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PROPOSAL FOR SAP PLANT MAINTENANCE MODULE ROLLOUT PREPARATIONS

Prysmian Finland, Oulu

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ABSTRACT

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The purpose of this research was to analyze legacy maintenance system data and create a proposal for SAP Plant Maintenance module rollout preparation for Prysmian Finland Oulu plant. The preparation proposal was built keeping in mind the future SAP Plant Maintenance rollouts in other Prysmian plants.

This thesis consists of introduction about Enterprise Resource Planning solutions history, and concentrates thereafter on theory and functionalities of plant maintenance solutions. Two examples of plant maintenance solutions of Computerized Maintenance Management System and Enterprise Resource Planning System are introduced. The SAP Fiori background is explained in the theory part and user interface functionalities in the results part.

The results portion presents user surveys together with proposals for plant hierarchy, technical objects coding, user profiles and groups, work order types, user training, and spare part management.

In the discussion chapter, suggestions are presented for what organizational functions are important to be involved in the future rollout preparation process.

The plan suggested in this thesis work is meant to serve as guidance for SAP Plant Maintenance module rollout preparation for Prysmian Finland Oulu plant. Later, the same modules will be implemented in other Prysmian plants in the Nordic region.

Part of the information is confidential and cannot be published in this report.

Keywords: Enterprise Resource Planning, plant maintenance, mobile applications, process improvement

CONTENTS

ABBREVIATIONS

Business Suite	A bundle of business applications in ERP
BoM	Bill of Material
CRM	Customer Relationship Management
ECC	ERP Central Component
ERP	Enterprise Resource Planning
FIORI	SAP solution for mobile devices
FL	Functional Location
GUI	Graphical User Interface
HANA	SAP's Latest in-Memory Platform
HSE	Health, Safety and Environment
HTML5	Hypertext Markup Language revision 5
IMG	Implementation Management Guide
OEM	Original Equipment Manufacturer
PCS	Process Control System
PM	Plant Maintenance
QR Code	Quick Response Code
SAP	System Analysis and Program Development
SCADA	Supervisory Control and Data Acquisition
SCM EhP	Supply Chain Management Enhancement Package
TCODE	Transaction Code
UI	User Interface
UX	User Experience

1 INTRODUCTION

Industrial work and the working environment have changed significantly during the past decades. Unlike before, the laborious manufacturing processes are now utilizing automatization, data processing is computerized, and efficiency in all functions plays an important role. Practices in plant maintenance have changed, too. In the past, companies put emphasis on the break-down repairs, barely keeping any record of the occurred incidents. Development is inevitable, and the approach started turning towards preventive maintenance when the availability of maintenance software increased.

The main purpose of maintenance activities is still the same: to keep the manufacturing machinery running. Maintenance is not just a stand-alone function, but is integrated with a company's other functions. The maintenance process has different components, such as people, machinery, resources, management, and software. Therefore, process improvements can be approached from many aspects. This work concentrates on the maintenance process's development and improvement from the software implementation aspect.

The implementation project of a new software or application can be challenging due to resistance to change, inadequate planning, unrealistic timetables, insufficient resources, and numerous other reasons. What if you could prepare your organization and stakeholders for the project in advance? What if you could have a chance to give a short introduction about what is going to happen in the project, possible changes it might require, a rough project plan, and expected benefits?

This thesis derives from the need of having comprehensive control over the Prysmian Oulu plant maintenance process and assets and to advance the software implementation process with an inclusive analysis of the project prerequisites. Control enhancement is realized by implementing a Plant Maintenance (PM) module of System Analysis and Program Development (SAP), Enterprise Resource Planning system (ERP). SAP Implementation consists of the PM module and the new user interface solution Fiori, which enables on-site mobile usage of the maintenance module. The final goal of the work is to describe the essential steps from defining the project prerequisites to the final plan of preparations before the actual implementation of the PM module and Fiori.

1.1 Objectives

The aim of this thesis is to:

-prepare a suggestion for the master plan for SAP PM and Fiori implementation, and roll out a project applicable for Oulu and other Prysmian plants in the Nordic region;

-create a systemic data package for maintenance organization and other stakeholders to prepare them for the SAP PM implementation;

-generate systematic coding for technical object hierarchy, together with the purification and structuring of data from current and legacy maintenance databases.

1.2 Methods

A qualitative research approach with interviews was chosen as the main data collection and research method. This method has proven to be the most suitable since the project is concentrating on a transition from an external service provider plant maintenance program to an internally managed program implementation, and the most accurate information and know-how about the processes lies within the company's own organization.

2 PRYSMIAN

Prysmian Group is a world leader in the energy and telecom cable systems industry. The company has about 140 years of experience and over 19,000 employees worldwide. In 2015, Prysmian Group had 88 plants in 50 countries and reached sales totaling 7.5 billion Euros. Prysmian is a public company, listed on the Italian Stock Exchange. (Prysmian Group 2016, cited 10 Oct 2016.)

In the field of energy systems, Prysmian supplies solutions for power transmission and distribution, underground and submarine cables, special application cables for various industries, and medium and low voltage cables for infrastructure and construction sectors. Solutions for the telecommunications industry consists of optical fibers, optical and copper cables and accessories for voice, video and data transmission. (Prysmian Group 2016, cited 10 Oct 2016.)

Prysmian Finland's headquarters are in Kirkkonummi, Finland. The company's roots date back to 1912. The company has two production facilities: one in Kirkkonummi and one in Oulu. Prysmian Finland was created after the merger of Draka Finland (Oulu) and Prysmian Finland (Kirkkonummi) in 2011. Prysmian Finland works in close cooperation with its Nordic and Baltic intercompany partners in Sweden, Norway, Denmark, and Estonia.

3 ENTERPRISE RESOURCE PLANNING SYSTEMS

Before establishing an implementation project of a new SAP module usage, it is important to understand the SAP ERP system, its functionalities, and environment. This chapter will provide the reader with background information about ERP development and SAP ERP.

Along with the development of microelectronics, computer hardware, and computerized data processing, the early stage development of Material Resource Planning (MRP)-systems -- predecessor of ERP systems -- started. Companies began to have the need for an integrated enterprise data management system that would provide enterprise-wide, inter-functional coordination of the business. In the past, large scale companies had concentrated on developing their own software within the company; but later on, software packages were bought from external suppliers. (Peeters 2009, 56-69.)

Different departments in the company have their own specific functions and traditionally the in-house developed software was optimized for their purposes only. An integrated system was needed for effective management and control of the business functions, such as Materials Management (MM), Production Planning (PP), Sales & Distribution (SD), Controlling (CO), Financial Accounting (FI), Quality Management (QM), Project Systems (PS) and Human Resources (HR). In the early 1970's, engineers of the company IBM suggested to have a single application that integrated all the business's functions where any action taken would appear simultaneously to each of the areas affected. (Worster, Weirich & Andera 2012, 46.)

ERP systems are modular software packages which were, in the beginning, targeted to the manufacturing industry. They covered the functions for planning and managing the main fields of businesses like sales management, accounting and financial affairs, and production management. (Parthasarathy 2007, 1-2.)

In 2015, the 10 largest ERP system suppliers covered 28% of the total market, the largest ERP supplier being SAP with a 6% share (fig.1).

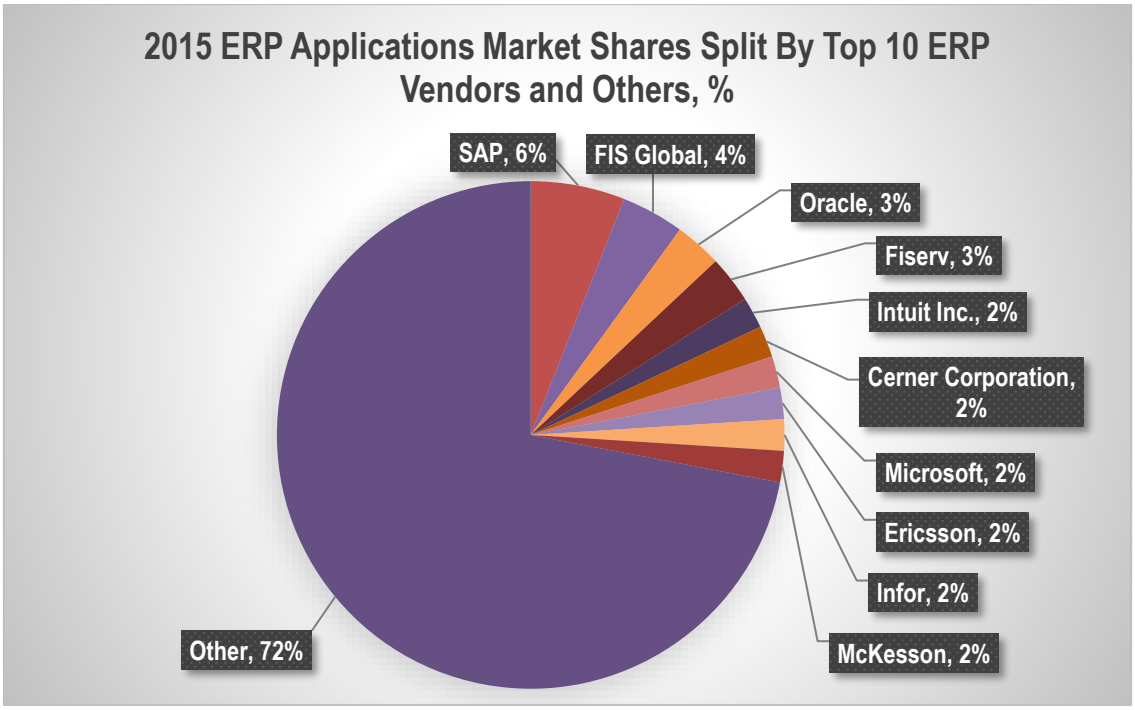

FIGURE 1. Top 10 ERP Software Vendors & ERP Applications Market Shares (Top 10 ERP Software Vendors and Market Forecast 2015-2020.2016, cited 27.10.2016)

In 2015, 28% of the global ERP applications market – including ERP Financial Management and ERP Services and Operations applications – were covered by the 10 largest ERP software vendors. SAP was the leader with a 6% share of the total market of nearly $82.1 billion (Top 10 ERP Software Vendors and Market Forecast 2015-2020.2016, cited 3 Nov 2016).

3.1 Overview and history of SAP Company

The history of the SAP corporation dates back to 1972 when five former IBM workers established a company they named SAP Systemanalyse und Programmentwicklung (System Analysis and Program Development). The team was determined to develop a software application capable of real-time data processing and enabling clients to integrate their different business processes. Today, SAP is a multinational software corporation that has over 320,000 customers in 190 countries and almost 80,000 employees. (SAP SE 2016, cited 16 Oct 2016.)

In the past the only programs available for enterprise data processing were systems where different business processes had their own separate system without the possibility of integration. Processes such as material management, controlling, human resources, and sales were individual systems. (De Bruyn, Lyfareff & Balleza 2014, xviii.)

Especially in large companies where the amount of data processed in separate systems increased, the launch of an integrated system was warmly welcomed. A new system design where each business process was built under its own module and the integration of the modules, was one of the key factors of SAP's success. (De Bruyn et al. 2014, xviii.)

SAP S/4 HANA is one of the latest solutions for enterprise management. The solution covers Finance, Human Resources, Sourcing and Procurement, Supply Chain, Manufacturing, Marketing, Sales, Service, Asset Management, and Research & Development (Reimagine Business in the Digital Economy Use Cases with SAP S/4HANA 2016, cited 18 Oct 2016).

3.2 SAP structure

The SAP ERP system is a structure of real-time linked modules for various processes where each module consists of numerous, small programs called transactions. They relate to the same field of business functionality with a set of screens to enter, change, or display data. (De Bruyn et al. 2014, xvii.)

SAP HANA is SAP's database system based on several existing technologies and it is designed to improve database accesses for reading data without slowing the simultaneous data insertion (Walker 2012, 14-15).

SAP systems consists of set of modules designed to run business related functions within a company. Each module contains transactions for entering, changing, and displaying the data. Integrated modules are:

- FI (Financial Accounting)
- CO (Controlling)
- SD (Sales and Distribution)
- MM (Material Management)
- PP (Production Planning)
- QM (Quality Management)
- PS (Project Systems)

- PM (Plant Maintenance)
- HR (Human Resources)

(saponlinetutorials.com 2013, cited 26 Oct 2016)

3.3 SAP in Prysmian Finland

Prysmian Finland launched SAP R/3 for the first time in 2002. In 2010, SAP One Client was launched at the Kirkkonummi plant and in 2012 at the Oulu plant. Prysmian Group had made a strategical decision already in 2007 to move from legacy systems to one common SAP ERP system worldwide. In 2016, 70 plants had already launched SAP. The most recent upgrade was on September 12th 2016 when Prysmian Group implemented Business Suite on HANA. (Prysmian 2016, cited 4 Nov 2016.)

4 PLANT MAINTENANCE SOLUTIONS

This chapter aims to introduce four different plant maintenance software and to describe some of the differences between Computerized Maintenance Management System (CMMS) and ERP-systems solutions for plant maintenance. There are several CMMS software and ERP providers in the world which all have their own little functional differences. The following comparison is done between two CMMS and two ERP systems.

A reliable production process requires well-maintained machinery and facilities. Plant maintenance activities can be executed in various controlling systems depending on the size of the business., For example, a small company can benefit more from a cheaper and flexible CMMS system while a large enterprise can benefit more from an integrated and ERP system and its plant maintenance module.

CMMS systems are designed to support their main purpose, maintenance management, while modular ERP systems are multipurpose solutions covering all enterprise functions. No matter which type of solution is chosen, the usability and possible benefits are dependent on the quality and quantity of inserted data: “Any system is only as good as the data that it contains” (Smith & Hawkins 2004, 82).

4.1 Computerized Maintenance Management Systems

“The initial purpose of the CMMS was to streamline the production of the maintenance work orders” (Bloch & Geitner 2006, 403). CMMS’s are specifically designed for maintenance management purposes. Their main functions include work management, fault reporting, machine registry, and spare part management. They can be defined as agile, forward-looking, technical management systems supporting real-time, maintenance needs and efficient work management.

4.1.1 MaintALMA

ALMA Consulting Ltd has been in the market for the past 30 years and provides a maintenance solution called MaintALMA. It is scalable system based on an ALMA-plant model which is integrated

into the system and represents the maintenance plant and hierarchy of production processes. In MaintALMA, the plant model's basic data consists of equipment, machinery, spare parts, and all related documentation which is accessible for maintenance personnel anytime. The program is suitable even for small-scale businesses, but can also be implemented in larger enterprises with multiple production plants and complex company structures. (ALMA Consulting Oy 2017, cited 12 Jan 2017.)

MaintALMA includes the following features:

- cost management and reporting
- various calendar views for different users
- planning, guiding and monitoring maintenance tasks
- diaries
- storage and materials management
- technical documentation
- registers of materials, products, customers, suppliers etc.
- project management
- work safety maintenance
- risk analysis
- mobile solutions (ALMA Consulting Oy 2017, cited 12 Jan 2017.)

For the maintenance personnel, the event monitoring feature makes it possible to align faults to the right location and equipment. The program offers several possibilities to maintain different classifications, like criticality of a certain spare part. It also allows for follow up of individual equipment's running times and record of notifications per shift. (ALMA Consulting Oy 2017, cited 12 Jan 2017.)

4.1.2 Arrow Novi

Finnish Arrow Engineering Oy has a new CMMS product called Arrow Novi, launched in 2014. This product is specially designed for the manufacturing industry and has suitable features for various equipment maintenance activities. It is suitable also for equipment manufacturer maintenance services and supports after-sales business. (ARROW Engineering 2015, cited 11 Jan 2017.)

The program operates on a browser and therefore does not require installing on a work station; it can be accessed on any tablet or smartphone. GUI can be modified to suit the personal requirements of an individual user. The program's main functions include:

- Work management and fault reporting
- Equipment register
- Technical documentation database
- Storage and spare parts management
- Reporting and analyzing
- Integration to customer's systems (ARROW Engineering 2015, cited 11 Jan 2017.)

As a CMMS, Arrow Novi is a versatile solution which has numerous features that make the program user-friendly. The fact that it can be integrated in to an existing ERP system makes it a strong plant maintenance solution candidate for enterprises.

4.2 Enterprise Resource Planning Plant Maintenance Modules

ERP systems commonly have their own modules for plant maintenance in an integrated system. The systems are considered to be more complex and approaching maintenance from a financial management point of view. ERP systems are suitable for larger enterprises as system complexity can be a disadvantage for smaller companies. The program customization and configuration required to meet the user needs can be more complicated and costly in ERP-systems than in CMMS.

4.2.1 Oracle JD Edwards

Oracle's, JD Edwards World Plant and Equipment Maintenance Management, is a plant maintenance system module in an integrated ERP system. Oracle's solution provides detailed enterprise-wide visibility of maintenance activities. Integrated preventive maintenance provides control of equipment with details like:

- Acquisition, warranty, and depreciation information
- Usage history and current equipment status
- Budget and actual costs, including maintenance

- Internal and external invoicing rates
- Incident and repair history
- Scheduling of preventive maintenance based on adjustable usage thresholds (ORACLE 2012, cited 5 Jan 2017.)

Oracle provides a mobile solution, JD Edwards EnterpriseOne Mobile, which delivers an array of mobile applications. These fit-for-purpose, role-based applications run on any mobile device and utilize Oracle's Mobile Platform and Mobile cloud service. To meet specific user requirements, JD Edwards provides an integrated development platform for customizing and developing applications. (ORACLE 2012, cited 5 Jan 2017.)

4.2.2 SAP PM

SAP Plant Maintenance module is a comprehensive solution that provides tools for maintenance activities within a company. A maintenance object is composed using technical objects representing the machinery and the actual plant model (Jayant 2016, chapter 5).

The SAP PM module consists of activities such as: management of technical objects, maintenance processing, and preventive maintenance. It is used to comprehensively plan, schedule, and execute the daily maintenance activities with integration to other SAP modules. For mobile use, the system can be accessed by using SAP's own solution, Fiori.

Technical object management consists of activities including:

- Inspection: to measure and follow the actual condition of a technical object.
- Preventive maintenance: to foresee the need of repairs and upkeep the optimal condition of technical object.
- Repair: to measure and restore the technical object.
- Other maintenance-related activities (SAP Help 2017a, cited 13 Jan 2017.)

Maintenance processing helps to control the actual maintenance work conducted in the maintenance plant. The process consists of three areas:

- Maintenance notification: to report a malfunction or to describe the technical object condition

- Maintenance order: to make detailed maintenance plan and to monitor work progress and settle the maintenance costs
- Maintenance history: to save the important maintenance data for reporting and evaluation (SAP Help 2017b, cited 13 Jan 2017.)

Preventive maintenance is a long-term process that aims to ensure high usability of equipment and functional locations, and to minimize the downtime caused by repairs. This feature supports the performance-based maintenance if Measuring Points or Counters are in use for technical object condition control.

The Preventive Maintenance component can be used to:

- Store task lists of activities to be performed
- Specify the extent of inspection work, preventive maintenance, and scheduling of the activities
- Specify the recurring maintenance frequency
- Specify the cost-based assignment of inspection activities and preventive maintenance
- Evaluate costs of future preventive maintenance and inspection work (SAP Help 2017c, cited 13 Jan 2017.)

4.3 Summary

MaintALMA, Arrow Novi, Oracle JD Edwards, and SAP programs have many common features. They all support preventive maintenance planning, provide tools for reporting, and allow real-time work order monitoring. All programs provide user-friendly mobile access on any portable device. Their main purpose is to comprehensively support all maintenance activities and other closely related functions, like purchasing and spare part management.

CMMSs are focusing on managing the maintenance work to improve the reliability of the maintenance objects. Maintenance modules in ERP systems, on the other hand, are designed to allow the executive level to ensure the maximum productive value of the asset and to monitor the maintenance cost development. Another important aspect is the risk management, especially in the companies where a breakdown of equipment can cause significant loss of manufacturing capacity or has remarkable environmental impacts. Generally speaking, ERP systems have broader range of

program tools and integration especially with accounting, human resources, and manufacturing functions. (Bloch & Geitner 2006, 403.)

For small and medium-size companies, the modern CMMS has enough features to run all necessary maintenance tasks, upkeep machinery database, plan and execute work orders, and plan preventive maintenance. ERP systems can handle cross-functional processes, like order-to-cash, in the same system. All activities are handled in sequence in the same system, which facilitates the monitoring of the process. (Loshin 2012, 16.) Based on ERP's integrity, large scale enterprises are more often choosing this system with a PM module as they need an integrated solution with appropriate modules to manage the large organization and its operations. It is often the case that an enterprise that has deployed an ERP system to expand the use of it by introducing new modules instead of investing money to a new external system like CMMS.

5 SAP PM

The SAP PM application module is designed to cover maintenance activities and the control of both machinery and facilities. SAP PM helps to integrate and optimize the scheduling and planning of inspection, preventive maintenance, and repair activities. Successful implementation of the PM module brings benefits in various ways: all maintenance work is managed in one system, better communication within the organization, full usage of Bills of Material (BoM), clear set up for maintenance plans, reporting, and better usage of production capacity.

PM functions are divided into four activities:

- Inspection: all measures that indicate the condition of a technical object
- Preventive maintenance: all measures that help to keep technical system in optimal condition
- Repair: all measures that recondition a technical system
- Other maintenance activities (SAP Help 2017a, cited 3 Nov 2016.)

All data of actions taken in above mentioned activities in SAP PM are stored to a common database and are available in other modules. In production, all maintenance actions aim to minimize the risk of machine breakdowns and to reduce the possible machine downtime.

Depending on the field of business, size of the enterprise, number of plants, requirements for the maintenance, and management decision, the PM structure can by described in the system in various ways. Basic components to be used in all cases are maintenance planning plant, maintenance plant, and technical object.

The following paragraphs explain topics that are important to comprehend before the planning stage of system configuration is started. The way the system is configured will greatly impact the usability of the PM module.

5.1 Maintenance Plant

The maintenance plant is used to indicate the location where the technical objects are installed and actual maintenance activities are performed. A PM structure can consist of several maintenance plants. (SAP Help 2016a, cited 3 Nov 2016.)

A company can have several units at its location where maintenance activities can be performed. These units can be warehouses, production, or service premises. For planning and scheduling purposes, maintenance plants are assigned to one or more maintenance planning plants.

5.2 Maintenance Planning Plant

In SAP PM's structure, all maintenance activities are performed in either the Maintenance Plant or the Maintenance Planning Plant. In SAP PM the planning function in a plant is an optional feature in addition to maintenance.

The maintenance planning plant is used to indicate the plant where maintenance tasks are planned and prepared for the technical object. Maintenance planning can be organized in three different scenarios:

- Centralized maintenance planning
- Decentralized maintenance planning
- Partially centralized maintenance planning (SAP Help 2016b, cited 3 Nov 2016.)

Maintenance planner groups are established to maintenance planning plants. Groups consist of one or more persons that plan and execute the activities in the maintenance plants. The activities performed by maintenance planner groups are:

- Defining task lists
- Planning materials, based on the BoM and related orders
- Scheduling plans for the maintenance activities
- Creating maintenance notifications
- Executing maintenance orders (SAP Help 2016b, cited 2 Nov 2016.)

5.3 Technical Objects

After the decision of how to organize plants in a company has been made, the existing technical systems have to be structured using either Functional Location (FL) equipment or their combination. The decision of how to represent a technical system in SAP depends on the field of business, organization of maintenance planning, and whether or not it focuses primarily on the structure of the entire company. (SAP Help 2016b, cited 28 Oct 2016.)

If a company wants to establish its data processing supported system for maintenance properly, the actual technical systems need to be structured on the basis of technical objects. Benefits of a good technical system structure are:

- Reduction of time used for managing technical objects
- Simplified processing of maintenance
- Data entering time during maintenance processing decreases significantly
- Faster and precise maintenance data evaluation (SAP Help 2016b, cited 28 Oct 2016.)

It is essential to pay attention to the structure planning of technical objects well in advance to avoid extensive changes at later stages. The chosen structure should reflect the structure of maintenance planning in the entire company. This involves accurately defining the maintenance plants as well as maintenance planning plants.

When subdividing the structure into smaller units from a technical perspective, it is important to concentrate on the tasks performed on the technical object. In object-related structuring the system is subdivided into pieces of equipment which represent the objects where maintenance activities are performed. A maintenance system can be built as a hierarchical equipment structure or as equipment at functional locations. Another way is structuring the system purely from an accounting perspective; this way of structuring refers to cost centers or tangible assets, and can be used in addition to technical perspective structuring. (SAP Help 2016b, cited 11 Dec 2016.)

5.3.1 Functional Location

In technical objects the functional location represents the site where the technical tasks are performed. A functional location can be, for example, a unit in a production line that represents the function. A production facility can be structured using functional locations as technical objects and represented in hierarchical structures. This enables maintaining data centrally, and hierarchical data transfer from higher levels to lower levels. (SAP Help 2016b, cited 11 Dec 2016.)

Every functional location is independently managed in the system and allows the following actions to an object:

- Individually managing all data from maintenance perspective
- Performing individual maintenance tasks
- Keeping record of maintenance tasks
- Collecting and evaluating data over a long period of time (SAP Help 2016c, cited 11 Dec 2016.)

5.3.2 Equipment

Another technical object in SAP PM module is an equipment. It is an individual object which has its own characteristic master data values and is independently maintained and managed in the structure. Actions related to equipment include:

- Managing object's individual data from maintenance perspective
- Accomplishing maintenance tasks for the object
- Collecting data of related maintenance tasks for the object
- Collecting and evaluating historical maintenance data (SAP Help 2016d, cited 2 Nov 2016.)

In PM hierarchical structures, a technical object can be either FL or equipment. Before implementing equipment as a technical object, the following areas of requirement need to be considered. Creating an equipment as technical object is needed if:

- Data of construction year, manufacturer, warranty period, and usage locations need to be managed

- Regular, planned, or damage resulted maintenance tasks are performed for the object
- Maintenance tasks record must be kept
- Object technical data is to be collected and evaluated
- Maintenance task costs are to be followed
- Usage time records at FL are needed (SAP Help 2016d, cited 2 Nov 2016.)

In case equipment are used as technical objects in the hierarchical structure, installation and dismantling of equipment is possible at FL. An equipment can be dismantled from the FL and another technically identical equipment can be installed as a replacement. Both equipment usage data is recorded and can be retrieved from the database. (SAP Help 2016c, cited 2 Nov 2016.)

5.4 Measuring Points and Counters

For performance-based preventive maintenance it is possible to configure an automatic work order creation which is based on the actual condition of a technical object. This type of maintenance can use measuring points and counters that follow values such as temperature, humidity, volume, or mileage. Measuring points and counters are located on functional locations or pieces of equipment. A measuring point takes measurement readings in particular intervals and triggers a maintenance work order when preset limit is reached. (SAP Help 2017d, cited 21 Jan 2017.) Another option is a counter that follows a counter reading in the technical object and generates a work order when certain preset counter limits are exceeded (SAP Help 2017e, cited 21 Jan 2017).

The actual reading in both cases can be collected either automatically or manually. If a system is not equipped with suitable sensors the readings can be collected by maintenance workers in planned intervals. To enter the readings, a classification system has to be first created where measurement characteristics are defined. These classifications can be then assigned to technical objects. (SAP Help 2017f, cited 21 Jan 2017.) In cases where a technical object's condition is monitored with any real-time Process Control Systems (PCS), the data can be transferred to SAP (fig. 2). Data from PCS is sent to Supervisory Control and Data Acquisition (SCADA) System and further to plant maintenance PCS interface. (SAP Help 2017g, cited 21 Feb 2017.)

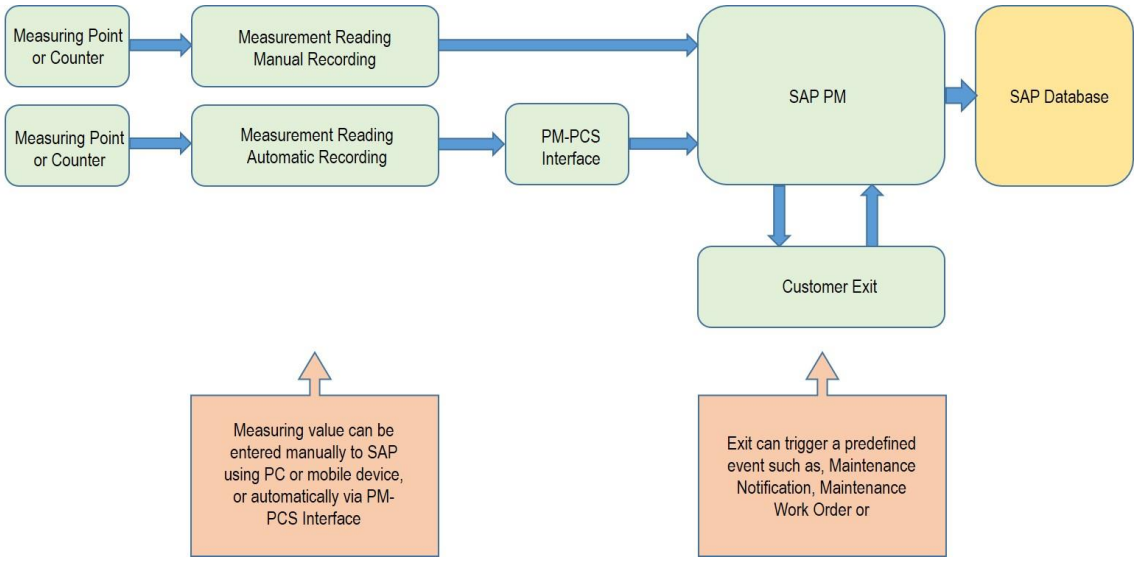

FIGURE 2. Measurement reading transfer to SAP PM. Modified from (SAP Help 2017h, cited 25 Jan 2017)

5.5 Work Centers

Work centers have different definitions and usage depending on which SAP module they are using. A work center can represent a machine, person, or a department and can be distinguished by the work center type. The same work center can be in use for production as well as for maintenance purposes. (SAP Help 2017i, cited 1 Mar 2017.)

For maintenance purposes three different work centers are used:

- Main Work Center: usually represents a department or a person responsible to ensure the actual execution of maintenance work by the performing work center. The main work center creates mandatory data and related master data is automatically copied to work a order at order creation.

- Performing Work Center: represents a person or a group of persons in maintenance order who are performing the work in the operations of an order. The performing work center is managed primarily for cost determination, scheduling, and capacity planning.

- Work Center as Production Machine: represents the object for maintenance activities in a maintenance order. This work center also represents the machine in Production which manufactures the products. This work center is entered to work order only if maintenance

work is executed on a technical object that is a machine in production (SAP Help 2017i, cited 1 Mar 2017.)

A work center has to be maintained on each technical object. Work centers' master data is automatically retrieved when maintenance notifications and maintenance work orders are created. Master data to be maintained varies depending on the type of work center.

5.6 Maintenance Work Order Process

The standard process of maintenance work starts from notification creation using standard Notification Types (Appendix 1). It can be automatically generated based on the maintenance plan, counter value, measuring point limit, or just created by any authorized user. The notification gives information about the location, time of event, and user's description of the malfunction. In cases where spare parts are needed, the process has ten steps (fig 3.)

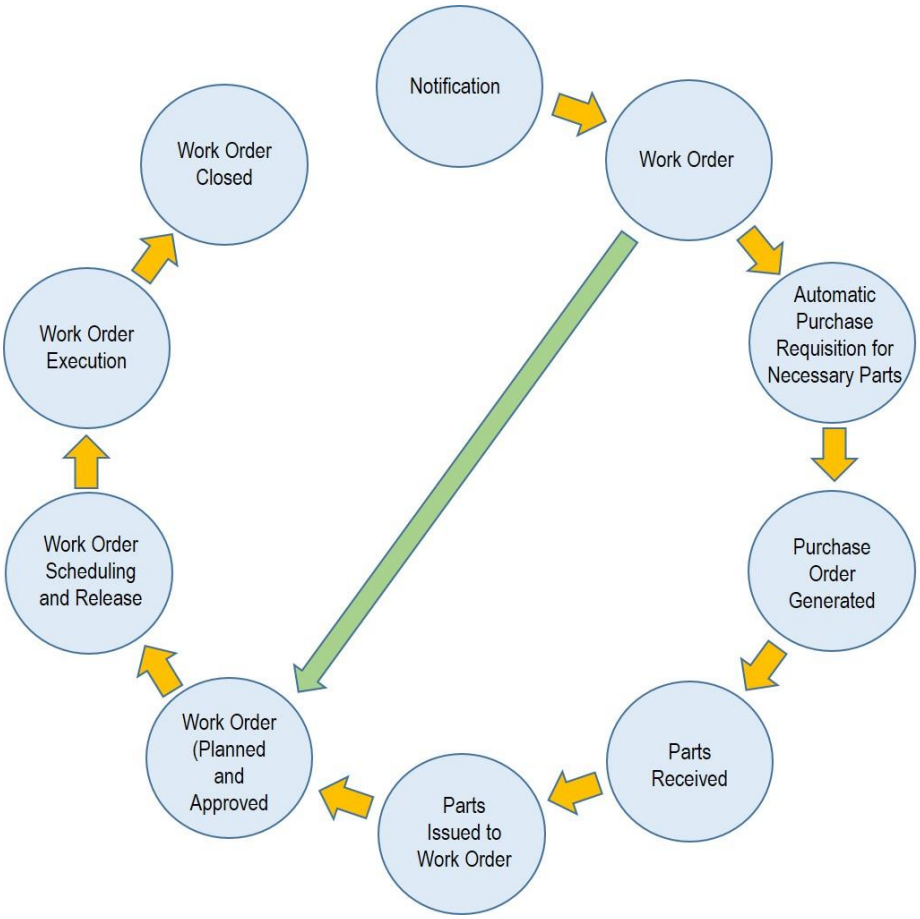

FIGURE 3. Work Order Process (modified from: (Tutorialspoint 2017, cited 1 Feb 2017)

In cases where the notification and following work order lead to a maintenance activity that consists only of labor, the steps from purchase request to part issuing can be disregarded (fig. 3).

Work orders (table 1) can also be created with or without reference to a notification. When creating a work order with a reference, all data is copied from notification to work order. At the first stage in creating a work order, users have to choose work order type, which indicates type of activity and can be used to group different maintenance work. The following are examples of work order types:

TABLE 1. Example of standard SAP work order types

Order Type	Name
PM01	Regular Maintenance order
PM02	Breakdown Maintenance order
PM03	Preventive Maintenance order
PM05	Calibration order
SM01	Service Order

Important information in work order, like technical details about the event such as type of malfunction, causes, objects affected, and activities to be taken, should be recorded.

Creation of work order with BoM will automatically generate purchase requisitions for the selected spare parts. The purchase order retrieves information from requisition, such as quantity and requirement date, and from material master data such as lead-time, minimum order quantity, and price. The purchasing process will eventually be completed with the arrival of spare parts and issuing a work order.

When spare parts are available, maintenance work can be planned and approved. After approval, the work order has to be scheduled and finally released, making the work order visible on the work list. In the scheduling stage, the work order is given start and finish dates which can be seen in production planning as capacity reservation in reference to the production work center. Set dates can also be used to follow the total maintenance workload and performance of the service provider.

Maintenance workers will execute the maintenance work and record elapsed time. As soon as the maintenance work order is finished, it will be closed by setting the process status: “Technically Complete”. From this point onward, the work order cannot be changed, but financial postings (such as invoice postings) can still be done.

6 SAP FIORI

Like any other traditional computer software, ERP systems have also been accessed via GUI on stationary PC locations or laptops. Due to rapid development of mobile devices, a large number of users are expecting improvements and possibilities for mobile use.

In the past, many SAP customers expressed their dissatisfaction concerning the old-fashioned look and feel of SAP screens as well as the shortcoming of exclusive access via the desktop GUI for the majority of transactions (like purchase order approval, sales order creation, self-service tasks, information lookup.) The feedback was appreciated and SAP took actions to improve the usability and the accessability. (Bince 2015, 365.)

On May 15th, 2013, SAP introduced their SAP Mobile Platform 3.0, an open platform that was available for software developers. Together with the introduction of the platform, SAP launched their new mobile product called Fiori. (SAP Fiori 2013, cited 9 Nov 2016.) This new product is based on five design principles (fig. 4).

Through this new user-centric mobile solution, clients now had access to a new solution where a collection of apps were possible to use on a variety of devices like desktops, smartphones, and tablets. In the first release Fiori included 25 apps to serve clients in their most common business functions. (SAP Fiori 2013, cited 9 Nov 2016.)

The new User Experience (UX) strategy was to provide all platforms and devices with Fiori. SAP did not only make it compatible with all devices, but they also made the User Interface (UI) less complicated. Running an application with many fields to fill in is not a problem on a desktop computer with a large screen. A simpler UI was a crucial improvement that especially helped users running apps on a small smartphone. (Bince 2015, 365.)

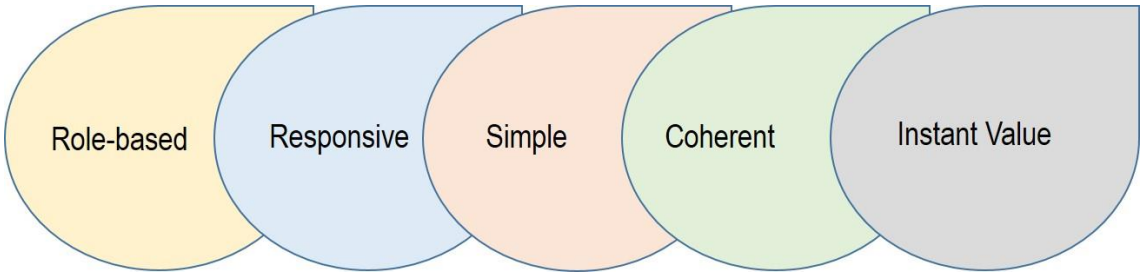

FIGURE 4. Fiori design principles. (Bince 2015, 365)

Role-based:

- user-centric apps depending on user responsibilities
- user can have multiple roles and run different tasks across multiple business domains

Responsive:

- HTML5-based; works seamlessly on different devices and sizes of screens
- automatically adjusting apps layout on the available screen
- supports various interaction modes like keyboard, mouse, and touch-based input

Simple:

- simple UI supports quick and easy completions of tasks
- has 1:1:3: approach: one user, one case, three screens (desktop, tablet, mobile)

Coherent:

- user can have numerous apps that all have the same design and usability
- easy to learn new apps after learning to use one Fiori app

Instant value:

- identical design pattern in apps reduces time and costs used to train new users

The number of applications in Fiori has now grown to over 500. With the release of S/4 HANA, SAP is now achieving their goal in replacing the old GUI for all their products with a new UX standard set by Fiori (Bince 2015, 365).

7 PROJECT ENVIRONMENT AND REQUIREMENTS

This chapter introduces the operating environment, Oulu plant, its current operations organization structure, and its maintenance process. The end of the chapter discusses the outcomes of the PM module implementation to organization and processes.

7.1 Operating environment

Prysmian Oulu plant produces low voltage cables and wires for domestic and export markets. Over half of the output is sold as intercompany exports to other Prysmian companies, mainly in the Nordic and Baltic countries. The company has sustained business relations with all domestic wholesale companies and is a major supplier to Original Equipment Manufacturer (OEM) industry. Cooperation with other Prysmian Group companies evens out the seasonal fluctuation effect of the market and other changes in the operating environment.

Challenging situations in the cable market are still expected to continue. The domestic construction industry market is showing some positive signs following the high demand of small-sized apartments. Intense competition in the cable market is expected to continue in the near future. The company is investing in the research and development of new products and has launched several new fire-retardant cable types to the market.

The 2013 European Commission made a decision for implementing a new regulation for harmonizing the construction products in the European market. Construction Product Regulation (CPR) aims to ensure the availability of the reliable information about the products to consumers, professionals, and public authorities for comparing the product properties from different manufacturers. This new regulation effects the products and their packages and requires extensive testing and official approvals.

Taking the operating environment to all cable manufacturers together is challenging. A lot of effort is put forth to fulfill customers' needs and beyond in order to stay competitive in the market.

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7.4 Implementation impact to organization and processes

The transition from an external service provider program to SAP PM will first impact the maintenance management process in Oulu plant. After rollout, the creation and update of long-term maintenance plans and upkeep of technical object master data are just some of the tasks that will be performed in SAP. The main principle in all cases is to do everything by using SAP and to record the actions' data there. That is the only way to cumulatively collect data about maintenance history and later use it for the purposes such as preventive maintenance planning, spare part control, and different process improvement projects.

Spare part management and stock values should be entirely the responsibility of maintenance management. The number of spare parts in their own stock is currently kept low, and purchased mainly on demand. The majority of the spare parts are supplied by the current service provider and invoiced periodically, but currently none of the spare parts are managed in SAP. Creating the most critical spare parts in SAP would help to monitor the availability, stock value, follow consumption and forecast demand.

PM rollout will lead to process changes and increase responsibility in many functions. Below it is explained how tasks are shared to functions and what responsibilities they currently have and should have in the future.

7.4.1 Production operators

Production operators should, without exception, open a maintenance notification when they notice a machine breakdown, or any other event that would require the attention of maintenance workers. Their responsibility is to enter a notification with as much information as they can to describe the event. Instead of writing emails or leaving notes, the PM module implementation will give all operators a great tool to report urgent incidents or non-urgent improvement suggestions in one system.

7.4.2 Production supervisors

Production supervisors should have full authorization to create and modify work orders for quick reactions in cases of sudden machine breakdown, especially if it happens outside of ordinary office

hours. During the day shift, it is the responsibility of the service provider's supervisor to create maintenance work orders. Production supervisors in all departments will need comprehensive training to be able to assist production operators with maintenance notifications.

The progress of notifications and planned work orders should be followed up on in production meetings where maintenance, production, quality, procurement, and sales departments have their own representatives.

7.4.3 Local IT support

As SAP has been in use for a long time and local IT support is very familiar with the standard system principles, general help and support with arising issues should not increase the work load remarkably. However, use of Fiori on PCs and mobile devices will be new for local IT support too, this will probably raise more support needs.

As the maintenance workers are accustomed to using their mobile device in their work, after the PM rollout Fiori will be their main tool for PM use. Local IT support should evaluate the types of mobile devices to be purchased and used with SAP Fiori. The size of the screen should allow workers to use the apps smoothly. After rollout, the user support will be the responsibility of Prysmian local IT.

7.4.4 Quality assurance

The quality department should be responsible for creating and updating the calibration plans and work orders for measuring tools and devices in production and laboratories. It should also be responsible for creating and maintaining technical objects within the calibration perimeter.

7.4.5 Purchasing and Warehousing

Purchasing is responsible for searching for reliable service, spare part, and machine vendors for maintenance needs. Purchase requisitions are based on the BoM in SAP master data, or they can be created manually if the necessary part is not in BoM. Purchasing works in cooperation with

maintenance management to make sure the chosen vendors fulfill the requirements and conduct supplier audits if needed.

One location should be designated for receiving spare parts. In this location, all purchased goods would be inspected and entered in to the system. An identification tag would be printed and materials placed in stock. Local IT support, together with purchasing, should define what type of printer would be the most suitable for the labeling purpose.

7.4.6 Production planning

When work orders are planned with a reference to the work center, production planning will be able to see maintenance capacity reservations in capacity planning. The production planners' responsibility should be to review the upcoming planned maintenance work orders and give response to maintenance management if any rescheduling will be needed on a monthly basis.

7.4.7 Maintenance management

The transition to an internal plant maintenance system will, in the beginning, increase the work load in the maintenance management as new tasks will include topics such as: the upkeep of master data, BoM, and the creation of preventive maintenance plans. The PM rollout will ease the daily monitoring of activities and when there is historical maintenance data available, the system can support decision making in fields such as: budgeting, spare part procurement, machine breakdown risk analysis, optimization of labor, and work shifts. The mobile use of Fiori will significantly improve the possibilities to follow up maintenance activities and speed up the decision making.

8 RESULTS: PROPOSAL FOR TECHNICAL EXECUTION

Oulu plant has been chosen to be the pilot factory for the PM rollout in the corporate Nordic region. Maintenance activities are centrally managed and the same maintenance workers work in all departments, therefore the pilot rollout is planned to cover the entire Oulu plant.

This chapter will discuss user surveys and the proposal for technical execution of the program, including areas such as: technical object proposal, maintenance scheduling, program transactions, user interface, work order types, user profiles, and user training. A detailed process of creating maintenance notifications using a PC is also explained.

Whenever new master data is being created in SAP, the system provides numerous options for different data entries. The majority of the entries are optional, but there are some minimum parameter requirements that the user needs to fill in. It is important to carefully study these parameters and their functions to build the master data correctly from the very beginning. Providing the minimum data, the system can be utilized, and more data can be added later if needed. For fast data entering, it is possible to use SAP's data mass-processing tool.

The data available from the legacy maintenance system contains very detailed information of technical objects. It is important to keep in mind from the very beginning of the project that there is no need to save all available data to SAP, but rather start from the most important and update the additional data later if needed.

8.1 User survey

A full survey was carried out to discover the users' opinions about how well the current maintenance programs are working and what features are important and in the most active use. Instead of sending the survey questionnaire (appendix 2) only to Oulu plant maintenance workers and supervisors, it was sent to Prysmian Pikkala plant maintenance workers and supervisors to enlarge the respondent population.

Although production operators will be using the new PM module to create maintenance notifications, currently they do not use any software for sharing the maintenance needs and were therefore left out from the survey.

8.1.1 Survey type and population

The questionnaire was composed from three types of questions: 24 Likert scale questions, five multiple choice questions and four open questions (appendix 2). Three of the open questions were for supervisors only. A five-point Likert scale was designed to find out how satisfied respondents were with the usability of maintenance software features. The following is the scale used:

- 1=easy to use
- 2=quite easy to use
- 3=neutral
- 4=quite difficult to use
- 5=difficult to use

The questionnaire was sent to 12 people and eight responses were turned in. From the Pikkala plant, the response rate was 100%, while from the Oulu plant, only 28.6%. Potential reasons for the low response rate could have been due to respondents not being Prysmian employees or not eager for software change and therefore reluctant to respond.

8.1.2 General level of user satisfaction

The results show that maintenance workers in the Oulu plant were more satisfied with their current system with an average result of 2.57, while respondents in the Pikkala plant scored 3.47 (chart 1). Being relatively satisfied with the software features could also be a reason for the low response rate from the Oulu plant. Respondents in the Pikkala plant were not very satisfied with their software usability and therefore could have been more eager to contribute to the survey.

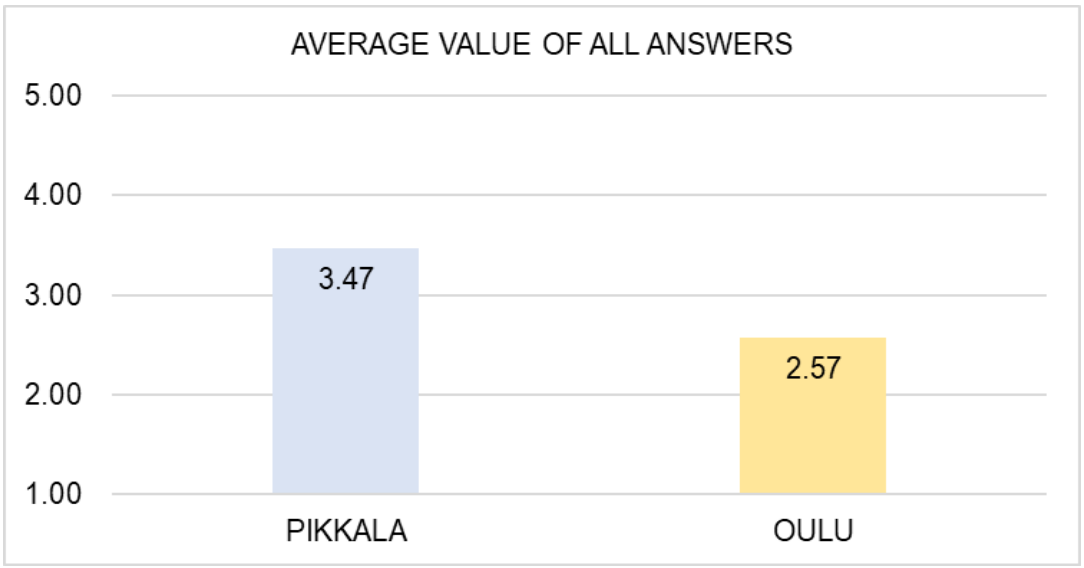

CHART 1. Comparison of overall user satisfaction of current maintenance software in Pikkala and Oulu plants. 1=easy to use, 5=difficult to use.

8.1.3 Mobile use

The current maintenance software in the Pikkala plant is Arttu 2000, which does not support mobile use and causes the mobile use questions to be inapplicable to Pikkala. In Oulu, the plant maintenance software is Artturi and is accessed via mobile solution MP Flow, which is MaintPartner's own application. All Oulu plant respondents were using the software on their mobile devices. Most of the respondents (66.67%) preferred using a mobile device instead of a PC to access the maintenance software. Based on the questionnaire, the overall rating of the software in mobile use is a score of 2.67. This indicates that users find the mobile application quite easy to use. Respondents were asked if they were using the feature of modifying to GUI in the current maintenance software. Results indicate that it was used and a similar feature will also be available in the new Fiori GUI.

A QR-code or barcode scanning feature was not available in the MP Flow. Fiori supports scanning and the use of a mobile device's own camera, but requires some additional configurations. This feature would be useful to expedite the process and avoid human errors when entering codes to the system.

Users criticize the current software for causing mobile device jamming. It is important to conduct enough testing with Fiori on mobile devices to ensure the smooth use of applications and to avoid excess loss of work time.

8.1.4 Most commonly used software features

Based on the questionnaire, the most commonly used feature on the maintenance program is the "creation of a new notification" (chart 2). Out of 24 listed features, 10 were indicated to be the most important by respondents: creating a maintenance notification, closing a maintenance notification, creating a maintenance work order, displaying a maintenance work order, modifying a maintenance notification, modifying a maintenance work order, closing a maintenance work order, displaying equipment maintenance history, recording work hours on work order, and displaying spare part availability.

These results should be taken into consideration when maintenance notification and order function parameters are configured. System testing and user training should concentrate on these functions to ensure desired usability among production operators and maintenance workers.

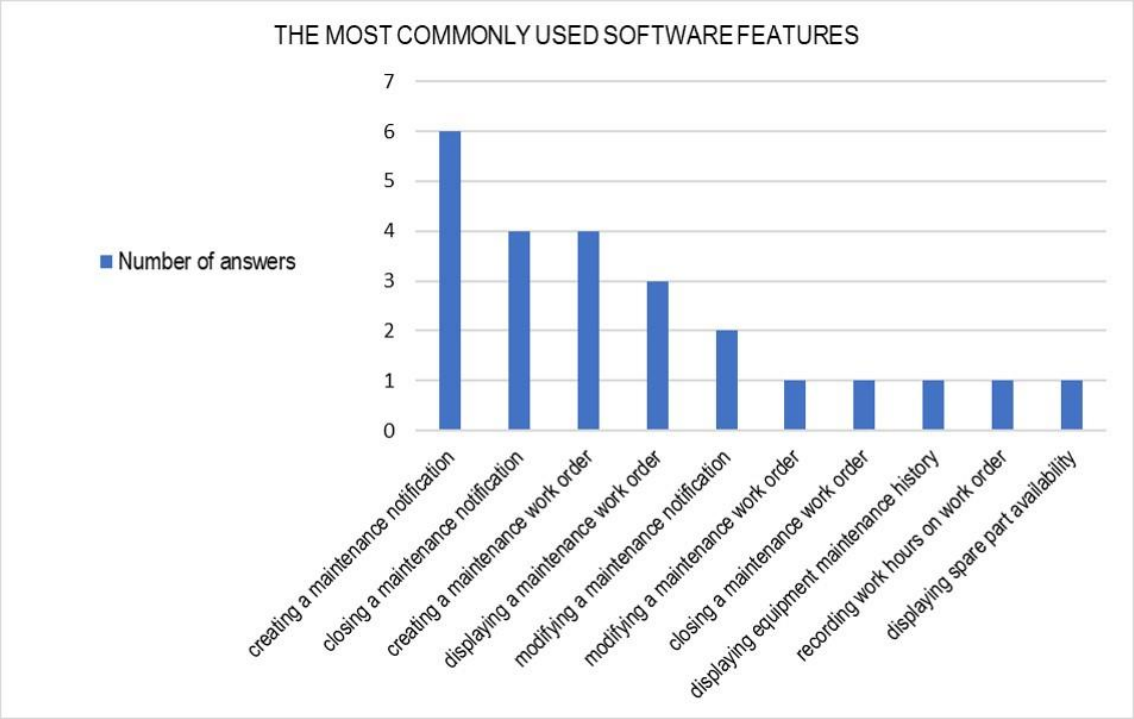

CHART 2. Most commonly used maintenance software features.

8.1.5 The most difficult software feature to use

This questionnaire has identified important maintenance software features that are challenging to use. Five of them scored value four or more, being "quite difficult to use" (chart 3). These features

require special attention when implementing the new program. They should be customized to be more user-friendly.

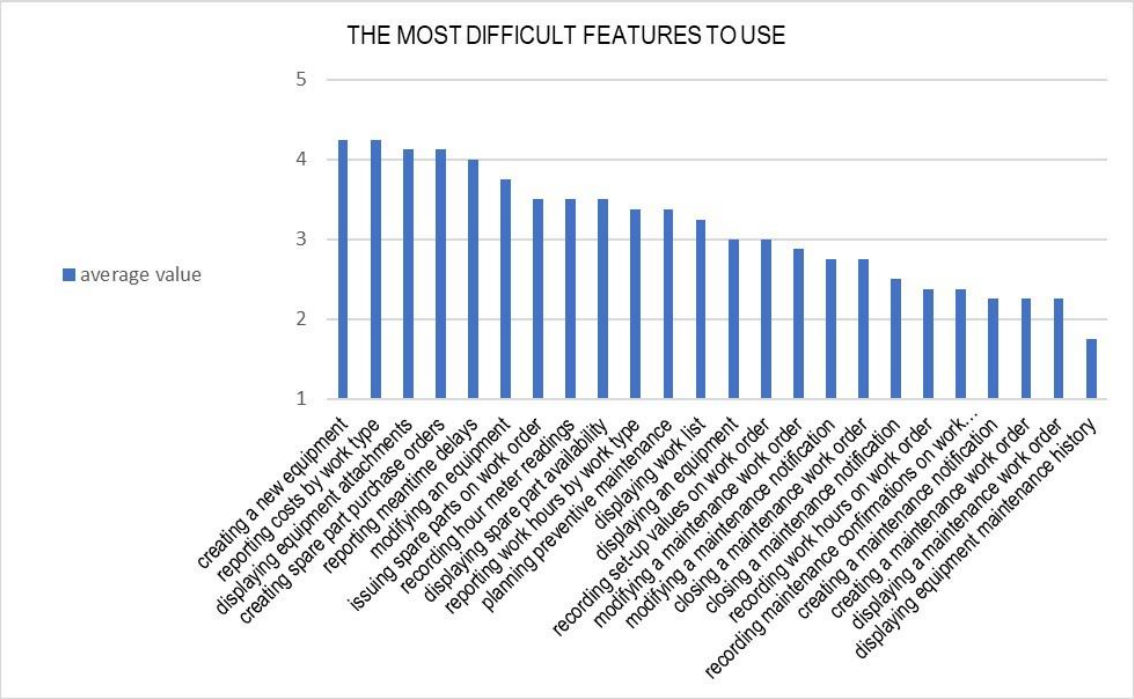

CHART 3. The most difficult features of maintenance software as identified by questionnaire.

8.1.6 Open question responses

The questionnaire had four open questions. Responses indicated that the technical object hierarchy was complicated and challenging to establish and modify. This, together with results of most difficult features to use, indicate that the training of maintenance management and supervisors should have a strong emphasis on technical object-related functions. Feedback was also given on the system's rigidity accompanied with a wish for the new software to be more user-friendly.

The procedure of creating a preventive maintenance work order follows the same pattern in both the Oulu and Pikkala plants. A work order is created with a reference to an equipment and is released to production after scheduling. The questionnaire responses did not give a clear picture about the procedure of issuing spare parts or consumables on work orders. After completing maintenance work on all defined tasks, the work order is marked as completed and closed.

In case of an unplanned maintenance, in the Pikkala plant a maintenance notification is created prior to the work order, while in the Oulu plant a work order is created without a maintenance notification. The practice in the Pikkala plant matches with the standard maintenance incident procedure in the PM.

8.1.7 Summary

The results of the user survey gave valuable information concerning the user experience of the current system in the Pikkala plant, giving a good base for the PM configuration process and user training planning. Although in the Pikkala plant there is no mobile solution in use and in the Oulu plant it has been in use for a longer time, this was a good time to receive feedback from two locations and compare the user opinions about program features and usability.

8.2 System customization

When process changes and responsibilities in the Oulu plant are reviewed and approved, the process of system configuration can begin; this would be the process of building the system to work as proposed and to perform the tasks that are defined earlier. In SAP, business transaction SPRO gives access to Implementation Management Guide (IMG) which contains all necessary actions for functionality configurations. (Bolstorff & Rosenbaum 2011, 221,225.)

Customizing is realized by professional SAP consultants, which need to be hired to assist and consult starting from the first steps of system configuration. Their contract has to cover system functionality introduction workshops, configuration, data conversion from legacy system, test-scenario creation and testing support, training, and go-live and post go-live support.

There are a number of configuration steps necessary to make the PM module work in the desired way. The technical structure has to be defined to manage the large number of equipment, maintenance planning work, and maintenance execution. In SAP, there are already plants established (FI20 and FI30), therefore they only need to be assigned for maintenance purposes. Currently, plant FI30 is only assigned to a small number of products and there are no production lines configured. For this reason, FI20 should be assigned both the maintenance planning plant and the

maintenance plant. As there are no production machinery to be maintained in plant FI30, the machinery related maintenance requirement flow is as seen in Figure 7. If needed, plant FI30 can be assigned as a maintenance plant in the future.

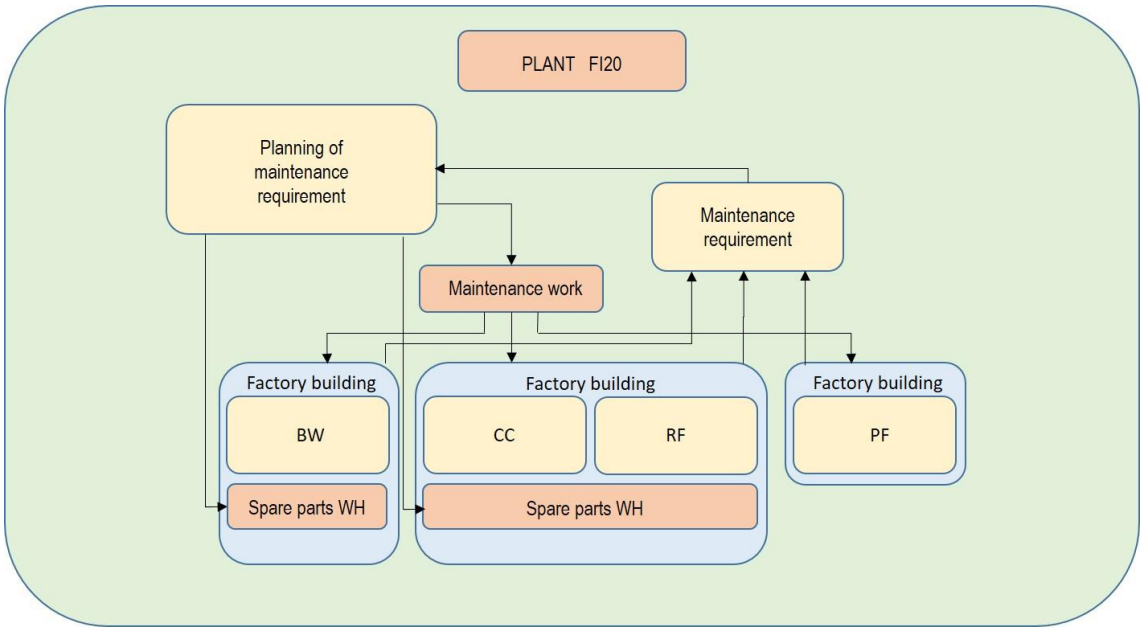

FIGURE 7. Maintenance Plant FI20 structure and maintenance requirement flows.

For categorizing the type of maintenance activity, cost control, and for reporting purposes, it is possible to configure keys in different PM functions or organizational units. There are three configurable keys which need to be evaluated and compared to the existing configuration of SAP: maintenance planner group, maintenance activity type, and main work center. These keys are all different, but they can all be used to categorize the type of work done.

For planning purposes, the maintenance planner groups should be configured. In a planning plant, the maintenance planner group defines a group of people planning the maintenance activities based on the requirements from all assigned maintenance plants. A planner group is assigned to technical objects and copied to all notifications and work orders as default.

In plant FI20 there are two main work categories for maintenance: mechanical and electrical. A third work category is the inspection of measuring and monitoring a device within the calibration perimeter. Three different maintenance planner groups could be useful in FI20: MEC (mechanical), ELE (electrical), and MEA (measuring and monitoring device). When a notification or work order is created, the planner group can be manually changed to match with the actual work done.

PM activity types are configured on cost center levels and used mainly for reporting purposes. Activity types are used as keys for the type of activity provided and to determine the costs of activities for an individual cost object. If only one maintenance planner group is used, an activity type can then be used for grouping different work types.

The main work center could also be used to define the work type. It is a group of people doing the maintenance task and therefore in FI20 work centers for mechanical, electrical and calibration work types should be configured.

8.3 Transactions

A Transaction Code (tcode) is a short code used in the SAP GUI address bar which gives the user access to different module related transactions. In mobile devices with Fiori, the same transactions are configured as icons on GUI. Each SAP user is assigned a user profile where authorizations to tcodes are specified. There are about 120 actively used tcodes that are related to PM use; they are often grouped to match the needs of different user groups and to ease the management of user profiles (Appendix 3).

To ease the use of tcodes, each user can create their own favorites in the SAP menu. English tcode descriptions can also be renamed to make it easier for the user to find the right tcode. It would be recommended to collect tcodes in the user menu during the training sessions and give them Finnish descriptions.

8.4 User Profiles

In FI20, the users of the PM could be divided into four activity-based groups (table 3), each having access to necessary tcodes. User group access authorization would be governed by the Maintenance Manager for maintenance related activities, and the Technical Manager for calibrations and measuring equipment related activities. Depending on organizational responsibilities, one user could have more than one group assigned to their own user profile.

TABLE 3. Proposal for tcode groups in PM

Group	Name	Main Users	Main Activities
1	Manager	Maintenance Manager, Technical Manager, Business Controller, Maintenance Engineer	Maintaining and scheduling maintenance plans and calibrations, creation of task lists, maintaining technical objects, and Bills of Material reporting
2	Supervisor	Production supervisor, Maintenance supervisor	Creation of Notifications and Work Orders, assign spare part, and modify BoM
3	Maintenance Worker	Maintenance Workers, Laboratory Workers	Creation of notifications, Work order confirmations, Viewing work lists, repair history, and spare part availability
4	Operator	Production Operators, Warehouse Workers, Forklift Drivers	Creation of notifications

8.5 User Interface and Requirements

The main users for the PM module are the personnel responsible for maitenance who review and update the task lists, create preventive maintenance plans and inspections, coordinate with the service provider, and, in general, run the daily maintenance activities in the system. Long-term planning work is a task that is easier to manage using a PC while monitoring the work status. The other, larger group is the maintenance workers who monitor the released work orders and insert data of completed tasks either on PCs or on their mobile devices.

SAP provides a comprehensive online library of the apps available for Fiori use. The library of SAP Fiori apps enables the user to explore the available apps and find information and technical data for configuration and installation. (SAP Fiori apps library 2017, cited 29 Mar 2017.) Fiori applications run on PCs and some of them on mobile devices. Standard mobile applications for maintenance use include:

- Request maintenance (operators)
- Analyze work center utilization (maintenance planner)
- Resource scheduling for maintenance planner (maintenance planner)
- Find maintenance notification (maintenance worker and planner)
- Find maintenance order (maintenance worker and planner)
- Find maintenance order and operation (maintenance worker and planner)
- Find maintenance order confirmation (maintenance worker and planner)
- Find technical object (maintenance worker and planner)
- Report and repair malfunction (maintenance worker) (SAP Fiori apps library 2017, cited 10 Apr 2017.)

In SAP web Integrated Development Environment, a set of embedded tools is available for developing a user's own applications for Fiori use. It lets the user to rapidly create their own design, build, configure, and deploy new applications. (SAP Fiori on Mobile Devices 2015, cited 10 Apr 2017.) As the number of standard Fiori mobile apps is limited, these tools will help to create unique applications to meet the user needs.

8.5.1 Maintenance notification creation

The following text will explain a case from the creation of a maintenance notification until the closing of a maintenance work order using standard SAP GUI on a PC. The steps of viewing a work order list and entering confirmations is also covered. Figures will illustrate the screen shots from the PM, containing examples of the main data to be entered.

The authorization of notification creation should be assigned to all user profiles in the Oulu plant, including maintenance workers from an external service provider. The notification process is the most important topic in user training, and the key users should be very familiar with the procedure.

To create a maintenance notification, users have to use tcode IW21. On the initial screen a notification type (fig. 8) has to be chosen from the dropdown list. On standard SAP maintenance request the notification type is M1.

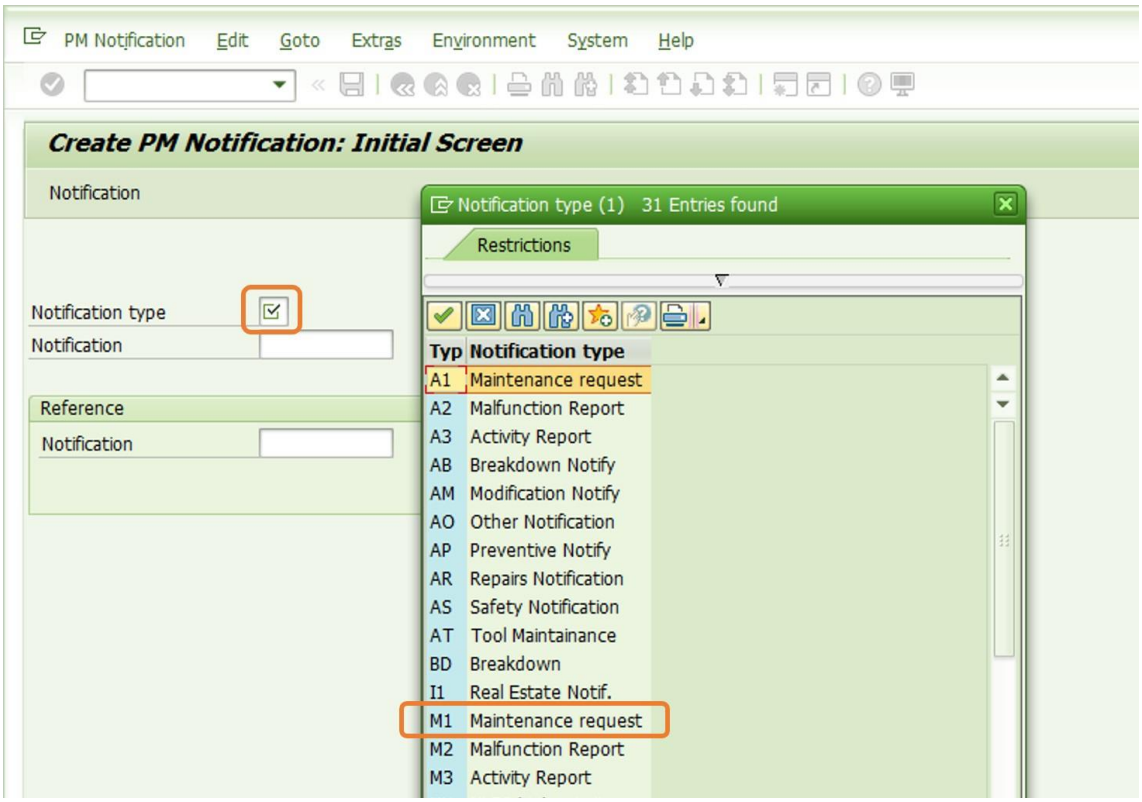

FIGURE 8. PM notification types in drop-down menu

On the next screen (fig. 9) a short description of the maintenance request is needed in the header level. This text will be automatically copied to the subject screen as the description. The maximum length of a description is 40 characters. More text can be added to the notification by pressing the long text button.

When inserting equipment, the system automatically retrieves the assigned FL and other master data that is saved, such as: main work center, plant, cost center, planner group, planning plant, ABC-indicator, business area, and asset number. As the description in the header level is restricted to a maximum of 40 characters, the user needs to describe the incident in the subject textbox. Here. The user can explain in detail what has happened, what sort of maintenance is needed, or write any other information related to the case.

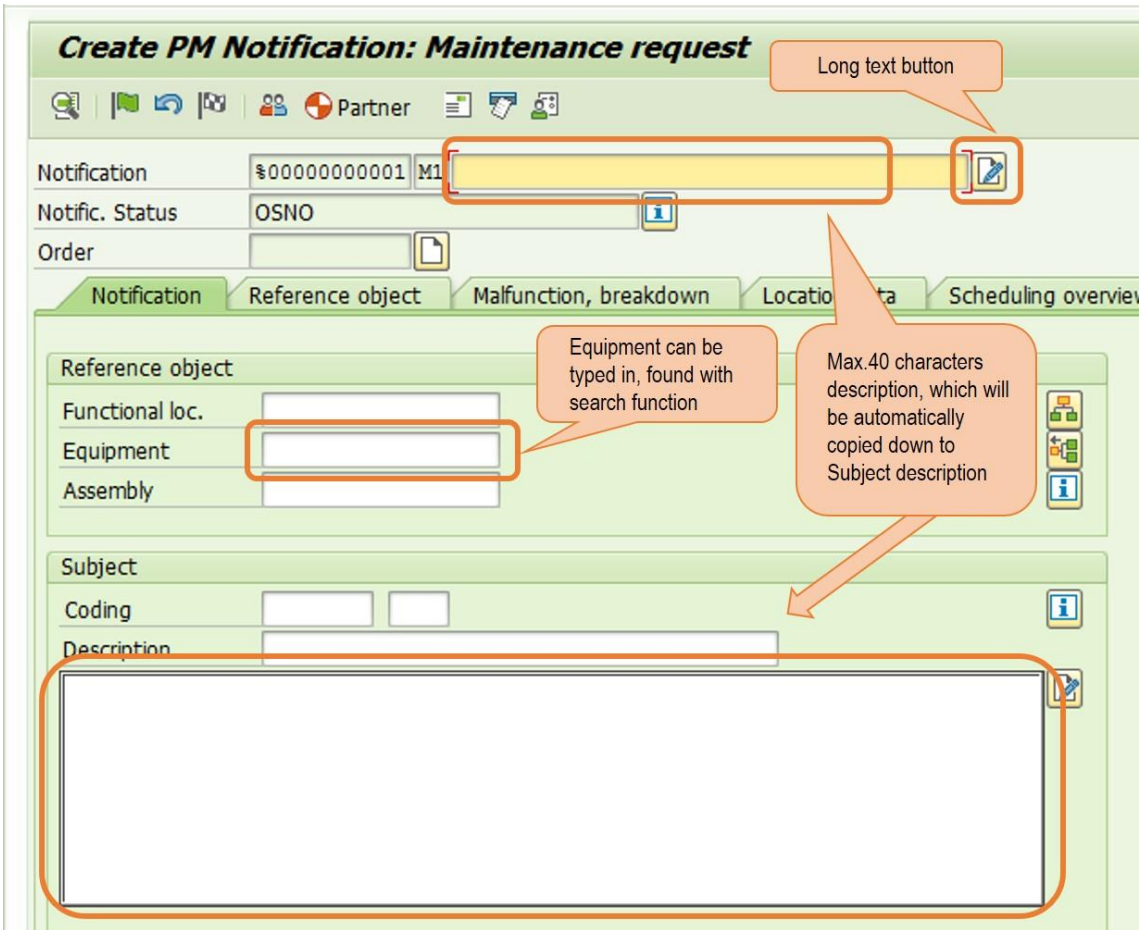

FIGURE 9. PM notification main screen user describes the incident and its location

When FL and equipment are established in SAP using a Finnish description, it will be easy for the user to find the correct equipment from the search results. Each technical object should have an identification label attached where the number and description of equipment is printed. The equipment code should also be printed as a bar code.

On the Notification tab, the system is automatically saving the notification's creation date and time. The same date and time is also set as a required start of the task. If the user wants to indicate the urgency of the incident, a required end date and time for the task can be inserted manually. As the maintenance capacity availability is not necessarily known at the notification's creation, it would be preferable to use a priority indicator to express the urgency. There are four options for priority: very high, high, medium, and low (fig. 10). The priority indicator will help the maintenance planner to decide which requests are the most urgent and to create work orders accordingly.

In the item data fields, the user should indicate the object part (appendix 4) and damage (appendix 5) by using available entries from the dropdown-lists. These entries are configurable and the lists are maintained as catalogs.

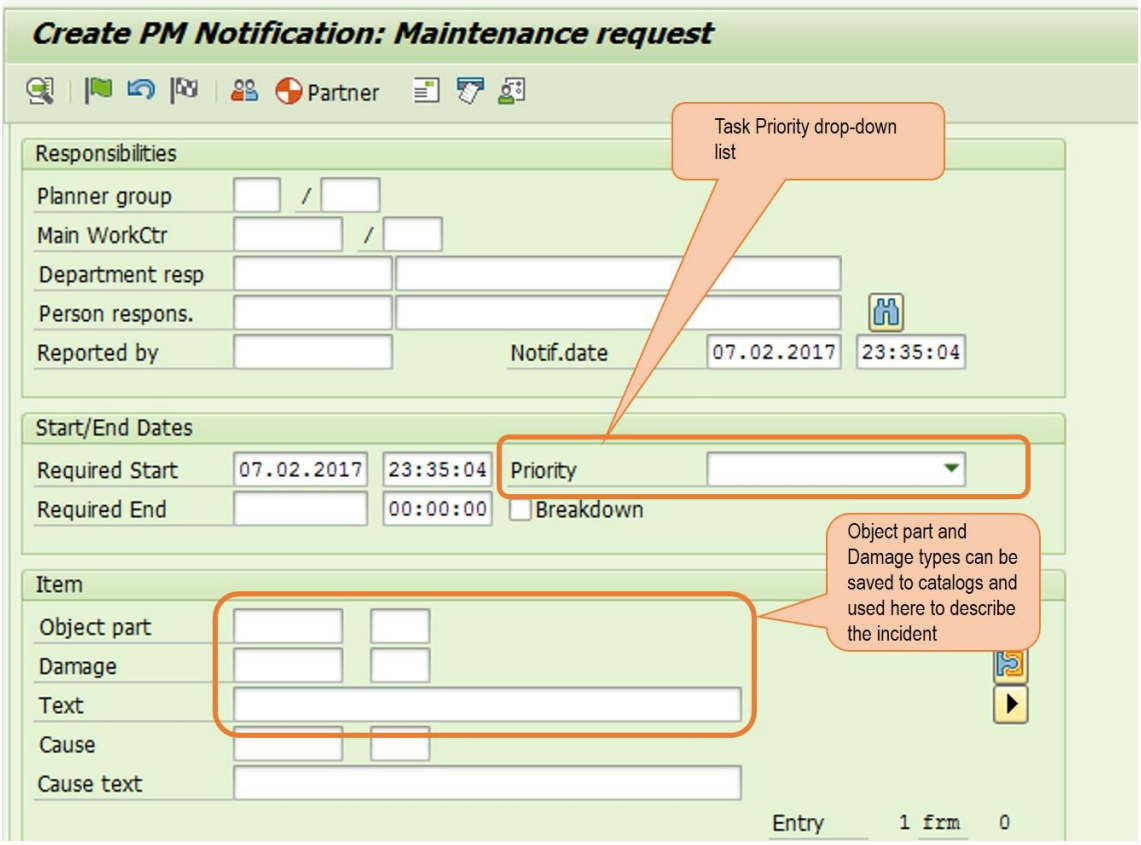

FIGURE 10. PM notification screen for Responsibilities, Start/End data, and Item information

For the other tabs regarding notification, the user does not need to fill in any other information. The notification can be saved and the system will generate a maintenance request notification number. This number is used as a reference when a work order is created.

Maintenance workers will be using the PM module on PCs and, additionally, Fiori on their mobile devices. The process of creating a maintenance notification remains the same for mobile use, but the tcodes are accessed through icons on GUI.

8.5.2 Maintenance work order creation

While maintenance request notifications are storing the technical history, the maintenance work orders also save the costs generated on order. The work includes recorded costs like working

hours of different maintenance workers, externally sourced services, consumables, and spare parts.

A work order with a notification reference is created using tcode IW34. This will retrieve data from the notification and the maintenance planner can change them if needed. If there have been multiple notifications created for the same equipment and for the same reason, it is possible to assign all of them to one work order. A standard work order creation does not need a reference notification (fig. 11).

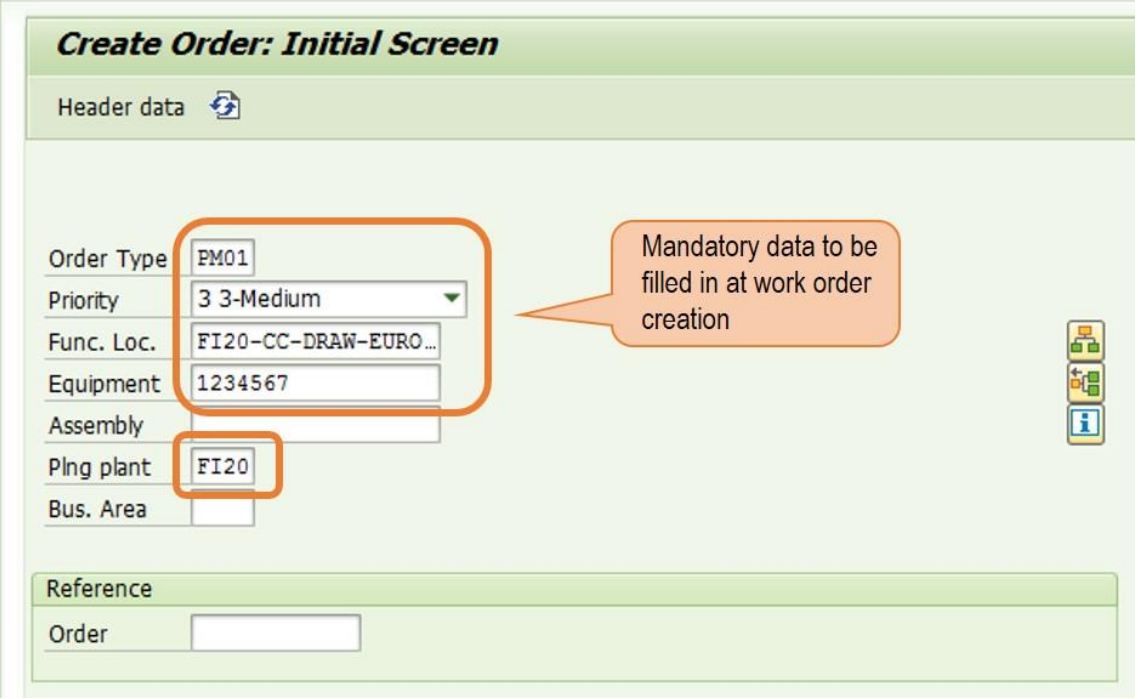

FIGURE 11. Work order initial screen

Correct work order dates are important in order to give correct input for production planning concerning the maintenance activities (fig. 12). The maintenance planner is responsible for evaluating the expected duration of work and to schedule it to the correct date. When repair work is done and spare parts are issued to the work order, their total cost can be seen on the header screen. Total costs include the spare parts, consumables, and confirmed maintenance work hours. If an external service provider is used, their invoice is posted to the work order and shown in costs.

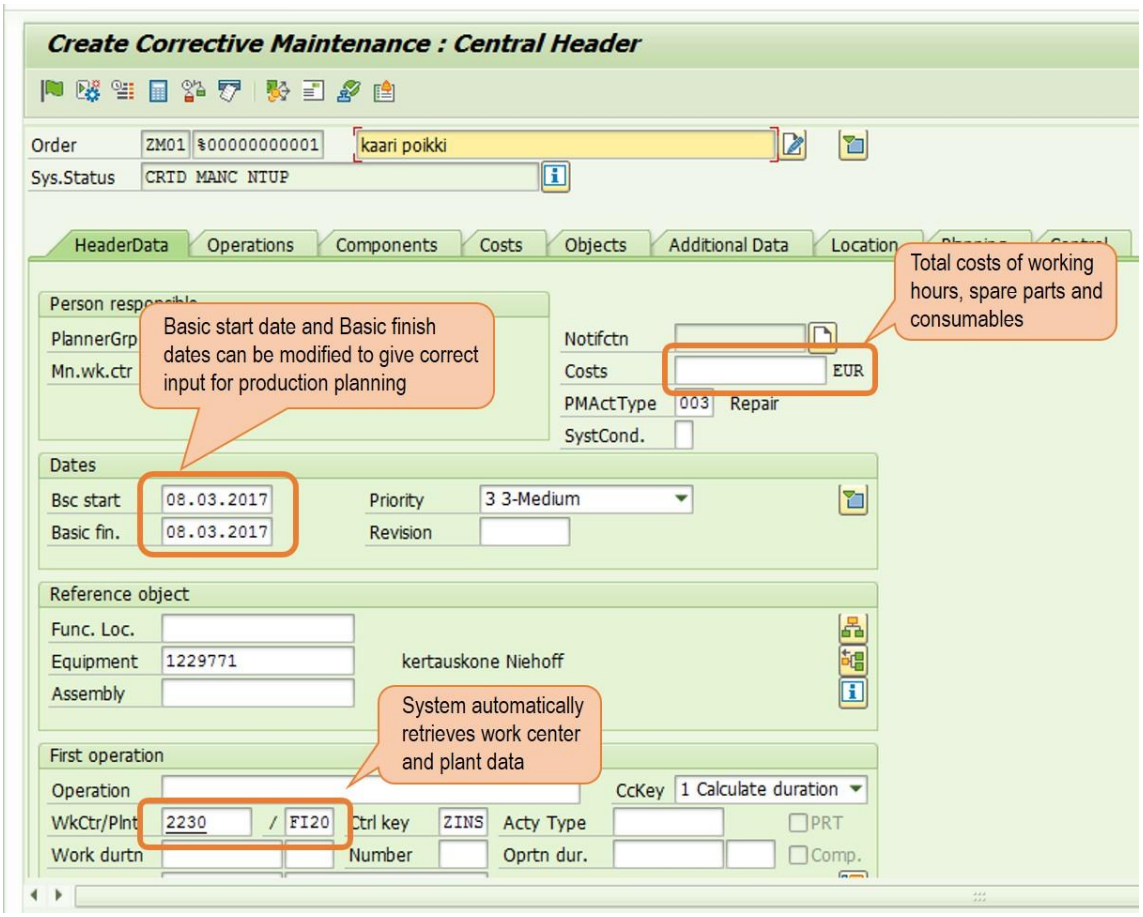

FIGURE 12. PM work order main screen

The planning of operations is performed in a work order in the Operations-tab (fig.13) by inserting different operations with the expected duration. The planner enters in the Operations-tab more descriptive information about the type of work and expected duration manually. Text should clearly describe what type of work is planned to be done.

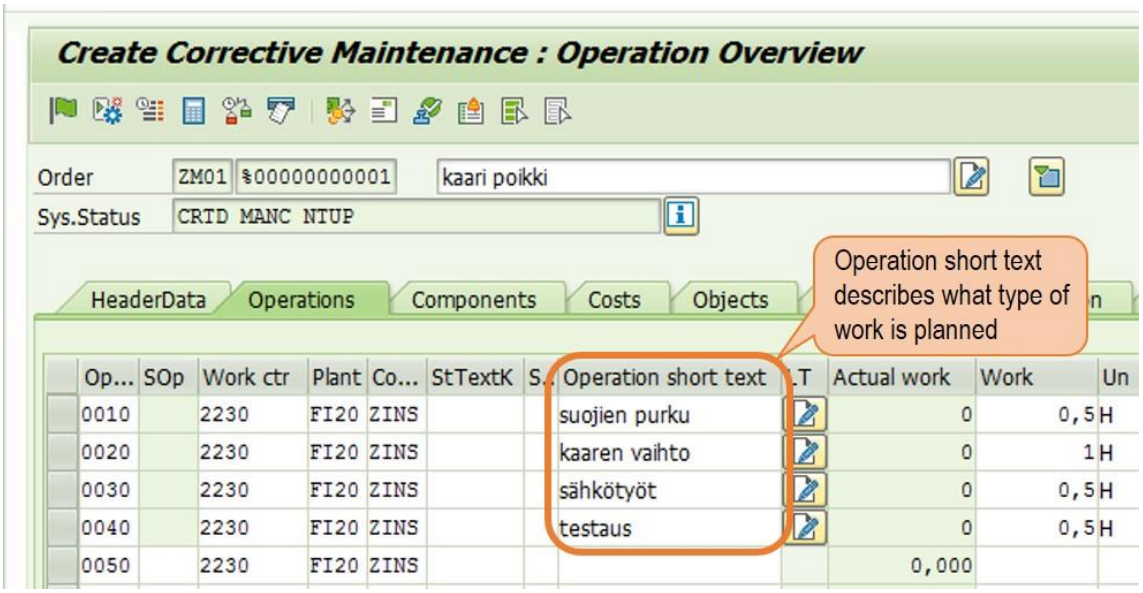

FIGURE 13. Operations-tab indicating the necessary maintenance work with planned duration

The planning includes assigning necessary spare parts which the planner can indicate in the Components-tab. Each component will create a material requirement; for non-stock materials, a purchase requirement will be automatically generated. (fig. 14). For components that are not within stock management before rollout, a general material code should be created to collect costs on work orders. As the main purpose of the general material code is to collect costs on a work order, the master data of the general code should not contain any specific information such as price, vendor, or info record.

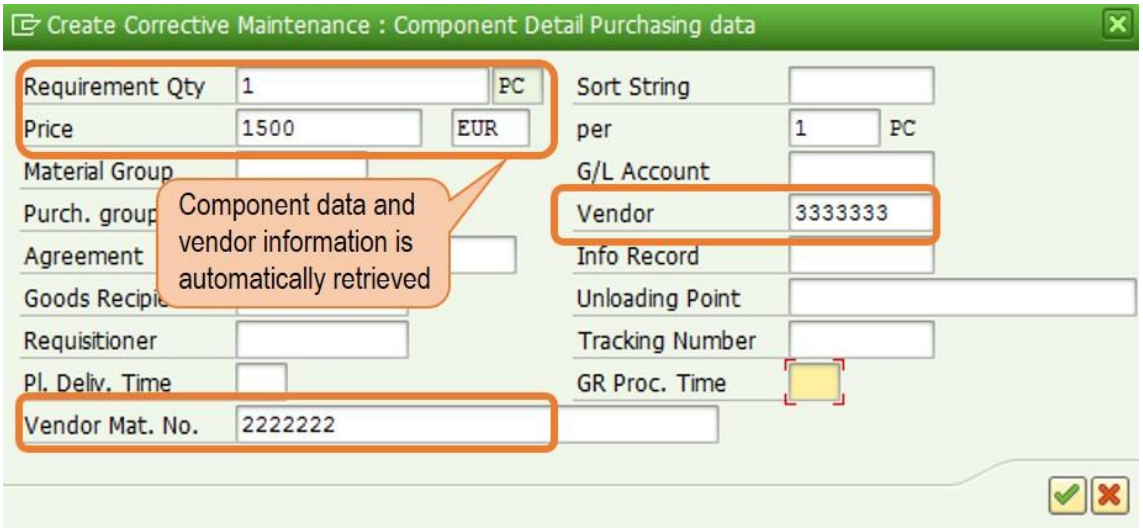

FIGURE 14. A purchasing data pop-up screen during work order creation

8.5.3 Work order list

Tcode IW38 gives maintenance workers access to the work order list where all released orders are available. Depending on the work shifts and task priorities, appropriate work orders are chosen to be executed. The maintenance supervisor should release the daily planning of tasks for completion (fig. 15).

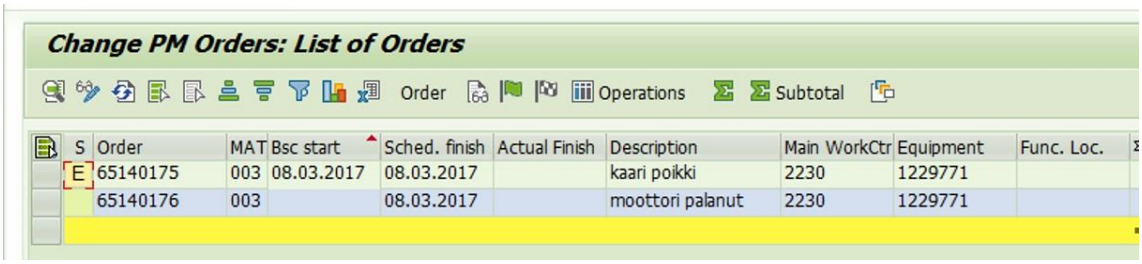

FIGURE 15. PM work order list

8.5.4 Confirmation

After the maintenance activities have been completed, a maintenance worker will record the actual time spent on work using tcode IW41. Here, confirmation is done for one operation at a time, but it is possible to confirm the same operation more than once. For instance, this may occur when work is executed in many short periods. This information needs to be very accurate as it will reflect the final cost calculation of work order.

8.5.5 Work completion

Notifications and work orders will remain open in the system until they are reviewed and labeled technically complete. The maintenance supervisor is responsible for reviewing the overall situation of the work order and update the data if needed using tcode IW42 (fig. 16). There are two main categories to review, time confirmations and goods movements. It is very important to review the causes recorded to the work order. This data will help to evaluate the methods of how to prevent or minimize the risk of reoccurrence.

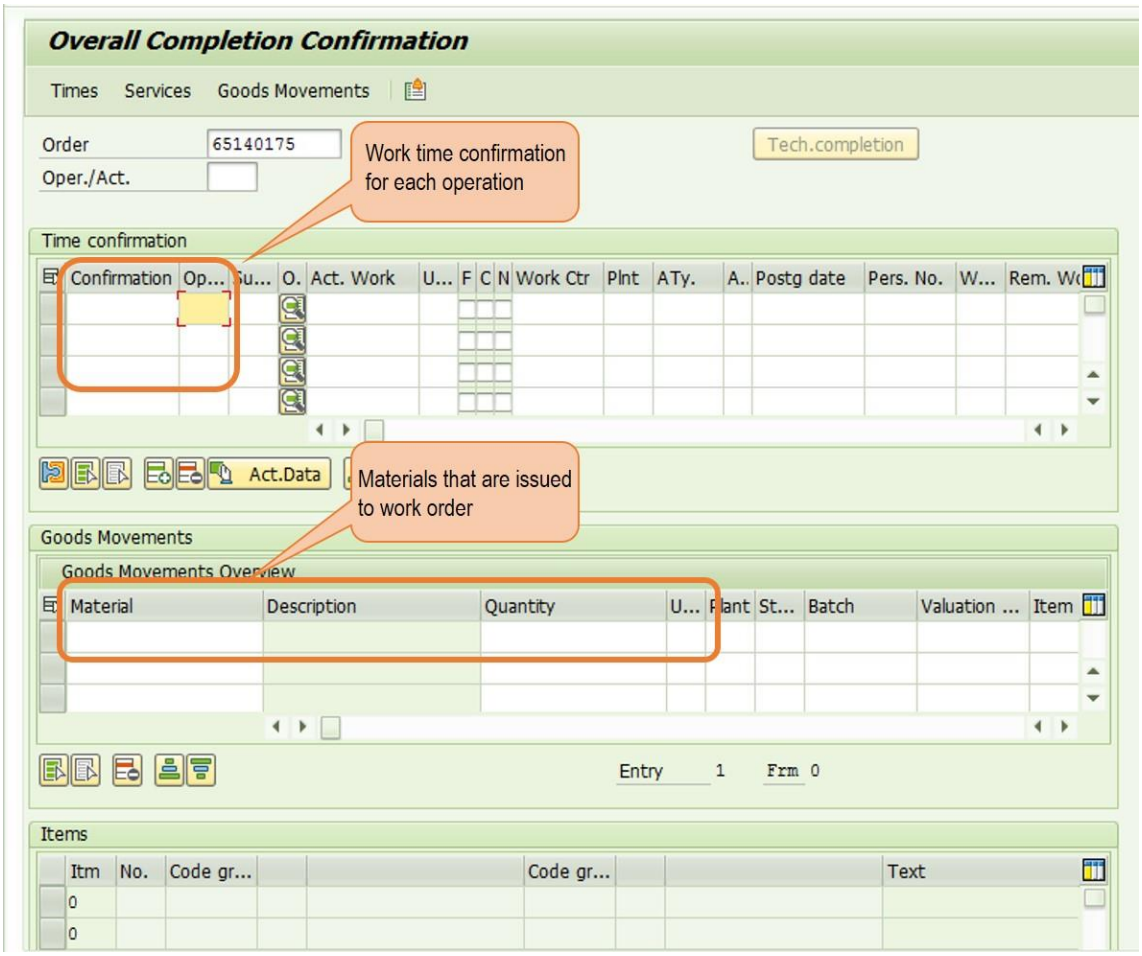

FIGURE 16. A completion confirmation screen which maintenance supervisor has to review and update before final completion.

8.6 Work Order types

In addition to standard PM work order types, four new types could be configured in the Oulu plant: PM07, PM08, PM09, and SM01 (table 4). These new types would help to categorize the maintenance work and ease the monitoring of maintenance activities. New work order types would cover activities related to development, Health, Safety, and Environment (HSE), real-estate, and service orders for external suppliers.

TABLE 4. Proposal for FI20 Work Order Types

Order Type	Name
PM01	Regular Maintenance order *
PM02	Breakdown Maintenance order *
PM03	Preventive Maintenance order *
PM04	Refurbishment order *
PM05	Calibration order *
PM06	Shutdown Maintenance order *
PM07	Development order **
PM08	HSE order **
PM09	Real-estate order **
SM01	Service order **

(*) standard PM work order types, (**) proposed new work order types

A development work order (PM07) is meant to be used in cases where, for example, a production line is radically modified according to prior plans, or when there is a new production line installed. An HSE work order (PM08) could be used to indicate all health-, safety-, and environment-related work, like the enhancement of safety markings or safety fencing. Real-estate maintenance orders (PM09) could be used for work that is directly related to real-estate, such as cleaning, roofing repairs, or painting of walls. A service order (SM01) is meant to be used in cases when any type of maintenance service is sold to an external party. For example, in the Oulu plant this could cover the maintenance and grinding of copper drawing dies.

The creation process of maintenance notifications and work orders is the same for any of the work order types. They can also be assigned a maintenance plan, which would help for example to plan HSE audits and regular inspections for real-estate objects.

8.7 User training

In information technology projects, the cost of user training is tightly related to how effectively the technology is used. When the costs are increasing and budgets become tight, training costs tend to be the first to be cut. By implementing the new technology but not investing enough for training, the use of new technology can be ineffective and cause even greater costs (King 2015, 306).

A strong emphasis has to be put on the user in order to ensure the successful rollout of the PM. Before the user training sessions, the system needs to be tested properly and the test environment readied. Testing should cover both PC use and mobile device use. Involving a maintenance supervisor in system testing before the actual end user training would be recommended to bring valuable experience about the current maintenance system's way of working. After system testing is completed and approved, the material for end user training should be created.

The training schedule and content has to be tailored depending on the type of audience. Training could be divided into four groups based on the SAP user profiles: operators, maintenance workers, supervisors, and managers. At this point, mobile device training should be given to all other user groups, except operators. A training coordinator should be appointed to organize the practical implementation.

8.7.1 Operators

The largest individual user group will be production operators, who will be responsible for alerting to incidents, such as machinery malfunctions and repair needs, by filing a maintenance notification. The current number of employees per department is 71 in Building Wires, 32 in Mobile Networks & Jumper & Fiber Optical Accessories, 30 in Copper Conductors, and 20 in Packing Factory. The training for production operators could take one day. Three to six key users from different departments should be chosen from this user group to help their colleagues after rollout. Training could be organized in groups of 10 operators. When it comes to scheduling and participants, the production supervisors in all departments should be in agreement with the training coordinator.

8.7.2 Maintenance workers

The second largest user group is maintenance workers. The number of workers may vary, depending on the work load. There are usually five to seven mechanics, five to seven electricians, and at least one assisting maintenance worker. The training should be planned for 15 workers. Maintenance workers have several years of experience of using their own maintenance system and they are also familiar with mobile device use. Probably the most challenging part of the transition will be the change of program language from Finnish to English. Basic features in the current system and SAP PM are relatively similar, so learning to use SAP and Fiori is assumed to be easy.

As seen in the survey results (table 5), maintenance workers and their supervisors are most often using the features related to maintenance notification and work order related actions.

TABLE 5. 10. Most commonly used software features and their percentage

10 Most commonly used software features	Percentage	Number of responses
1. Creating a maintenance notification	25,00%	6
2. Closing a maintenance notification	16,67%	4
3. Creating a maintenance work order	16,67%	4
4. Displaying a maintenance work order	12,50%	3
5. Modifying a maintenance notification	8,33%	2
6. Modifying a maintenance work order	4,17%	1
7. Closing a maintenance work order	4,17%	1
8. Displaying equipment maintenance history	4,17%	1
9. Recording work hours on work order	4,17%	1
10. Displaying spare part availability	4,17%	1
TOTAL	100%	24

Training could take one to three days for maintenance workers with the main emphasis on practicing the use of Fiori. Training does not need to be done on a mobile device, as Fiori runs on PCs too. User training should primarily cover topics such as:

- Creating maintenance notifications
- Confirming work orders
- Displaying work orders and printing them if needed
- Issuing materials and spare parts from warehouse
- Recording maintenance data of performed tasks
- Recording measuring point readings
- Creating measuring documents

8.7.3 Supervisors

Supervisors, service provider's one and Prysmian's three, should receive training covering the same topics as the operators and maintenance workers. They should additionally receive training for monitoring and managing the maintenance activities. This training should also be for workers doing calibrations and measuring device inspections. Training should cover topics such as:

- Creation and update of maintenance/calibration work order
- Display of maintenance/calibrations plans
- Display of technical object structure and their location

In general, supervisors need to have a broader understanding of the program functionalities, like how different modules are integrated and what impact actions in the PM have on other modules. Training for supervisors could take up to three full days. One to two key users from this user group that will be independently able to support all PM users after rollout should be chosen. The service provider's supervisor would be the key user and support to all maintenance workers.

8.7.4 Managers

Prysmian maintenance management is responsible for maintaining all master data of PM-related parts. They need training that covers the master data principles and system functions, including calibration activities. They should receive the most extensive training covering all above mentioned topics and additionally the following:

- Managing all PM master data
- Managing all maintenance activities
- Usage of reporting tools
- Usage of cost management related tools

After rollout, supervisors and maintenance management will inevitably face situations where the user input is erroneous and is causing further errors. User training should cover about how to correct and reprocess the faulty input.

Supervisors and Prysmian maintenance management need to receive the most extent training which covers not only daily tasks, but also planning, reporting and cost related topics. User training could take up to four full days.

These training sessions, or part of them, could also be valuable for production planners, business controllers, purchasers, and process development engineers. Before agreeing on the final plan for the training sessions, these people should be given a chance to express their opinion about the training needs.

After rollout, users will inevitably find some errors, face difficulties with system use, and come up with improvement ideas. Therefore it would be reasonable to arrange combined post go-live training and discussion sessions.

8.8 Technical object proposal and data administration

Keeping in mind the future PM rollouts in other Prysmian Group facilities, it is important to evaluate the FL coding structure and equipment-naming in a wider respect. As English is used as the corporate language, the FLs code should be based on the English definitions of processes and machinery. Preferably, the code should be kept short but descriptive, so that it is easy to decode by employees working with SAP.

In cable manufacturing, raw materials and cable types vary, but many manufacturing processes and machinery are relatively similar. This rule applies to Prysmian Group production facilities too. Therefore, a similar type of coding could be applied in the other rollouts as well. When creating the FL and equipment master data, all other data should be in English but the technical object descriptions may be in the local language. This information would help users to search and locate the right technical object. Technical Objects can be further categorized by using different Object Types.

8.8.1 Functional location proposal

There are currently 73 production lines to be configured as FLs. In addition to those, there are warehouse locations, laboratories, buildings, silos, raw-material and finished goods warehouses, emulsion centers, and a tooling workshop (appendix 6). The total number of FLs to be created is 87. Technical data for 68 production lines can be retrieved from the FI20 legacy maintenance system.

The functional location name should clearly indicate the physical location and function of the technical object. Below is explained, as an example, a FL coding suggestion for an Euroalpha wire drawing line with related equipment located in the Copper conductor department in the Oulu plant (fig. 17). The structure is built to be applicable for other Prysmian plants too. A 4-level Structure Indicator XXNN-XX-XXXX-XXXXXXXXXX is used for FL coding. In the Structure Indicator, X can be an alphanumeric value, and N only a numeric value. The highest level indicates plant, the second level indicates production department, the third level indicates process, and the fourth level indicates any characteristic technical feature of the object. A 4-character abbreviation can be used to describe the process on the third level (appendix 7).

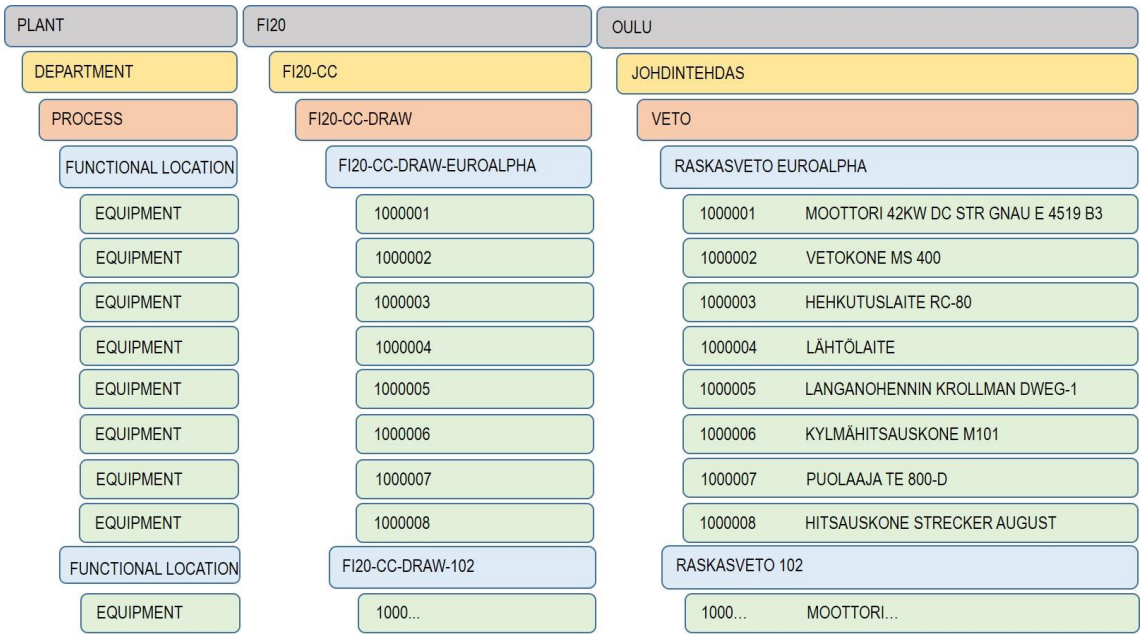

FIGURE 17. Plant hierarchy example for FI20-CC-DRAW-EUROALPHA functional location

When creating a new FL, it is possible to retrieve the Finnish production line description from the legacy system. Using a familiar description would help maintenance workers to find the correct location in the production premises.

8.8.2 Equipment proposal

As the production lines consists of several technical items, under each FL there would be needed to create and assign equipment. From the legacy system, over 1250 possible entries can be received for equipment. In addition, there are a total of 456 measuring and monitoring devices currently in use that should be created as equipment. After a comprehensive revision and purification of legacy data, active equipment could be created to SAP and let the system automatically generate an equipment identification number (fig. 18).

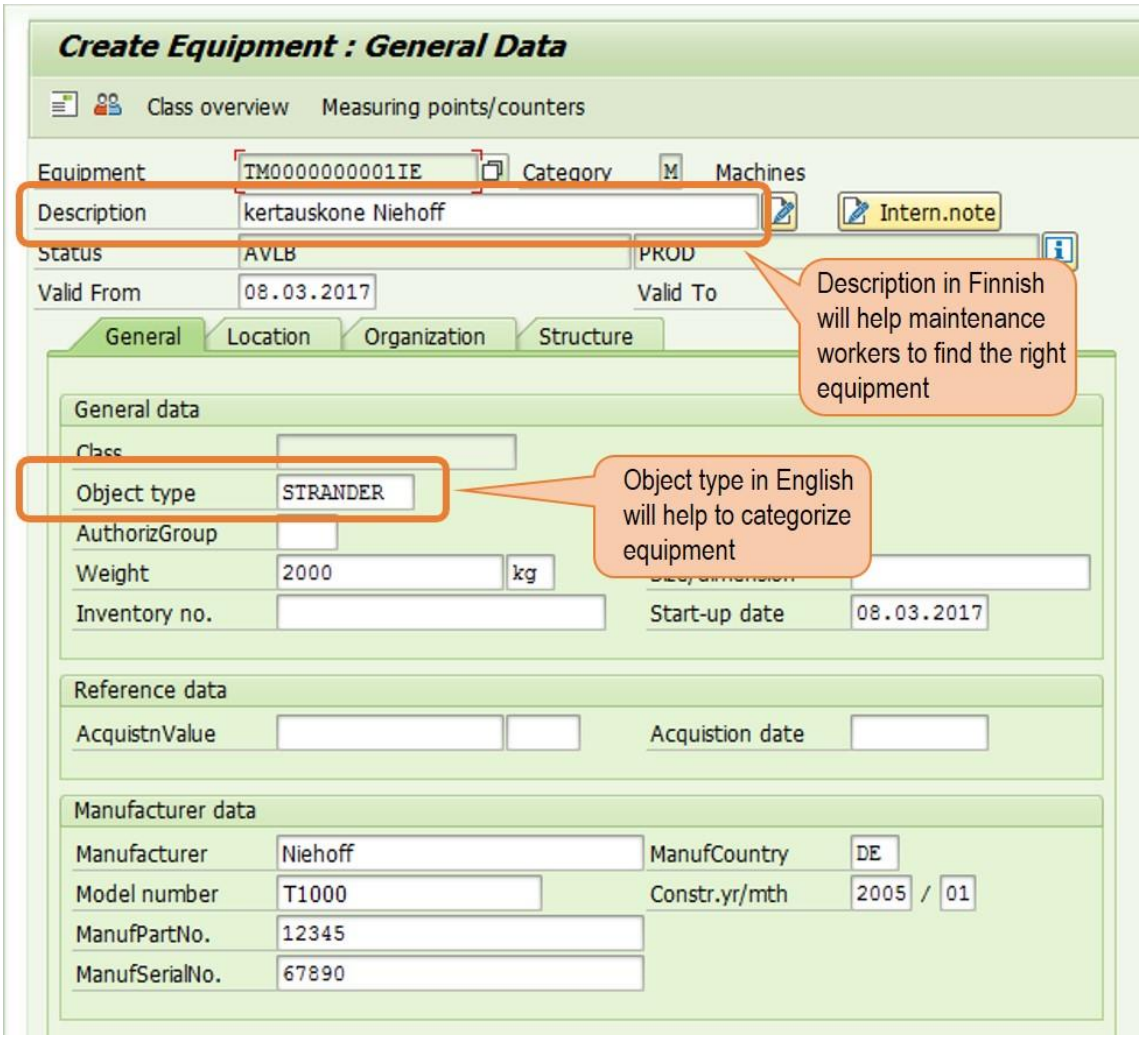

FIGURE 18. Equipment creation data

Like FLs, equipment should also carry a description in Finnish. In general, for the data of an equipment it is necessary to use the Object Type (appendix 8) to divide equipment into categories. With object type it is possible to separate, for instance, measuring equipment from production equipment. When the PM is implemented in other Prysmian plants, it will be easy to search for inactive replacement equipment from other locations in case of a sudden machine breakdown.

A new label should be attached to equipment indicating the name and new number, and the number should be also in the barcode. Maintenance workers using a mobile device equipped with a camera could use it with Fiori to scan barcodes and make the insertion of data faster and more accurate.

All FL and Equipment related technical documents that are currently stored in separate databases can be saved as attachments. Saved documents will appear in the technical object BoM. Data to

be saved could include documents such as, old calibration documents, technical drawings, and maintenance history.

8.9 Applications of Measuring points and Counters in Oulu plant

Optimizing the maintenance labor time, consumption of spare parts, and consumables in preventive maintenance should principally be related to the measurable condition, or follow the count of actual operating time of an equipment. In the Oulu plant some equipment are currently equipped with an hour meter and the readings are registered by maintenance workers.

The production line status is currently monitored by Machine Track, a program provided by a company ARROW Engineering Oy and launched in the Oulu plant in 2011. The Project started with 17 production lines and currently the monitoring covers 27 production lines. The program is developed for real-time measuring, data collection, and analysis with visual representations of the entire production facility. It can be linked to a bidirectional data transfer with ERP systems. (ARROW Engineering Oy 2015, cited 23 Jan 2017.) This tool is used in Oulu for real-time data collection of main production lines and packing machines. The line status is updated by a line operator manually, processed in the Machine Track program, and then displayed with different colors on a screen located in the office area.

SAP has a maintenance planning feature which allows time-based planning of the maintenance cycle to be connected with a counter reading. A plan can have an interval of, for example, six months with the additional condition of counter reading of 3000 hours. In case the equipment operating hours reach 3000 before six months have passed, the system will automatically trigger a maintenance work order.

Even without an online counter reading connection, a time-based maintenance planning feature with a counter value could be used in the Oulu plant for the scheduling of equipment lubrication, air filter replacements, and oil changes. A maintenance plan with a relevant weekly or monthly maintenance interval could have a counter reading limit assigned as an additional trigger point. In the future the hour meter readings could be transmitted directly to SAP to reduce the manual work and to have real-time data.

It would be important to take advantage of the existing monitoring hardware and the Machine Track program and evaluate the possibility of integrating it together with hour meters to the PM module. If integration is seen as feasible and as a cost-effective option, in the future, more counters could be added to expand the automatic maintenance monitoring. Another option could be the construction of a new wireless measuring point and a counter network connected to SAP through any proper PCS; the Machine Track would be left as a separate line status monitoring system.

8.10 Scheduled plans

The current maintenance activities of technical objects in the Oulu plant concentrate on acute repairs instead of planned, preventive maintenance. The PM rollout is the right moment to introduce the first step of regular preventive maintenance executed in SAP. A good starting point is to transfer the current plan for equipment lubrication, air filter replacement, and oil changes to the PM. The next step could include inspection plans and result recordings of the process's emulsion quality.

It is important to start preventive maintenance planning practice at the rollout and use the feature for some time to gather valuable experience. When there is more historical data of maintenance, the focus should gradually turn from corrective maintenance towards the preventive maintenance.

8.10.1 Preventive maintenance

The creation of equipment maintenance plans requires extensive knowledge of past maintenance actions, as there is no history data available in SAP to support the decision of automatic work order creation intervals. It would be important to find out if it is possible to acquire maintenance history data from the current maintenance provider's maintenance system. When the service history data accumulates in SAP, it is reasonable to have the maintenance plans reviewed and adjusted.

8.10.2 Calibrations

To produce goods that comply with the product specifications in a cost-effective way, the manufacturing process requires accurate monitoring of product quality. The cable manufacturing process is

controlled by using various types of measuring devices. In the Oulu plant there are over 450 technical measuring or process monitoring devices within the calibration perimeter. Each device should be created to SAP as an equipment and included to the PM calendar-based inspection planning.

8.11 Spare part management

Basically, no spare parts or refurbished equipment in stock are coded or managed in any database. Maintenance workers know well where certain equipment spare parts are stored and can find what is needed. All spare parts and consumables stock is property of Prysmian; replenishing is carried out by the maintenance service provider.

Each department has a physical storage location where its production tooling and spare parts are stored. These locations have several pallet locations and the content of each pallet is indicated on a list attached to the pallet. Some of the critical electric motors have a suitable replacement motor in stock, both new and refurbished. The most important and critical spare parts include: AC-motors, DC-motors, drive belts, stranding machine bows, bearings, and special fuses. Since some of the parts of cable manufacturing machinery are interchangeable, the old, removed equipment are still stored in the factory warehouses for possible later need or refurbishment. There is no clear or systematic follow-up of these machinery and parts.

To use the PM module effectively, each technical object should have an allocated maintenance Bill of Material (BoM). The maintenance BoM linked to a technical object can contain a comprehensive list of assigned assemblies, documents, and materials with technical descriptions and material codes. When a maintenance task requires the purchasing of a material, the correct part can be found easily from the maintenance BoM. When the correct material is chosen and if there are no spare parts in its own stock, SAP automatically assigns the correct spare part material number to purchase requisition and retrieves all other data from the material master data. The purchase order will be based on the requisition, including data such as preferred vendor and lead-time.

To improve the management of spare parts and to enhance the maintenance process, each department should produce an inventory and list the most critical parts to be established in SAP. Materials that have similar attributes, like spare parts, have their own Material Type in SAP, which has to be configured and activated before establishing materials. The material master creation

would require a list with part material descriptions both in English and Finnish. The material description that is visible on the main screen of the material master for purchasers and maintenance workers should describe the part in Finnish. An English description could be added to the classification data for easier searches in case the part is interchangeable with technical objects located in other Prysmian factories abroad.

At the first stage, the establishing of materials should be concentrated only to the most critical parts in stock. In the future, the number of materials in SAP can be expanded and linked to technical objects in maintenance BoMs. To collect the actual costs to work orders, a general code for non-coded spare parts should be created. This code would be used for parts that exist in stock, but that do not carry a code and their exact value is unknown. Estimating the value to such parts on work orders is not truly accurate, but it would be better to have at least some value than no value at all. After the PM module rollout, the number of spare parts established in the material master will automatically increase as the maintenance related materials will be ordered only through SAP. For the currently existing spare parts in stock, a separate project would be recommended prior to the PM module rollout to evaluate the part's necessity to be established in SAP.

At least one special printer would be needed as all parts should carry a tag including the material description, material number, and a barcode or QR code. Smaller items stored in a container should include the same information clearly visible for the user. Maintenance workers can use SAP Fiori on their mobile device equipped with a camera and scan the code from the tag when posting a goods issue to a work order. Tags should be made of robust material and be resistant to oil and other strong chemicals.

The actual work of managing spare parts master data and creating new materials could be allocated to purchasers as they already have a broad understanding of master data configuration and are currently responsible for creating, for example, raw-materials and accessories. Purchaser's authorization to administrate spare parts master data is configured under Material Type. Maintenance management has the full accountability of spare parts stock value and will, therefore, cooperate together with purchasers to determine safety stock levels or re-order points to ensure the timely availability of spare parts.

9 CONCLUSIONS

The aim of this work was to identify the preparation needs of different organizational functions from the maintenance point of view, and to come up with a proposal for the SAP Plant Maintenance module rollout preparations that could be used in future rollout projects. As a result, a number of rollout prerequisite subjects were identified and preparation suggestions were given to each of them.

Data from the legacy maintenance program database was retrieved and a suggestion for a functional location coding proposal was built on it. The English language-based coding proposal was created to suit other Prysmian plants in their SAP PM rollouts.

Results also cover a proposal for system customization which represents the plant hierarchy and the required information flows with reference to maintenance planning plants and maintenance plants.

A proposal for user profiles is built to match the existing user groups and their main activities. Based on the profile, the user is given access to a group of tcodes.

The additional work order types proposal is meant to ease reporting by categorizing different types of maintenance work into their own categories; they will help to separate manufacturing maintenance work from other types of maintenance work.

The user training groups proposal indicates the different training groups and most important topics to go through during each of the sessions. Adequate and comprehensive training of all user groups will increase the utilization of the SAP PM features and decrease the post go-live support need. Training needs of other stake holders have to be taken into consideration when training sessions are planned and scheduled.

The above mentioned results will significantly help when preparing for the rollout projects, first in the Oulu plant and later in other Prysmian factories in the Nordic region. The suggested technical object hierarchy and systematic coding will be applicable in other rollouts and it will help to organize the machinery in a logical way. A well-structured training session plan will ensure the PM module

features are explained and all necessary user groups are trained. It should also diminish the change resistance when users are given enough time to exercise and adapt to the new PM use.

10 DISCUSSION

The goal for the thesis was to develop a repeatable plan for the SAP Plant Maintenance rollout first to be used in Prysmian Oulu plant. While the project achieved the majority of the results from a technical point of view, it did not achieve the expected results from user a feedback point of view. The questionnaire survey response rate from the Pikkala plant was 100% while from Oulu plant it was 28.6%. Although the total number of survey answers was low, the answers of the survey gave valuable information about the current state of maintenance activities and its challenges.

This work has taught the importance of planning the steps in advance and communicating the unfinished results during the process. It has also given an understanding of how the human factor influences the progress of any projects.

The questionnaire survey was chosen as the method of collecting user feedback of the existing maintenance system and to receive improvement ideas for the new plant maintenance. The survey was sent to Maintpartner maintenance workers and their supervisors in Oulu, and additionally to Prysmian maintenance workers in the Pikkala plant. Along with the survey, several specialists from different organizational functions were given targeted questions.

In future rollout preparation projects, it will be important to involve the maintenance supervisors and technicians at a very early stage to give feedback and opinions about their work. A questionnaire survey is a good way to collect data, but a personal interview would work better for a small group of people. Interviews could also give more detailed information about the manner in which work is executed in the field and reveal possible bottle-necks of the processes.

It would be wise to more deeply study the availability of ready-developed Fiori mobile applications and possibilities of developing Fiori mobile applications with the SAP web Integrated Development Environment before the new rollouts in Prysmian.

Doing this project has been at times very challenging, but a rewarding process at its conclusion.

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SAP STANDARD SYSTEM NOTIFICATION TYPES APPENDIX 1

Notification Type	Notification Origin	Notification Category
M1 - Maintenance request	01 - Maintenance request	Maintenance notification
M2 - Malfunction report	02 - Malfunction report	
M3 - Activity report	03 - Activity report	
S1 - Problem notification	04 - Problem notification	Service notification
S2 - Service request	05 - Activity report (Service)	
S3 - Activity report	06 - General notification (Service)	
Q1 - Customer complaint	Q1 - Customer complaint	Quality notification
Q2 - Complaint against vendor	Q2 - Complaint against vendor	
Q3 - Internal problem notification	Q3 - Internal problem notification	
$$ - Feedback notification	R3 - Feedback notification	
C1 - Claim (internal)	C1 - Internal claim	Claim
C2 - Claim (external)	C2 - External claim	
G0 - General notification	G0 - General notification	General notification

SURVEY FORM APPENDIX 2 (1/3)

Toimipaikkasi: ☐ Oulu ☐ Pikkala	
Tehtävänkuvasi: ☐ Työnjohto	☐ Kunnossapitotyöntekijä ☐ Sähkö ☐ Meka ☐ Muu
Oletko Prysmian Finland:n työntekijä: ☐ Kyllä ☐ Ei	
Käyttämäsi kunnossapitojärjestelmän nimi:	

1. Valitse mitä eri toimintoja teet kunnossapito-ohjelmalla, sekä arvioi niitä ympyröimällä kyseisen toiminnon käytettävyys asteikolla 1-5 (1=helppokäyttöinen, 5=vaikeakäyttöinen)

Toiminto	**1=helppo 5=vaikea**				
Vika- / häiriöilmoituksen luominen	1	2	3	4	5
Vika- / häiriöilmoituksen muokkaaminen	1	2	3	4	5
Vika- / häiriöilmoituksen sulkeminen	1	2	3	4	5
Työmääräimen luominen	1	2	3	4	5
Työmääräimen katselu	1	2	3	4	5
Työmääräimen muokkaaminen	1	2	3	4	5
Työmääräimen sulkeminen	1	2	3	4	5
Uuden laitteen luominen järjestelmään	1	2	3	4	5
Laitetietojen katselu	1	2	3	4	5
Laitetietojen muokkaaminen	1	2	3	4	5
Laitteen huolto- / korjaushistorian katselu	1	2	3	4	5
Liitetiedostojen katselu (konepiirustukset, kytkentäkaaviot jne.)	1	2	3	4	5
Työlistojen katselu (lista kaikista avoimista työmääräimistä)	1	2	3	4	5
Varaosien ja tarvikkeiden kirjaaminen työmääräimelle	1	2	3	4	5
Tehtyjen tuntien kirjaaminen työmääräimelle	1	2	3	4	5
Tehtyjen toimenpiteiden kirjaaminen työmääräimelle	1	2	3	4	5
Uusien säätöarvojen tai asetusten kirjaaminen työmääräimelle	1	2	3	4	5
Käyttötuntimittareiden lukemien kirjaaminen	1	2	3	4	5
Varaosien saatavuustarkastelu (varastosaldo)	1	2	3	4	5

Toiminto	1=helppo 5=vaikea				
Varaosien ostotilausten luominen	1	2	3	4	5
Työlajikohtainen tuntiraportointi	1	2	3	4	5
Työkohtainen kustannusraportointi	1	2	3	4	5
Töiden viiveraportointi (suunnitellun ja toteutuneen ero)	1	2	3	4	5
Ennakkohuoltojen suunnittelu	1	2	3	4	5

2. Valitse yllämainituista toiminnoista 3 useiten käyttämääsi: No:_____
   No:_____
   No._____

3. Nykyisen kunnossapitojärjestelmän pääasiallinen käyttölaite:
   ☐ PC
   ☐ Mobiililaite: ☐ Älypuhelin
   ☐ Tabletti

4. Jos käytössä on mobiililaite, voiko käyttäjä itse muokata käyttöliittymän toimintoja:
   ☐ Kyllä
   ☐ Ei

5. Yleisarvosana kunnossapito-ohjelmasta mobiililaitekäytössä (1=helppo, 5=vaikea):_____

6. Hyödynnetäänkö mobiililaitteilla viivakoodin tai QR-koodin lukua:
   ☐ Kyllä
   ☐ Ei

7. Nykyjärjestelmän kehityskohteet, ja muita kommentteja sekä kehitysideoita uutta järjestelmää ajatellen:

   _____

   _____

   _____

   _____

   _____

   _____

   _____

   _____

SEURAAVAT KYSYMYKSET VAIN TYÖNJOHDOLLE

8. Mitä eri käyttäjärooleja nykyisessä järjestelmässä on, ja mikä on niiden käyttäjämäärä:

_____

_____

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_____

9. Kirjaa vaiheittainen kuvaus, mitä eri asioita järjestelmässä käytännössä tehdään kun kyseessä on:
   A) Huoltotyö (ennakkoon suunniteltu)

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   B) Korjaus (suunnittelematon)

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_____

G	R	O	U	P				
Manager	Supervisor	Maintenance Worker	Operator					
1	2	3	4		**Tcodes for Maintenance Plan:**			
					IP01	Maintenance Plan Create	IA06	Change General Maintenance Task List
					IP02	Maintenance Plan Change	IA07	Display General Task List
					IP03	Maintenance Plan Display	IA08	Change PM Task Lists
					IP10	Scheduling of maintenance plans	IA09	Display Task Lists
					IP11	Create/Change Maintenance Strategies	IA10	Display Task Lists (Multilevel)
					IP12	Display Maintenance Strategies	IA17	Print Maintenance Task Lists
					IP13	Create Package Sequence	IB01	Equipment BOM Create
					IP15	Change Maintenance Plan	IB02	Equipment BOM Change
					IP16	Display Maintenance Plan	CT04	Characteristic Create
					IP24	Scheduling overview list form	CL02	Classs Create
					IP30	Deadline Monitoring	IR01	Work Center Create
					IP41	Add single plan	IR02	Work Center Change
					IP42	Add strategy-controlled plan	CR05	Work Center List
					IA01	Create Equipment Task List	IPMD	Permit Create
					IA02	Change Equipment Task List	IK01	Measuring Point Create
					IA03	Display Equipment Task List	IK02	Measuring Point Change
					IA05	Create General Maintenance Task List	IK08	Measuring Points Change
					Tcodes for Maintenance Information System and Updating Maintenance Orders			
					IA09	Display Task Lists	IW49	Display Operations
					IA10	Display Task Lists (Multilevel)	IW65	Display activities
					IA17	Print Maintenance Task Lists	IW67	Display Tasks
					IH08	Display Equipment	IW69	Display Notification Items
					IE07	Equipment List (Multi-level)	IWBK	Material availability information
					IH04	Equipment Structure	MCI1	PMIS: Object Class Analysis
					IH06	Display Functional Location	MCI2	PMIS: Manufacturer Analysis
					IL07	Funct. Location List (Multi-Level)	MCI3	PMIS: Location Analysis
					IH01	Functional Location Structure	MCI4	PMIS: Planner Group Analysis
					IK07	Display Measuring Points	MCI5	PMIS: Object Damage Analysis
					IK17	Display Measurement Documents	MCI6	PMIS: Obj.Statistic.Analysis
					IP16	Display Maintenance Plan	MCI7	PMIS: Breakdown Analysis
					IP19	Maintenance scheduling overview	MCI8	PMIS: Cost Evaluation
					IP24	Scheduling overview list form	MCJB	MTTR/MTBR for Equipment
					IPM2	Change Permit	MCJC	FunctLoc: Mean Time Between Repair
					IPM3	Display Permit	MMBE	Stock Overview
					IW29	Display Notifications	CR05	Work Center List
					IW30	Notification List (Multi-Level)	IW3D	Print Order
					IW31	Create Order	IW3K	Change order component list
					IW32	Change Order	IW3L	Display Order Component List
					IW33	Display PM Order	ML81N	Creation of Service Entry Sheet
					IW34	PM Order for PM Notification	AC06	Service Entry List
					IW37	Change Operations	QE11	Record results for inspection point
					IW38	Change PM Orders	QE12	Change results for inspection point
					IW39	Display PM orders	IW37N	Change Order and Operations
					IW40	Display Orders (Multi-Level)		

G	R	O	U	P				
Manager	Supervisor	Maintenance Worker	Operator					
1	2	3	4					
					Tcodes for PM Master Data			
					IE03	Display Equipment	IK07	Display Measuring Points
					IH08	Display Equipments	IK17	Display Measurement Documents
					IE07	Equipment List (Multi-level)	IR03	Display Work Center
					IB03	Display Equipment BOM	CR05	Work Center List
					IH03	Equipment Structure	AC03	Display Service Master
					IL03	Display Functional Location	AC06	Service Master List
					IH06	Display Functional Locations	CL03	Display Class
					IL07	Funct. Location List (Multi-Level)	CS03	Display Material BOM
					IB13	Display Functional Location BOM	IA09	Display Func. Loc./Equip./General Task List
					IH01	Functional Location Structure	QS42	Display Catalog
					IK03	Display Measuring Point		
					Tcodes for Work Confirmation, Creatio and Change of Measuring Documents			
					IK11	Create Measurement Document	IW41	PM Order Confirmation
					IK12	Change Measurement Document	IW42	Overall Completion Confirmation
					IK13	Display Measurement Document	IW43	Display PM Order Confirmation
					IK16	Coll. Entry of Measurement Documents	IW44	PM Order Collective Confirmation
					IK17	Display Measurement Documents	IW45	Cancel PM Order Confirmation
					IK18	Change Measurement Documents	IW47	Confirmation List
					IK21	Coll. Entry of MeasDocuments : FL	IW48	Confirmation using operation list
					IK22	Coll. Entry of MeasDocuments : Equipment	IW49N	Display Orders and Operations
					Tcodes for SAP PM Notifications and Notifications Processing			
					IW21	PM Notification Create – General	IW30	Notification List (Multi-Level)
					IW22	PM Notification Change	IW37	Change Operations
					IW23	PM Notification Display	IW64	Change Activities
					IW24	Create PM Malfunction Report	IW66	Change Tasks
					IW25	Create PM Activity Report	IW68	Notification Items Change
					IW28	PM Notification Change	IW69	Notification Items Display
					IW29	PM Notification Display		

OBJECT PART APPENDIX 4 (1/2)

battery	akku
bearing	laakeri
bellows	johdesuoja
belt	hihna
break	jarru
cables	kaapelit
carbon brushes	hiili
chain	energiaketju
circuit board	piirikortti
connector	liitin
cylinder	sylinteri
dipstick	mittatikku
filter	suodatin
fuse	sulake
gaskets	tiivisteet
gauge	mittasauva
gear-wheel	hammaspyörä
hose	letku
info	info
key	kiila
lead screw	johtoruuvi
lighting	valaistus
limit switch	rajakytkin
locking	lukitus
lubrication device	voitelulaite
magnetic switch	magneettikytkin
micro	mikro/serveri
monitor	monitori
motor	moottori
other	muu
overload relay	lämpörele

pipe	putki
potentiometer	potentiometri
power	poweri
power supply	virtalähde
power transmission	voimansiirto
program	ohjelma
pulse sensor	pulssianturi
pump	pumppu
push button	painonappi
rectifier	tasasuuntaaja
regulator	säädin
relay	rele
resolver	resolveri
R-S converter	r-s muunnin
servos	servot
shaft	akseli
shaft drive	akselikäyttö
shaftscrew / nut	akseliruuvi / mutteri
solarpanel	valokenno
solenoid	solenoidi
spring	jousi
switch	kytkin
tachometer	takometri
thyristor module	tyristorimoduuli
tool measurer	työkalunmittaaja
transfer gear	siirtovaihde
transistor module	transistorimoduuli
valve	venttiili

DAMAGE APPENDIX 5

abnormal wear	kuluminen(epänorm.)
dent	kolhu
heat	lämpö
impurity	lika
information	info
material defect	materiaalivika
normal wear	kuluminen (normaali)
other	muu
overload	ylikuorma
programming fault	ohjelmointivirhe
regulating fault	säätövirhe
unknown	selvittämätön
user error	käyttövirhe

FUNCTIONAL LOCATION PROPOSAL FOR OULU PLANT APPENDIX 6 (1/3)

FUNCTIONAL LOCATION	DESCRIPTION	WORK CENTER
FI20-CC-DRAW-EUROALPHA	103 2j Raskasveto	1115
FI20-CC-DRAW-110	110 2j Vetokone	1225
FI20-CC-DRAW-115	115 1j Vetokone	1230
FI20-CC-DRAW-147	147 1j Vetokone	1420
FI20-CC-DRAW-150	150 1j Vetokone	1330
FI20-CC-DRAW-156	156 12j Monilankavetokone	1312
FI20-CC-DRAW-3870	3870 10j Monilankaveto	3870
FI20-CC-DRAW-4062	4062 12j monilankaveto	4062
FI20-CC-DRAW-155	155 8j Monilankavetokone	1340
FI20-CC-STRD-113	113 KERTAUS MAX. 70 MM2	2110
FI20-CC-STRD-271	271 Lesmo 16-95 mm2	2271
FI20-CC-STRD-261	261 Lesmo 0,5-10 mm2	2261
FI20-CC-STRD-KRAFT	Kraft 201	3030
FI20-CC-STRD-LESMO	LESMO 2,5-35 mm2	2111
FI20-CC-STRD-ISO LESMO	Lesmo 10-95 mm2	2272
FI20-CC-ARMO-NAUHA	RF Armeeraus	3899
FI20-CC-STRD-3611	Häkkikertaus	3611
FI20-CC-STRD-2NIEHOFF	259-260 Niehoff 0,5-10 mm2	2259
FI20-CC-STRD-4NIEHOFF	216-219 kertaus 0,5-10 mm2	2215
FI20-CC-STRD-3LESMOT	4066-68 Lesmot	2220
FI20-CC-STRD-8NIEHOFF	251-258 Niehoff	2230
FI20-CC-BRDG-SPIRKA	Spirka braiding machine 16sp 5r 4007	1799
FI20-CC-TAPE-KMB NAUHA	KMB taping machine 6r 3632	1798
FI20-CC-STRD-VASTUSL	Vastuslankakertaus	2216
FI20-CC-BRDG-24PALMIK	Braiding 24-Spools	1801
FI20-CC-TINN-2230	TI 2230	3010
FI20-CC-TINN-4034	TI 4034	4034
FI20-CC-ANNE-4010	Tyhjiöhehkutus	4010
FI20-CC-SPOL-PUOLAUS	Puolaus - johdin	5200
FI20-CC-EMUL-01	Emulsiokeskus 1	

FUNCTIONAL LOCATION PROPOSAL FOR OULU PLANT APPENDIX 6 (2/3)

FUNCTIONAL LOCATION	DESCRIPTION	WORK CENTER
FI20-CC-EMUL-02	Emulsiokeskus 2	
FI20-CC-EMUL-03	Emulsiokeskus 3	
FI20-CC-RMWH-VARASTO	RA-varasto	
FI20-CC-BLDG-JOHDIN	Tehdasrakennus	
FI20-CC-TOOL-JOHDIN	Johdin Hiomo	
FI20-CC-LABO-JOHDIN	Johdin Laboratorio	
FI20-BW-INSL-1247	ER2 AJ	1247
FI20-BW-INSL-1602	ER3 AJ	1602
FI20-BW-INSL-1122	ER1 MCMK	1122
FI20-BW-INSL-1610	ER4 KJ	1610
FI20-BW-INSL-5128	VA KJ	5128
FI20-BW-INSL-ITAL	BW ER ITAL ERISTYS	1797
FI20-BW-INSL-1701	ER6 MMJ	1701
FI20-BW-STRD-KJ LESMO	KE Lesmo KJ-solu	4613
FI20-BW-STRD-SZ MCMK	KE SZ-KE MCMK-solu	4186
FI20-BW-CORR-PUTKIJOHTO	Putkijohtolinja	0249
FI20-BW-SHTH-5702	VA MMJ1	5702
FI20-BW-SHTH-5605	VA MCMK	5605
FI20-BW-SHTH-PR VAIPPA	VA-PR VAIPPAUSLINJA	1788
FI20-BW-SHTH-ITAL	BW VA-Ital vaippaus	1795
FI20-BW-TEST-MMJ	KO MMJ	7707
FI20-BW-TEST-MCMK	KO MCMK	2708
FI20-BW-RESP-TARK MCMK	PU-Tarkastus MCMK-solu	6608
FI20-BW-RESP-TARK KJ	PU-Tarkastus KJ-solu	6607
FI20-BW-VULC-SAUNA	VULCANIZATION SAUNA	1800
FI20-BW-LABO-AJ	AJ Laboratorio	9701
FI20-BW-RMWH-VARASTO	RA-varasto	
FI20-BW-FGWH-BESTHALLI	Lopputuotevarasto	
FI20-BW-BLDG-AJ	Tehdasrakennus	
FI20-BW-SILO-AJ	massasiilot	

FUNCTIONAL LOCATION PROPOSAL FOR OULU PLANT APPENDIX 6 (3/3)

FUNCTIONAL LOCATION	DESCRIPTION	WORK CENTER
FI20-PA-COIL-R1	NI R1 Kelmupakkaus	8704
FI20-PA-COIL-R2	NI R2 Midi-pakkaus	8709
FI20-PA-CBOX-T&K	NI NI-PR TRONRUD T&K	1790
FI20-PA-CBOX-1791	NI NI-PR SKALTEK LTK	1791
FI20-PA-RBOX-1793	NI NI-FK SKALTEK 4628	1793
FI20-PA-CBOX-1792	BW NI NI-MK Skaltek 4623	1792
FI20-PA-DRUM-WINDAK	Kelapuolauslinja	0202
FI20-PA-REEL-MULLER	PU S4	6805
FI20-PA-SPOL-DECOMBE	PU KELAPUOLAUS DECOMBE	1794
FI20-PA-SPOL-1796	PU PK KELAPUOLAUS 1796	1796
FI20-PA-SPOL-8235	PU1 Puolaus	8235
FI20-PA-SPOL-8241	PU2 Puolaus	8241
FI20-PA-SPOL-8604	PU3 Puolaus	8604
FI20-PA-FGWH-VARASTO	RA-varasto	
FI20-PA-BLDG-PAKKAUS	Tehdasrakennus	
FI20-RF-INSL-ER2	RF Eristys2	3132
FI20-RF-INSL-ER3	RF Eristys3	3133
FI20-RF-INSL-ER1	RF Eristys1	3131
FI20-RF-SHTH-MAXIWEMA	RF Maxiwema	3863
FI20-RF-TUBE-PUTKILINJA	RF Putkilinja	3865
FI20-RF-SHTH-UNIWEMA	RF Uniwema	3861
FI20-RF-SHTH-PROWEMA	RF Prowema	3862
FI20-RF-SHTH-VELTTOLINJ	RF Velttolinja	3864
FI20-RF-MCUT-MITTAUS	RF Mittaus/pakkaus	5210
FI20-RF-PACK-PAKKAUS	RF Pakkaus 1	1365
FI20-RF-SPOL-PUOLAUS	RF Puolaus	1030
FI20-RF-ASSY-JUMPPERI	Jumpperi	NKJL01
FI20-BW-SILO-AJ	massasiilot	
FI20-PA-COIL-R1	NI R1 Kelmupakkaus	8704

FUNCTIONAL LOCATION STRUCTURE INDICATOR KEYS FOR PROCESS APPENDIX 7

anne	annealing
armo	armouring
assy	assembly
bldg	building
brdg	braiding
cbox	coil in a box packing
coil	coil packing
corr	corrugating
draw	drawing
drum	drum packing
emul	emulsion
fgwh	finished goods warehousing
insl	insulating
labo	laboratory
mcut	measuring and cutting
pack	packing
rbox	reel in a box packing
reel	reeling
resp	respooling
rmwh	raw-material warehousing
shth	sheathing
silo	silo
spol	spooling
strd	stranding
tape	taping
test	testing
tinn	tinning
tool	tooling
tube	tube-extruding
vulc	vulcanizing

accumulator	varaaja
annealer	hehku
armouring	armeeraus
battery	akku
binder	sitoja
binder/stranding	kertauksenpito
building	kiinteistö
cable marker/paint	maalimerkkaus
capstan	vetopyörä
caterpillar	vetolaite
caterpillar/belt	hihnavetolaite
color dispenser	väriannostelija
compressed-air dryer	paineilmakuivain
compressor	kompresori
cooler	jäähdytylaite
cooling reservoir	jäähdytinallas
cooling system	jäähdytysvesijärjestelmä
cooling trough	jäähdytysränni
corrugation line	putkijohtolinja
corrugator	korrukointilaite
cutter	katkaisulaite
dancer	tasaaja
die	langanohennin
drawing line	vetolinja
drawing machine	vetokone
dryer	kuivaaja
emulsion	emulsio
extruder	puristin
granule air conveyor	granulaattikuljetin
granule dispenser	granulaattiannostelia
granule silo	granulaattisiilo

granule system	granulaattijärjestelmä
granule tank	granulaattisäiliö
high pressure washer	korkeapainepesulaite
hopper loader	granulaatti-imuri
hydraulics unit	hydrauliikkayksikkö
ink printer	mustesuihku
insulating line	eristyskone
labeling device	etikettilaite
lift	nostin
marker/box	laatikkomerkkaaja
measuring equipment	mittalaite
motor	moottori
oil remover	öljynerotin
packing machine/box	laatikkopakkaus
packing machine/coil	nippupakkaus
packing machine/drum	kelapakkaus
packing machine/film	kelmupakkaus
packing machine/reel	kertakäyttökelapakkaus
pallet hold	lavamakasiini
pallet wrapper/film	lavakelmutuslaite
pay-off	lähtölaite
pay-off/basket	lähtölaite häkki
pay-off/drums	lähtöpukki
pay-off/funnel	lähtölaite suppilo
pay-off/tape	lähtölaite nauha
peeling machine	kuorimiskone
plastic grinder	massamurskaaja
pneumatics	paineilmalaitteet
preheater	esilämmitin
preheater/wire	langan esilämmitin
pre-strander	esikertaaja

printer	kirjoitinlaite
pulley	taittopyörä
robot	robotti
robot/pallet	lavarobotti
rod break-down	raskasveto
roller conveyor	rullarata
safety lighting	turvavalaistus
soldering station	juotosasema
spooler	puolaaja
spooler/box	laatikkopuolaaja
spooler/coil	nippupuolaaja
spooler/double	kaksoispuolaaja
spooler/scrap	romupuolaaja
spooler/tape	nauhapuolaaja
stapler	nitoja
strander	kertauskone
strander/cage	häkkikertauskone
SZ-strander	SZ-kertauskone
SZ-strander/tube	putkikertaaja
take-up/basket	häkkipuolaaja
take-up/drums	vastaanottopukki
talcum equipment	talkkauslaite
talcum owen	talkkiuuni
tape washer	nauhanpesulaite
taping machine	nauhoituslaite
taping machine/PES	PES-nauhoituslaite
testing field	koestuskenttä
testing field/1-phase	koestuskenttä 1-vaiheinen
testing field/3-phase	koestuskenttä 3-vaiheinen
tinning line	tinauslinja
tinning machine	tinauskone

ultrasonic washer	ultraäänipesulaite
vacuum	imuri
welder	hitsauskone
welder/cold	kylmähitsauskone
welder/spot	pistehitsauskone
welder/TIG	TIG-hitsauskone