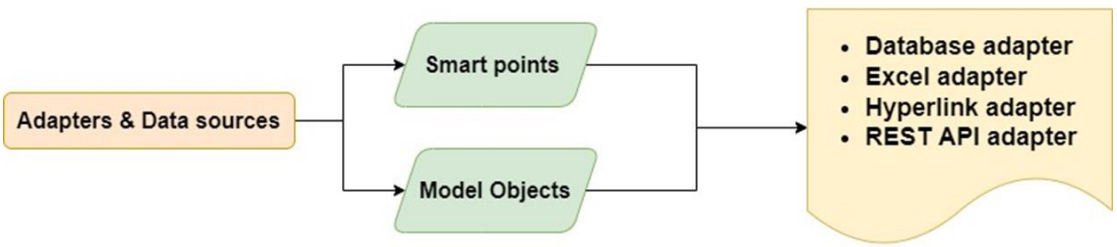

Figure 11: Adapters and Data sources working in principle

Here is one example how eShare can integrate query data from Comos with the database adapter.

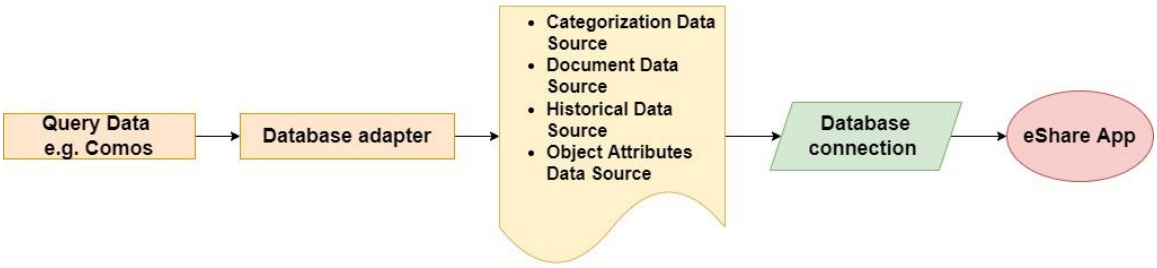

Figure 12: External database adapter.

With the database adapter configuration and considering the type of data source eShare imports queried data as object attribute from the Microsoft SQL server.

Here are few ways how eShare can access external systems and retrieve project related data.

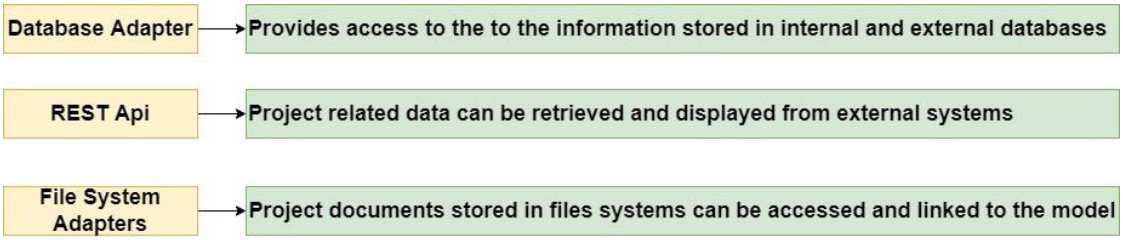

Figure 13: Information from external sources

Smart points

In eShare, Smart points are a type of unique markers that are linked to an object or object group that can hold and retrieve information from various external sources. Smart point is a very functional tool and can be implemented for numerous purposes in eShare. Smartpoints can be created both eShare and eGo and the updates will appear in both programs. Smartpoints are visualized with special icons on the 3D model.

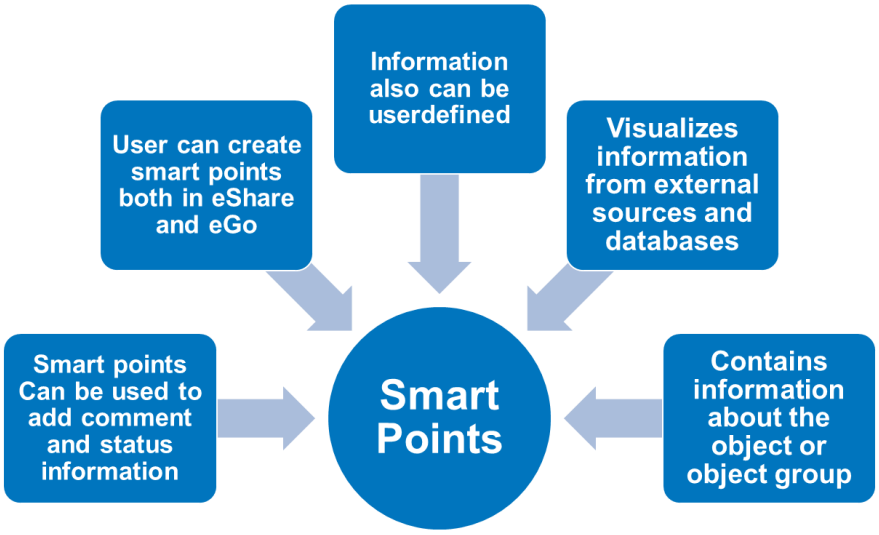

Figure 14: Smart points in eShare

Before a user can create a smartpoint, the administrator must define the smartpoint type configurations. There are several smart point type configurations available depending on the purpose of use. Project administrator can define the smart point type and set up the external data source from where the smart point will retrieve information. Smart point configurations can be exported easily from one project to another which allows project administrator to develop standard configurations.

Markups

In eShare, Markups are functional tool that allows users to collaborate in a design project. Project personals can add comments or update status information to 3D model and model objects. This functionality makes project collaboration trouble free among the participants. Design change/update request can be easily done via markups in eShare. With the markups user can request design change by providing information and by attaching image with the markups. User can assign tasks to other users using markups as it is possible to select individual assignee while creating markups. As eShare is synchronized with eGo (Tablet version), it is possible to take photos on site and attach them in markups with eGo. The markups improve the communication between the site and office. Designers and engineers can get insightful information from the site via markups.

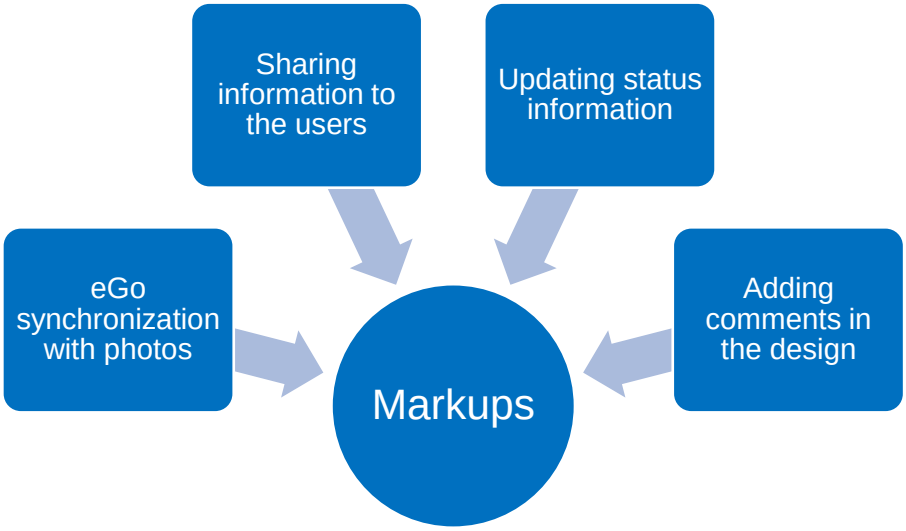

Figure 15: Markups in eShare

There is one default markup type available in eShare. Project administrator can configure additional markup types depending on the need. Administrator also defines which user groups can see/create/modify/delete markups in a project.

Status Tracking

Status tracker is a method in eShare that allows users to track the status of the project. In the 3D view, the model objects and object groups are visualized according to the status tracking values. The color of the objects in 3D view changes according to the status tracker values when the respective visual style is selected.

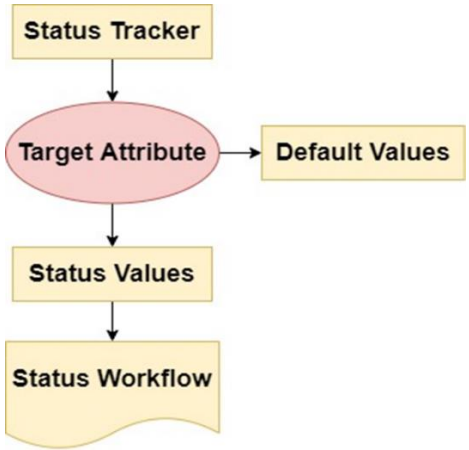

Figure 16: Attribute specific status tracker

The administrator can configure new status trackers. Status trackers are always attribute specific. To have a status tracker an object or object group must have the attribute. In the status tracker configuration, the administrator can define general settings, target attribute, status values and colors, and status workflows.

For example, simple application of the status tracker would be to track the installation progress. If project manager requires status update of installation progress and estimated time required for installation, a status tracker named Installation with a target attribute can be created. The value of the status tracker can be simply Yes and No. The status values will have defined colors and user from the site can update the installation status with the eGo(Windows Tablet version) and project manager will have detailed visualization of installation progress in eShare.

Document management

Document handling is one of the significant capabilities of eShare which give users access to 3D model and associated document in a single window. User can switch between the 3D model of an object to a document that holds information regarding that object. And this is possible because of bidirectional object to document linking in eShare. As SFW uses M-Files as the document management system, verified project related documents are coming to eShare from M-Files. eShare is retrieving project specific documents from M-files via Rest API adapter. In the Rest API adapter configuration M-files is configured as the document data source.

Document type configuration defines how documents that are coming from external sources will be linked to the correspondent 3D model. Under the document type configuration, document type detection and document processing rules define how text labels in the documents will be converted to links that will open the 3D model.

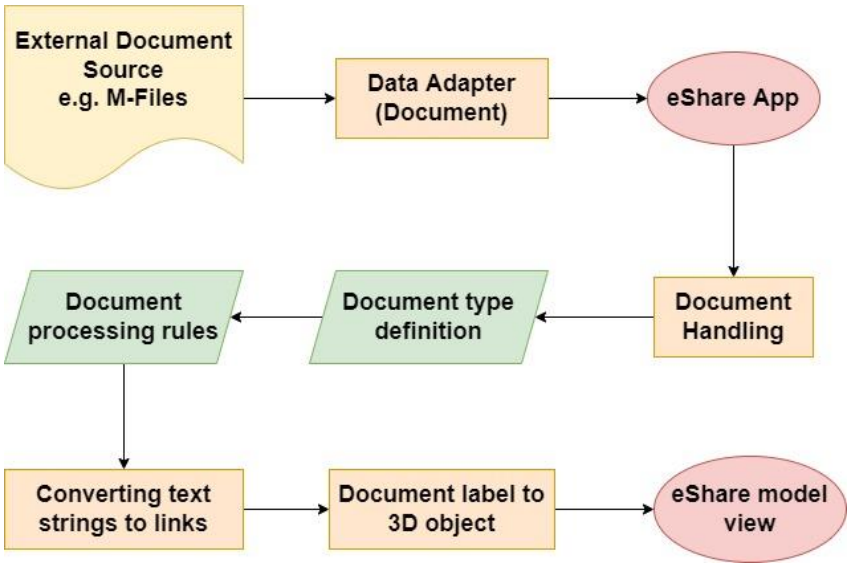

Figure 17: Document processing in eShare

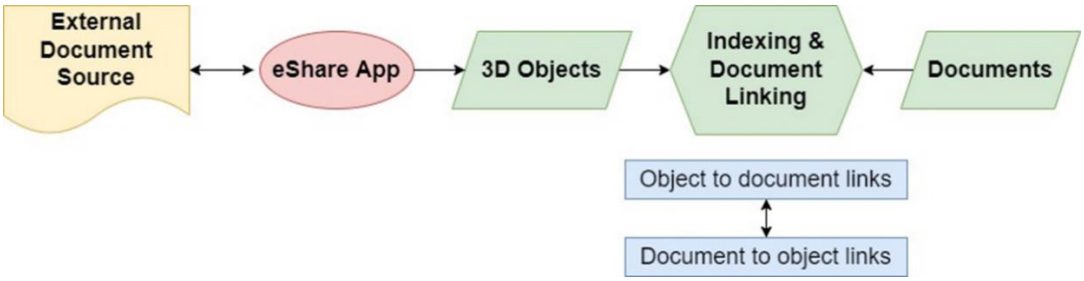

Figure 18: External document to object linking

eGo (Windows tablet version of eShare)

As mentioned earlier eGo application is the windows tablet version of eShare application. eGo has all the functionality that eShare has. eGo application is a great tool for the plant site visit and supervision. It is quite handy to carry a tablet during a site visit. eGo has the same information as eShare which means user have the access to the plant model, engineering data and project related documents during the site visit. Instead of carrying physical documents and diagrams user can just carry the tablet that have all the necessary information. Markups in eGo makes site visit even more easier, as it is possible to make remarks, comments and change requests with markups in eGo. The ability to take pictures with eGo and to attach them with the markups gives more detailed information of the plant site status. eGo improves the communication between the site and office, as it is synchronized with eShare.

eGo have the built in QR code scanner which can read QR code from documents generated from Cadmatic application. It is possible to read the QR codes in printed documents from eGo that contains information regarding model objects and object groups. Scanning the QR code redirects to the linked object and object groups and user can see the available information. If customer sites have their own QR codes that is not generated from Cadmatic eShare, it is still possible to read the QR codes with eGo by configuring a script.

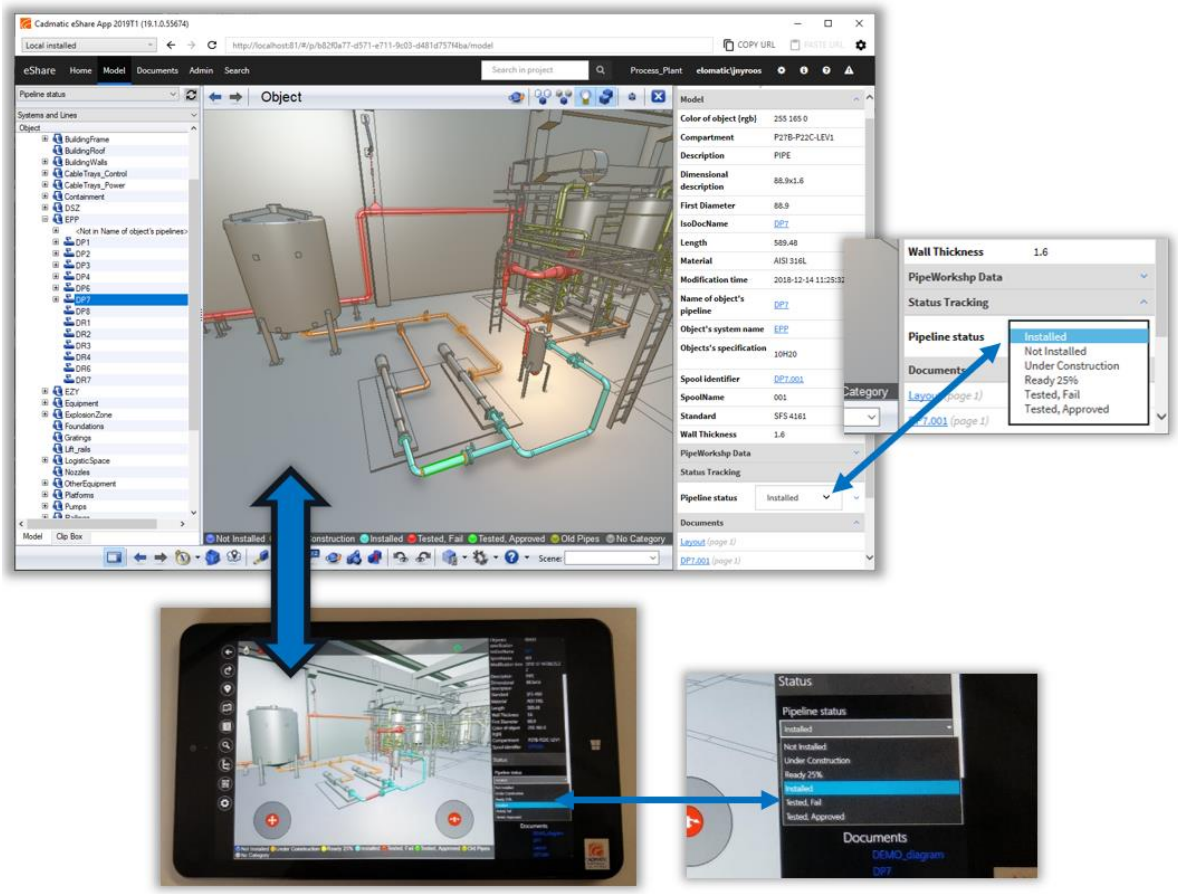

Figure 19: eShare and eGo synchronization (Demo) (Global Engineering IT, 2021)

4.3 Data integration in eShare

The diagram below shows current data flow in eShare. Engineering information from Amigo, Comos and Esten are collected into intermediate database. eShare reads engineering data (Attribute values) from the intermediate database.

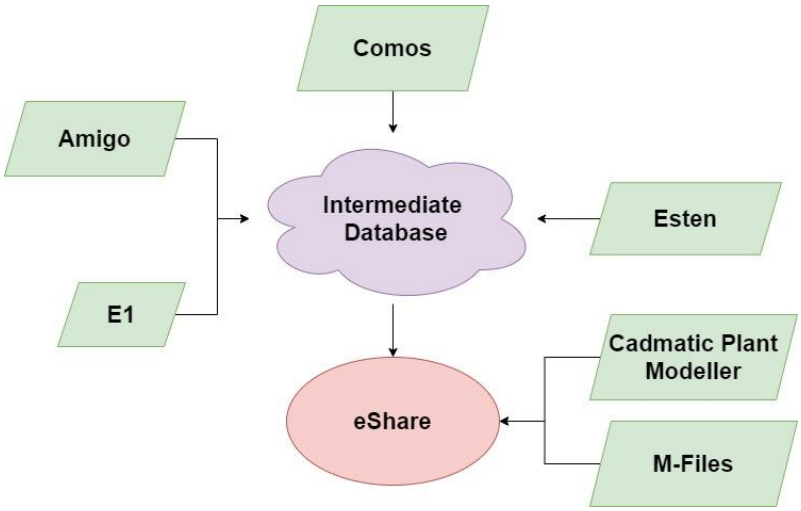

Figure 20: Data integration in eShare (Global Engineering IT, 2021)

eShare uses exported reports from JDE E1 (ERP Software). M-Files owns the document coding which is based on KKS code. Cadmatic plant modeler publishes the latest model in eShare.

4.4 Evaluation of eShare as a plant digital twin platform

As previously addressed, depending on the industry and the use case, the concept of digital twin can convey different meaning. In SFW, with the implementation of eShare the focus is on acquiring plant digital twin platform. The roadmap to acquire a plant digital twin platform can be described in sequential stages. With Cadmatic eShare SFW is making sure the development of the early stage of the roadmap that will be the base for the next steps. Currently, SFW projects are available in eShare. Both old and new projects have been configured in eShare environment. New projects that are starting with Cadmatic plant design are also configured in eShare. To be considered as plant digital twin, a platform must have few key capabilities. At this early stage, it is logical to evaluate eShare as a platform, whether it fulfils the requirement of early development of plant digital twin and also, does it possess the capability for the future development. For this thesis, the evaluation of eShare platform can be done from the following perspectives:

Digitalization

First steps towards plant digital twin involves digitalization of plant information which means the ability to have plant related information in digital formats. Digitalization limits the use of physical mode of information sharing. eShare provides a great support in digitalization with its specially tailored tools and features for the process industry. For example, Cadmatic eShare and eGo application makes plant site visit truly digital. It omits the use of physical documents (2D drawings, P&ID diagrams in paper) during the site visit.

Integration

Integration is one of the major keywords in terms of plant digital twin. In this context integration means the ability of a platform to integrate information from different systems. When it come to the interoperability of eShare, it possesses substantial capacity. Interoperability is the ability to exchange information with other systems in real time. As mentioned earlier, eShare provides significant adapters that can connect to different data sources and retrieve project related information. Availability of the adapters in eShare enables the opportunity to integrate project related information from different sources. Currently eShare integrates information from databases, document management systems and engineering applications. In future development of eShare, it will expand its integration level to more systems that will bring value to the SFW projects.

Visualization

Integrating information from connected data sources into a single platform have a lot of advantages in the execution of SFW projects. The ability to visualize the information in a meaningful way gives added benefits in the successful execution of projects. Cadmatic eShare have the ideal user interface that visualizes the connected information in a user-friendly way. eShare model viewer combines the 3D CAD model of projects with project related documents and engineering data in a single window. This eShare UI gives user a more informative and interactive experience.

Information Sharing

One of the core principles of eShare application is to share information among users digitally and efficiently. eShare have features and tools that makes the information sharing among the project workers smooth and real time. eShare models are directly coming from the Cadmatic plant design software and it updates the model to the latest version in a predefined time interval. This means everyone in the project team have the access to the latest model. eGo application makes the on-site/office communication more efficient. Features like markups and smart points makes design collaboration, change management and communication more efficient.

5 BENEFITS OF USING ESHARE IN SFW

5.1 Digital twin centric organization

The concept of digital twin centric organization reduces the information gap between different departments inside an organization. The core idea of plant digital twin involves combining information from different departments and developing a virtual copy of the plant. When information is combined from different sources the system becomes more transparent. eShare combines 3D plant design and 2D documents with engineering data that which gives user a better understanding of the plant. Only the plant design or the attribute values doesn´t tell the whole story.

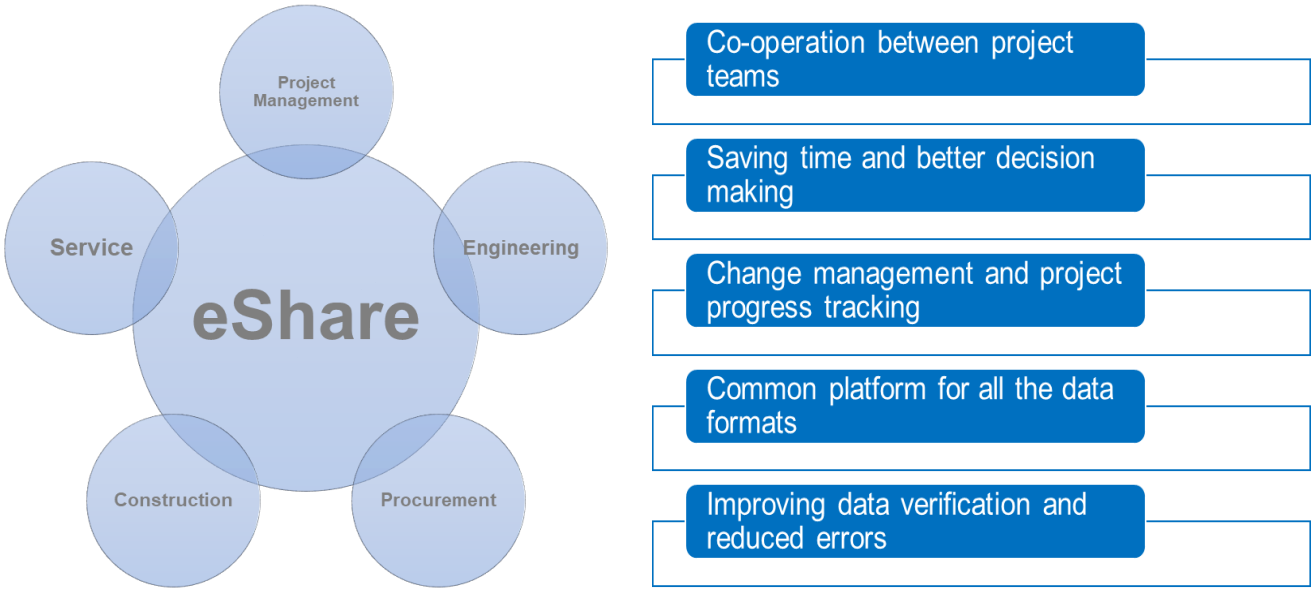

Figure 21: Digital twin centric organization with eShare

5.2 Connecting and visualizing static data

eShare currently possesses both SFW proposal and execution projects. Latest model updates of the projects from the plant design software are available in eShare. At this stage, each eShare project consists of:

- Plant model of the project
- Attributes from model and engineering applications
- Relevant project related documents

Connecting and visualizing the static project data with the interactive 3D model provides user a wide range of benefits in overall project management.

Document Data

Now depending on the rights approved user is able to review models and project related documents from single project window. Connecting object specific documents to the 3D model have significant benefits in terms of project document management. In traditional document management system e.g. File systems project related documents are stored in allocated vaults. Users have to manually navigate through the vaults to find the required documents. This process is time consuming and can be complex without the proper sorting tools. eShare document linking connects object specific documents to the 3D model. In this way user can navigate to the specific object and access only object specific documents which makes the process simpler and effective. eShare is accessing M-files and documents are linked to 3D model with KKS code as the key attribute. eShare doesn´t require to store the documents from M-files which makes the process also logical.

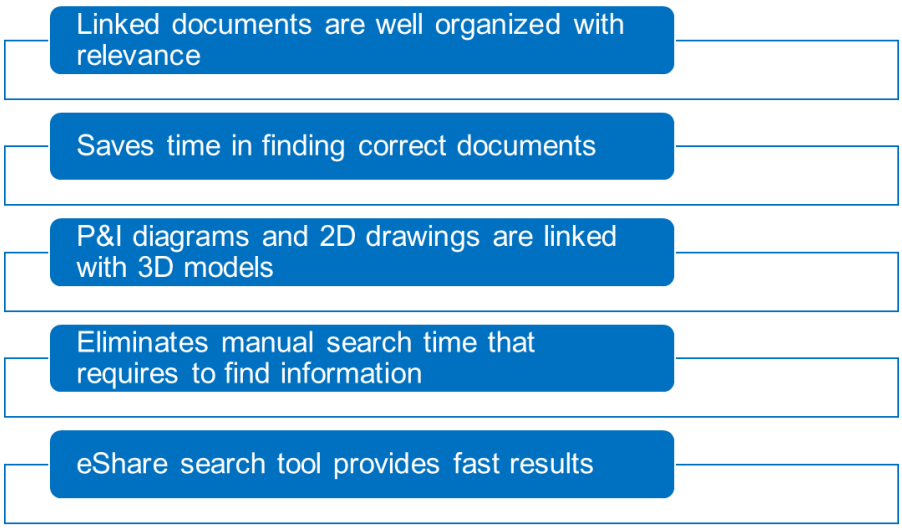

Figure 22: Benefits of linked documents

Data Validation

Data validation tool compares the attributes and their values that are coming from model and Comos. Integration of data validation tool in eShare creates new way of performing inconsistency checking of data. eShare visualizes attribute values from both the model and comos. User can compare the attribute values in a single eShare window alongside the 3D model. User can markup any

inconsistencies in the attribute values which is accessible to the designers and engineers through eShare. Designers and engineers can update the attribute values according to the markups.

5.3 Benefits of eShare over Navisworks

One of the core principles of implementing eShare is to replace the use of Navisworks both internally and externally. Exceptional use of Navisworks will be still available in terms of customer specific requests. SFW uses Navisworks to review the 3D plant models and objects. eShare provides all the necessary tools and features that requires for the model review process. One of the key benefits of eShare over Navisworks is that user can share information regarding model review using markups and smart points. Inclusion of markups and smart points makes the user´s task simpler and more interactive because with Navisworks user needs to report the changes in separate documents.

eShare	Navisworks
User friendly and easy access to projects	Navigation to project is time consuming
Assisting model review with features like markups and smartpoints	Only limited model review features
Change request can be made with markups	Seperate documentation is required for change request
Integration of attribute values with the model provides user more acqurate experience	Only limited attributes are available
Linking of 2D diagrams with 3D model objects makes the experience a lot more informative	There is no access to 2D diagrams and object related documents

Figure 23: Benefits of using eShare over Navisworks

6 OPPORTUNITIES IN SUMITOMO SHI FW

6.1 Development of eShare platform

Currently SFW projects are available in eShare based on the built-in features and tools of the platform. One of the objectives of this thesis was to identify the future development opportunities of the platform. During this thesis built-in features and tools of the eShare platform were tested. From the results of the tests future development ideas were generated. Development discussions were conducted with potential future users and feedbacks were collected from the users. eShare already improves the processes how designers and engineers collaborate and perform their tasks. eShare enhances the efficiency of collaborative design work in SFW. eShare provides great capabilities to be developed as a more functional plant digital twin platform. To achieve the functional plant digital twin platform numerous development tasks needs to be performed. The range of the development tasks is comprehensive but considering the requirement of SFW, priorities can be put into several

areas. In the following development plan, some of the focused development areas are mentioned and the initial steps of the development process are introduced.

One of the major advantages of Cadmatic eShare is the availability of windows tablet version application eGo. eGo offers many opportunities that can improve SFW project execution from different aspects. To enable the use of eGo few developments need to be performed. Specially there can be updates in UI (User Interface) and tools can be tailored according to the SFW operational requirements. Cadmatic eShare for Hololens provides the ability to integrate digital 3D models which are configured in real world environment. (Cadmatic eShare, 2022) Use of augmented reality creates new opportunities in SFW project management and gives realistic experience of the plant from the office. To implement the AR (Augmented Reality) technologies 3D models needs to be configured in eShare for hololens and necessary tests needs to be performed before taking it into use.

eShare platform development	Step 1	Step 2	Step 3
Point cloud integration	Investigation on point cloud formats	Importing point clouds	Real time point clouds
Advanced user management	Scheduled user group update to ommit manual task	Synchronization with different AD groups	User rights to customers and subcontractors
eGo (Tablet version)	Development of the User Interface	Development of tools according to the need of SFW	Testing the application on site
QR code functionality	QR code use in delivered parts	QR code reading script for external sources	Use of QR codes in inventory management
Visualization	Defined object groups and color coding	Development of document tree visualization	Improvement of visualization control
VR, AR integration	Development of VR,AR models	Testing VR,AR models	Use of VR,AR models with MS hololens
Continuous development	Optimizing built in tools and features	Developing new tools to support SFW technology	Expanding the use

Figure 24: Development plan of eShare

6.2 Integration of additional systems into eShare

To expand the use of eShare, it is required to integrate more systems in the platform. eShare have the capacity to integrate multiple SFW systems that will bring more users and it will be even more informative. As a part of this thesis investigation was performed to identify the potential systems that can be integrated to eShare platform. In this context, integration means the ability to import information from the systems and visualizing it to the users.

SFW provides digital service solutions through in house digital service department. Digital service collects real time plant data with IoT (Internet of things) and Sensor technologies and uses this data to provide various services for example predictive maintenance. Integrating real time plant data into eShare model will allow engineers and designers to have more comprehensive understanding of the plant and eventually help them to improve future designs. Not only engineers and designers but also SFW service department will be hugely benefitted from the real time data integration to the eShare model.

One of the future development plans of the eShare is to provide support to the SFW customers. To sell the eShare service to the customers it needs to be ready according to the demand of the customers. eShare projects will be configured considering the requirements of customer and information from the customer will be integrated into eShare.

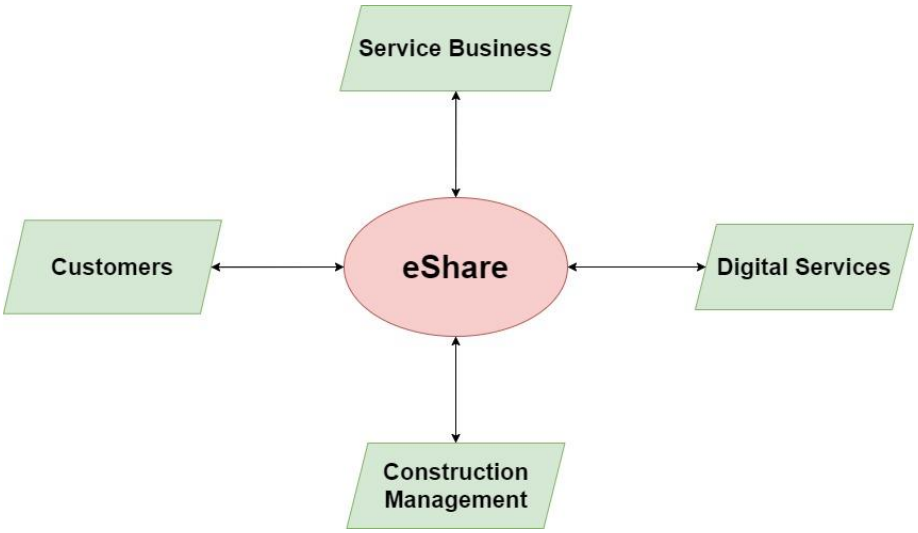

Figure 25: eShare integrating additional systems in future

7 RESULTS

The process of this thesis was carried out according to the objective. As the thesis was written under Global Engineering IT department, eShare environment setup was carried out incorporated with the EIT engineers. EIT engineers contributed to the thesis by demonstrating SFW engineering applications. The data flow of the internal applications was also explained by the EIT engineers.

Sumitomo SHI FW will receive a draft of the thesis which will be available for further development. The candidate will participate in future development of the plant digital twin platform as an application support in SFW. This thesis will act as the support manual in the prospective development of Cadmatic eShare. This thesis introduced the concept of plant digital twin to SFW by using eShare as the plant digital twin platform. Key attributes and tools of eShare that enables the future expansion of the platform were also identified during the thesis process. Moreover, current benefits of implementing eShare in design and engineering departments of SFW were also presented in this thesis.

The EIT engineers have provided continuous feedback on this thesis. Thus, it was fixed and updated on a continuous basis throughout the process. Both supervisors from SFW and Savonia gave positive feedbacks regarding the outcome of the thesis.

8 CONCLUSIONS

This thesis was written for Sumitomo SHI FW by fourth year Mechanical Engineering student of Savonia University of Applied Sciences. One of the key points this thesis brings out is the benefits of having industrial networks. The candidate was acquainted with Sumitomo SHI FW during one of the cooperative projects of Savonia. Following the cooperative project, the candidate had grown interest towards the organization which led to the thesis topic. Cooperative projects with industries help students to identify the need of the companies and prepare themselves accordingly. On the other hand, the companies can utilize the creative ideas from the students.

The cooperation with SFW from start to finish of the thesis was outstanding. SFW have valued and welcomed new ideas from the candidate and provided necessary assists in the implementation of new ideas. SFW associates gave both positive and constructive assessment on the thesis which helped the candidate to move forward.

All in all, this thesis empowered the candidate to grow as a professional in the technology industry. Communication, Presentation and Documentation are some of the professional skills that was necessary during the process of the thesis. Application presentation and demonstration were one of the major tasks during the process. Documentation of the user and administration manual of eShare helped the candidate to gain industry grade documentation skills. The implementation of Cadmatic eShare will continue and the candidate will support the process as an application support under Global Engineering IT department of Sumitomo SHI FW.

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