MAINTENANCE DATA MANAGEMENT DEVELOPMENT IN PRODUCTION PROCESS CHANGE PROJECTS

Case Studies of Ongoing Investments

Lappeenranta–Lahti University of Technology LUT

Master's Programme in Mechanical Engineering, Master's thesis

2024

Jesper Kero

Examiners: Docent Harri Eskelinen

Katriina Mielonen, D. Sc. (Tech.)

ABSTRACT

Lappeenranta–Lahti University of Technology LUT

LUT School of Energy Systems

Mechanical Engineering

Jesper Kero

Maintenance Data Management Development in Production Process Change Projects: Case Studies of Ongoing Investments

Master's thesis

2024

121 pages, 28 figures, 4 tables and 6 appendices

Examiners: Docent Harri Eskelinen and Katriina Mielonen, D. Sc (Tech.)

Keywords: maintenance data management, physical asset management

In the thesis was studied maintainability consideration in production process and equipment change projects in UPM Finland Pulp Operations' pulp mills (Kymi, Kaukas, Pietarsaari).

The background of the work is the observed delays and deficiencies on considering maintainability of the equipment taken into use in investment projects of target company's pulp mills. When taking the equipment into use, the equipment's documentation, criticality classification, equipment information, maintenance plans and spare part information are not completely or partly processed. The goal of this thesis is to find information on what could be done to avoid the delays and deficiencies.

First the existing literature about the prevailing maintenance strategies and what should be considered in the production process change projects is studied. Next, six case studies from three different mills of the target company were conducted. In the case studies, tasks to be done during the project related to maintainability of the modified production process, were identified from the existing instructions. A theoretical state and an actual state of the project's maintenance data management process related aspects was modelled. Development needs were revealed trough comparing the states. Finally, development ideas were studied through focused interviews arranged for specialists within the field.

In the work, areas needing development were identified, how the current process and operating method could be developed, so that the maintainability would be better considered during the project.

TIIVISTELMÄ

Lappeenrannan–Lahden teknillinen yliopisto LUT

LUTin energiajärjestelmien tiedekunta

Konetekniikka

Jesper Kero

Kunnossapitotiedonhallinnan kehittäminen tuotantoprosessien muutosprojekteissa: tapaustutkimuksia meneillään olevista investoinneista

Konetekniikan diplomityö

2024

121 sivua, 28 kuvaa, 4 taulukkoa ja 6 liitettä

Tarkastajat: Dosentti Harri Eskelinen ja Katriina Mielonen, TkT

Avainsanat: Kunnossapidon tiedonhallinta, tuotanto-omaisuuden hallinta

Opinnäytetyössä tutkittiin kunnossapidon huomioimista tuotantoprosessi- ja laitemuutosprojekteissa UPM Suomen kuituliiketoiminnan sellutehtailla (Kymi, Kaukas, Pietarsaari).

Työn taustalla ovat havaitut viiveet ja puutteet kohdeyhtiön sellutehtaiden investointiprojekteissa käyttöön otettujen laitteiden huollettavuuden arvioinnissa. Laitteen käyttöönoton yhteydessä laitteen dokumentaatiota, kriittisyysluokitusta, laitetietoja, huoltosuunnitelmia ja varaosatietoja ei käsitellä kokonaan tai osittain. Tämän opinnäytetyön tavoitteena on löytää tietoa siitä, mitä voitaisiin tehdä viiveiden ja puutteiden välttämiseksi.

Ensin tutkitaan olemassa olevaa kirjallisuutta vallitsevista kunnossapitostrategioista ja siitä, mitä tuotantoprosessin muutosprojekteissa tulisi ottaa huomioon. Seuraavaksi tehtiin kuusi tapaustutkimusta kohdeyrityksen kolmelta eri tehtaalta. Tapaustutkimuksissa, olemassa olevien ohjeiden mukaiset projektin aikana suoritettavat tehtävät, mitkä liittyvät muunnetun tuotantoprosessin kunnossapidettävyyteen projektissa tunnistettiin. Projektin kunnossapitotietojen hallintaprosessiin liittyvien näkökohtien teoreettinen tila ja todellinen tila mallinnettiin. Kehitystarpeet selvitettiin malleja vertailemalla. Lopuksi kehittämisideoita kerättiin asiantuntijoille järjestetyissä kohdennetuissa teemahaastatteluissa.

Työssä tunnistettiin kehittämistä vaativia alueita, miten nykyistä prosessia ja toimintatapaa voitaisiin kehittää niin, että kunnossapito huomioidaan paremmin projektin aikana.

ACKNOWLEDGEMENTS

I would like to express my gratitude to the thesis examiners and the representatives from the research target company fort their invaluable contributions and unwavering support throughout the research process. The received guidance, insightful feedback, and mentorship have been fundamental in shaping the thesis and ensuring its completion within a remarkably tight timeframe alongside working fulltime. Their expertise and commitment have not only enriched the quality of the thesis but also broaden my understanding of the subject, research process, including myself as a professional. I would like to thank also everyone participated in providing insights for the research, which consists of numerous people around Finland in Tampere, Pietarsaari, Kouvola, and Lappeenranta, and some located around the world in Poland, Spain, and United States.

My family and friends have given me the needed space for finishing, not only this thesis, but the whole program, all while balancing a full-time job with everything else, so they deserve my gratitude as well. A special thanks goes to my spouse, who has supported me throughout everything and helping me stay focused on accomplishing my goals. Now it is time to have a look around what have happened outside my fulltime job and the studies during the past 7 months and move forward from there, staying curious.

Jesper Kero

Jesper Kero

Rauma, 25.3.2024

ABBREVIATIONS

AI	Artificial intelligence
AR	Augmented Reality
BRICS	Countries (Brazil, Russia, India, China, South Africa)
CBM	Condition-Based Monitoring
CMMS	Computerized Maintenance Management System
DMAIC	Design, Measure, Analyze, Improve, Control
ERP	Enterprise Resource Planning system
FID	Final Investment Decision
IoT	Internet of Things
JIT	Just in Time
MM	Maintenance Management
MOP	Minor Operative Project
PDCA	Deming cycle, Plan-Do-Check-Act
QFD	Quality Function Deployment
RCM	Reliability Centred Maintenance
ROI	Return on Investment
SAP	ERP system of the research target company
SPC	Statistical Process Control
TPM	Total productive maintenance

Table of contents

Figures

Tables

1 Introduction

This study has been carried out for UPM Finland Pulp Operations which is referred to as the target company in this study report. UPM Kymi, Kaukas, and Pietarsaari pulp mills are part of UPM Finland Pulp Operations. UPM Pulp Finland Operations is part of UPM Pulp Business area, which together with UPM Timber forms the UPM Fibres reporting segment. UPM Kymmene Oyj corporation consist of 7 reporting segments in total UPM Fibres, Energy, Raflatac, Speciality Papers, Communication Papers, Plywood, and other functions.

In this study, information is gathered for developing maintenance data management process in projects related to production process changes and equipment renewals in the target company. In this chapter is presented the research motivation, problem, objective, methods, scope, and contribution.

1.1 Motivation and research problem

Intensified globalization has led to manufacturing capacity being moved closer to the market, away from Finland. The target countries are usually the so-called BRICS-countries (Brazil, Russia, India, China, South Africa), where the economic growth is strong. During this transition, the Finnish companies and mills must remain competitive with aging machinery, while the production facilities of the BRICS countries have the latest and most efficient equipment resources at their disposal. The key elements are effective production and the expertise, i.e., how an efficient process can be run optimally. (Järviö & Lehtiö 2017, p. 16.)

One of the key points in UPM Kymmene Oyj is about effective capital allocation meaning investing capital in projects offering sustainable and attractive returns, supported by clear competitive advantage (UPM 2023). This means for example the possibility to upgrade a part of a mill production process by a solution that has i.e., a certain return on invested capital. The mill availability plays a key role in ensuring the return on investment (ROI). When changes are made in the production process, it means the way of operating the mill will change and the resources (employee skills, maintenance management system, technical documentation, spare part needs) needs to be developed accordingly to meet the new operating environment. A major part for mill availability is to have the maintenance data

(operation and maintenance instruction, maintenance plans, spare parts, equipment hierarchy and data) up to date to ensure the modified production process is operated and maintained, according to equipment manufacturer instructions and the operating environment requirements. In the target company, when production process changes are implemented, maintenance data management process is based on reliability centred maintenance (RCM) strategy. The strategy is implemented to ensure mill effectiveness and availability when the changed production process is started up. Maintenance data management process needs to be implemented effectively and by making no mistakes to ensure that the mill can be operated and maintained successfully already when new machinery is taken in to use. When this maintenance data management process is executed successfully in a project the equipment is operated and maintained considering the manufacturers and the operating environments requirements and no unforeseen machine faults or downtime shall occur. As a basis for the maintenance data management process is the manufacturer requirements and the equipment criticality classification, which is considering the operating environment safety, environmental, failure interval, repair costs, quality costs and loss of production in predictable situations.

Maintenance is data and competence-based management of production physical fixed assets. Maintenance is an investment for which the benefit comes from the optimized and controlled management and use of the production process. The more efficient the management is the more product can be manufactured. This is a way to maintain or improve the cost efficiency of the company. The efficiency of the management of the production assets is formed by two factors: desire, and ability. Ability is formed by knowledge and skills and if these are not in order, sufficient ability and further efficiency cannot be achieved. (Järviö et al. 2017.)

The target company maintenance strategy and organization have been developed and studies, about different maintenance strategies have been implemented. Earlier published master thesis studies done by the target company, are listed in appendix 1. Detailed instructions, training and data management software based on the earlier experience have been implemented with the aim to improve the maintenance data management in production process change projects. The software is meant for project organizations use to receive, review, utilize, and archive the information related to a project. This also includes the maintenance data management, where information is received from suppliers, reviewed, utilized, and finally achieved in the needed systems (project document archive and

maintenance management system). The system is not utilized in smaller scale projects according to company requirements. Project organizations are finding workarounds and managing project documents in other ways, causing the data to be stored mostly in unmanaged ways which leads to not having a working archive for project documents and not having the data available for the maintenance and operations personnel when new machinery is taken into production.

The target company internal documents related to this research is listed in appendix 2.

Despite continuous development and investments, the maintenance data management for assets modified, removed, and upgraded in production process change projects is not yet implemented in accordance with the set requirements. This deficiency affects the reliability of the maintenance management system (plant maintenance module of SAP ERP). Managing maintenance-related data for new assets during the project is crucial for the asset life cycle and the mill availability. The maintenance data management process requires specialists' attention from both the manufacturers and the user's side and requires coordination. The maintenance data management process shall be followed by the project organization responsible for the implementation of the change. A part of the maintenance data management process is a list of tasks to be finished during the project related to maintainability of the assets affected by the project. The status of the list is followed up and reported on monthly basis. Based on the follow up reports from the past 5 years the maintenance data management process is not finished in many of the projects. Reports shows that some mills are performing better than others related to completing the tasks.

1.2 Objective

A profound study of the maintenance data management process in production process changes projects and the prevailing challenges which shall be turned in to development opportunities. Creating a proposal for what the target company could do, to ensure that the maintenance requirements would be considered in production process change projects during the project implementation phase.

In the theoretical part, the objective is to review the prevailing maintenance strategies, how those have evolved, how processes shall be developed and how changes should be

successfully implemented. Maintenance strategies are examined to understand the prevailing maintenance strategies and how those have evolved. Process management theories are examined to understand what needs to be considered when developing existing processes (management processes). Change management theories are examined to understand how the changes shall be implemented in this context where available processes are changed.

The experimental part consists of two entities. The objective of the first entity is to review how project organization personnel responsible for project maintenance planning, is following the company requirements in practice and how this compares to the company available maintenance data management strategy. The comparison is utilized to find out what are the key challenges faced in the process that needs to be developed. The second entity is to find out how the challenges faced, in the current process, could be developed.

The main research question of this study is:

- How and on what basis could the target company develop the existing maintenance data management process to ensure that the production process change projects implementation meets the company maintenance requirements?

1.3 Research methods

The study consists of a two main parts, theoretical and empirical research. The study is a multi-methodology research where both qualitative and quantitative research methods are utilized. In the theoretical part of the research a literature review is conducted and the empirical part of the research compiles observations from experiments and measurements received trough case studies and focused interviews where the results of the theoretical part are noted to know possibly how the shortcomings of the process could be developed. Qualitative research: Literature review, Focused interviews. Multimethodology, both qualitative and quantitative research: Case studies.

Chapter 2 focuses on a literature review. In the literature review answer will be researched for research questions built based on the main research questions. The questions are available in each chapter introduction. Literature review introduces maintenance evolution and prevailing maintenance strategies, practices, and their development during industrial revolutions to figure out the current state of maintenance. A brief introduction is done of

process management and change management to understand the principles to what shall be considered related to development and implementation of management processes. Literature research will be done not only researching for facts, but also ideas about how things could be, to help eliminate existing grievances.

In chapter 3 is a detailed description of the research process and the methods are reviewed in detail including the implementation of the research. A questionnaire is implemented based on the company instructions which is utilized as a basis for case studies and focused interviews. Six projects in total, two projects from all each of the three mills of the target company are selected as case studies to model the project machinery related maintenance data management theoretical and actual state. The theoretical and actual state is compared to find out the development needs for the current maintenance data management process. Focused interviews are arranged for specialists to gather development ideas.

In chapter 4 the research results will be reviewed. Based on the earlier chapters and studies an answer is given to why the maintenance data updating is not done currently according to instructions and available processes and why is not the process implemented according to company requirements and what could be the development possibilities for the process in the future. The fundamentals for a more effective maintenance planning process will be reviewed and possibilities to develop the process.

In chapter 5 is the discussion of the study. Comparison of the research results by other research and literature review, research objectivity, research reliability and validity, error checking, key findings, the novelty value of the results, usability and generalizability of the results and further research topics is discussed.

In chapter 6 is the conclusions of the research. How well the research achieved its objectives and what was the findings. and what they mean in a wider perspective and for the future.

The research flow chart is presented in figure 1.

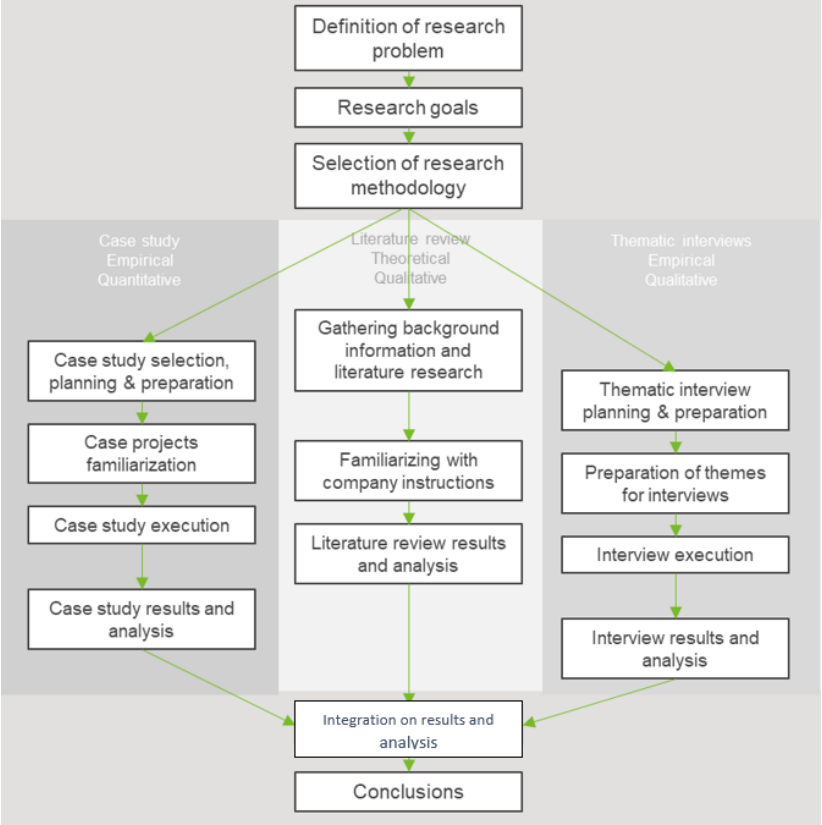


Figure 1. Flow chart of research flow

For more detailed flow chart where each research method research question is presented can be found in appendix 3.

1.4 Scope

The study will focus on maintenance data management process and related instructions and supportive tools development in the target company three different pulp mills from mechanical renewal projects perspective and mechanical maintenance point of view. Other disciplines such as Automation, Electrification, and Civil are excluded from this study.

The maintenance data management process consists of reviewing and updating of maintenance data listed below:

- Functional location numbering
- Equipment Criticality classification

- Technical documentation
- Equipment data
- Maintenance planning data
- Spare parts and spare part data
- Equipment bill of material
- Warranty information for equipment
- Old data removal/deactivation

The maintenance data management process related instructions and supportive tools are listed in appendix 2 and below is listed the parts for which the development possibilities will be reviewed in this study.

The maintenance data management process supportive tools are listed below.

- Project document management software
- Templates related to equipment manufacturer data management.
    - Document delivery template
    - Equipment data template
    - Periodical maintenance planning templates
    - Spare part master data template

The maintenance data management process supportive instructions are listed below.

- Project document management (305)
- Maintenance planning in projects (307)

Development topics outside the above list is left outside the research.

1.5 Contribution

The research will give a status on what issues the research target company is facing related to maintenance data management process and how that could be implemented based on the combination of latest theories and experiences. Aim is to study how the maintenance data management process, supportive tools and related instructions could be developed and how the suggested development steps are justified.

2 Literature review

This chapter consist of the literature review of this study, which focuses on gathering information about maintenance, process management, and change management. The aim of the literature review is to gather insights that will inform the implementation of focused interviews and case studies which together address the main research question specified in the introduction. At the end of this chapter an answer is provided to answer the research questions for literature review. The research questions for this literature review are structured according to the main research question.

- What are the prevailing maintenance strategies and practices, how have they evolved?
- What should be considered in projects so that when commissioning new equipment and machinery, the maintenance system would be updated, considering the information of the equipment manufacturer and the end user?
- What are the principles of process management and change management? How can these principles be utilized in the development of the prevailing maintenance data management process in target company?

All in all, 44 references are studied in this literature review to figure out the answer for the specified research questions. Books, conference releases and articles are utilized in this literature review.

2.1 Maintenance

In Finnish standard SFS-EN 13306 (2017, p. 8) maintenance is defined as a “combination of all technical, administrative, and managerial actions during the life cycle of an item intended to retain it in, or restore it to, a state in which it can perform the required function”. The same standard defines maintenance management (MM) as “all activities of the management that determine the maintenance requirements, objectives, strategies and responsibilities, and implementation of them by such means as maintenance planning, maintenance control, and the improvement of maintenance activities and economics” (SFS-

EN 13306 2017, p. 9). Standard SFS-ISO 55000 (2014, p.11-15) describes asset management as “coordinated activity of an organization to realize value from assets”, where assets are described as “item, thing or entity that has potential or actual value to an organization”. Organization is defined as “person or group of people that has its own functions with responsibilities, authorities and relationships to achieve its objectives”, where objectives is described “results to be achieved”. Asset management activities required to be done by an organization can be controlled, coordinated, and directed with the utilization of an asset management system. (SFS-ISO 55000 2014, p. 11-15.)

The definition of maintenance is aligned to other maintenance literature such as Fausto, Garcia and Mayorkinos, Marquez, Velmurugan and Dhingra and Lambert-Torres, Bonaldi and Oliveira (Bonaldi, Lambert-Torres & Oliveira 2023; Velmurugan & Dhingra 2021; Garcia, Fausto & Mayorkinos 2020; Marquez 2022). By Bonaldi, Lambert-Torres & Oliveira, (2023): “In addition maintenance, include protective and corrective actions to keep the plant operational system in intended conditions or to maintain the acceptable manufacturing conditions. Optimum maintenance policies aim to sustain system reliability and robustness within minimum cost. In line with the progress of industry, increase in the system, material, and manpower costs, increasing demand for robustness and the complex structure of the machines also increases the importance of maintenance policies.”. According to Marquez (2022, p. 7): “Although maintenance management and asset management are technically different, they are still interrelated and should work in an integrated manner.”

Maintenance plays a central role in ensuring the reliable operation of production line machinery. Maintenance has changed from necessary unwanted tasks to be performed, to a common partner of the production, supporting the use of available assets. Before, maintenance was part of the manually implemented production work, but with development it has become more and more automated. (Vartiainen 2023.) Life cycle costs (LCC) are the sum of all the costs during the asset lifecycle, from planning phase until the disposal of an asset. When focusing on the reliability and maintainability of an asset acquired in an investment/project, the conceptual and development phase should be implemented carefully, as studies are showing how during this early stage of the project 95% of the LCC are determined for an asset. Once new machinery and equipment reaches the manufacturing and installation stage in the implementation of the project, there is only a 5% opportunity left, where the maintainability and the reliability of the machinery and equipment can effectively

be improved (Houshyar 2005). Opportunities to influence the costs are high at the planning phase and decreases significantly, and stays low during the operation, until the disposal of the asset. In the figure 2 is presented how opportunities to influence and cumulative costs are evolving trough time (Hastings 2021).

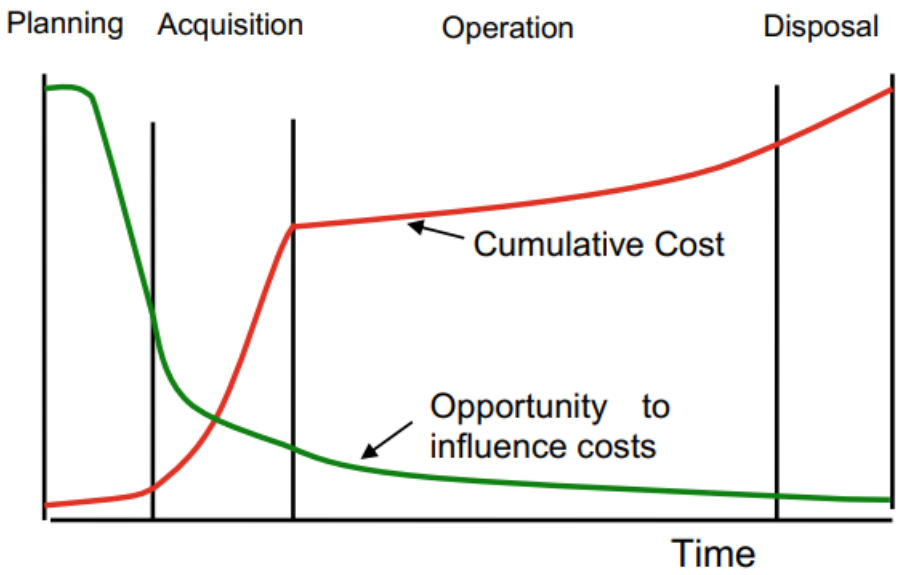


Figure 2. Lifecycle stages (Hastings 2021).

2.1.1 Maintenance evolution and prevailing maintenance strategies and practices

Industrial development has gone through four major revolutions and simultaneously with the industry development, MM has constantly developed to be able to respond to the evolving requirements of industrial revolutions (Shaheen & István 2022). The industrial revolutions are industry 1.0, 2.0, 3.0 and 4.0.

Klaus Schwab in his book “the fourth industrial revolution” describes the first industrial revolution to have started in the 18th century taking place to the 19th century bringing mechanical innovations like the steam engine, cotton spinning and railroads (Schwab 2016). This revolution brough the first-generation maintenance to awareness. Downtime did not matter much since the industry was not very highly mechanized. It was not a very high

priority to prevent equipment failure since downtime did not matter. At the same time, most equipment was simple and mostly those were overdesigned because of the large safety factors, which corrected the calculation of dimensioning, there was no need for any kind of systematic maintenance additionally to tasks that was very simple such as cleaning, basic maintaining, routinely performed lubrication cycles, and therefore there was no need for any special skills for personnel doing the works. (Basson 2019.)

During the first-generation maintenance methodologies such as quick responding and correction when equipment failure occurred was utilized. Preventive maintenance mainly consisted of cleaning, adjusting and lubrication. (Marquez 2022). Maintenance was mainly reactive and maintenance team was reinforced by trained craftsmen and the operational equipment effectiveness was below 50% (Poor, Basl & Zenisek 2019).

The second industrial revolution has started in 19th century taking place to the mid-20th century that brought mass production trough assembly lines and electrification (Schwab 2016). This phase brought second generation maintenance. During the Second World War, the increased demand for all kinds of products, together with the availability of labour collapsing, led to the development of mechanization. Machines became more complex, and industry began to depend on them. Due to this dependence, production interruptions became worth noting, which led to the idea that equipment failures can and should be successfully prevented, which in turn led to the development of preventive maintenance. Preventive maintenance in the mid-twentieth century mainly consisted of pre-defined fixed schedules. This led to a radical increase in maintenance costs in relation to production costs, which in turn led to planning of maintenance and use of control systems. During this period the people started seeking ways to maximize the life of the assets. (Basson 2019, p. 12; Järviö et al. 2017.) The constant tightening of the competitive situation caused that the profitability of companies depended to an increasing extent of the efficiency of the use of machines. Maintenance was more complex, machinery brough a new type of failure mechanism, that was time dependent and where early-stage failures started to occur. This also increased the need for maintenance management. As a result, preventive maintenance was developed, which at first was mostly periodical maintenance and was done at predetermined intervals. The increase in costs also led to maintenance planning and management, with the help of which efforts were made to reduce the costs of using resources to tolerate levels and increase the operational reliability of the machines. (Järviö et al. 2017, p. 22.)

During the second-generation maintenance methodologies became more systematic. Periodical maintenance operations, maintenance planning and maintenance work was managed. During this stage computers were utilized but those were very big and slow. (Järviö et al. 2017, p. 24.) Maintenance started to be based on planning, covering instrumental inspection and maintenance team was reinforced by inspectors. The operational equipment effectiveness was increased compared to earlier revolution. (Poor et al. 2019.)

The third industrial revolution to started in twentieth century taking place to the twenty-first century that brought mainframe computers, personal computing, and the internet (Schwab 2016). Third generation maintenance started. This generation started by the results of American space project concepts and innovations implementation in industry sector. The reliability requirements could be set to a whole new level. Research created new approaches, tools, and techniques. The importance of efficiency and reliability increased. The degree of automation of the mechanisms of production machines increased, so that business operations became more and more dependent on the machines and their reliability. Disruptive shutdowns were more expensive than avoiding breakdowns. New technologies changed the focus of operations; the ability to innovate and manage new technology became a critical success factor. Competition became global and intensified. Additional pressure was also created by the difference in cost structures (for example salary costs). The JIT operating model became more common. When buffer storage of any kind costs money, the reliability of the machines must be brought to such a level that interim storage is not needed. More and more capital became tied up in the production equipment. The liberalization of world trade and globalization led to a situation where the importance of locality as a competitive factor decreased; quality, know-how, affordable price and keeping delivery promises have taken their place. These are influenced by controlling the usability, reliability, and consistency of the quality of the delivered products. Environmental friendliness also rose to the same level. Machines are complex wholes that use several technologies. better raw materials, more precise design methods and more advanced manufacturing methods are available. These together have given rise to new failure models, which are characterized by the amount of use. (Järviö et al. 2017, p. 22.) Life and manufacturing went digital including the internet, digital technologies, personal computing, and mass customization when the expectations changed to wanting reliability from having high availability. The new technologies allow more stakeholders to collaborate on new products. (Basson 2019, p. 12.)

During the third-generation maintenance, the hallmarks of this phase was condition monitoring, consideration of maintenance and reliability during machinery design, basic analyses (risk and failure), specialized systems and multiskilled maintenance personnel. (Järviö et al. 2017, p. 24.) Maintenance started to be productive covering instrumental monitoring the state by sensors and maintenance team was during this time reinforced by reliability engineers and the operational equipment effectiveness increased (Poor et al. 2019).

Industry 4.0, Predictive maintenance when the relationship between physical assets and digital assets.

The fourth industrial revolution is also described as the second machine age and is far more different from the previous industrial revolutions. Technologies are merging the biological, physical, and digital worlds and has an impact in all the disciplines, economies, and industries. Through digital networks, billions of people can be connected at the same time, which can have an effect to significantly improve the organizations efficiency and even manage assets in different ways. It is also possible to work in sustainable ways, even repairing the damage caused by previous industrial revolutions. (Schwab 2016.) the revolution started in late 20th century during the breakthrough of microelectronics and IT technologies. The integration of manufacturing processes and the increase in automation increase the prices of production machines. New technologies, such as electronics, pneumatics, information technology and complex (using many different technologies) production equipment change the also skill requirements of maintenance workers. Shorter life cycles of products also affect machine usage strategies; the sales of the product or the features of the machine often run out before the machine is used up. A serviceable, even a relatively new machine must be rejected. Remote monitoring brings top expertise to places that seem almost impossible if necessary. For example, if the ship's main engine is not working properly, in the middle of the ocean, you can contact the manufacturer's experts, who will record the measurement results and the video image. With maintenance information systems, the masses of information related to the operation of the device can be managed and served to the maintenance staff. Reliability and performance are not based on the principle of quick repairs, but on the fact that the machine is used appropriately and the users, for their part, participate in nurturing the efficiency of reliability. (Järviö et al. 2017 s. 23.) Technologies continues to develop and becomes even more integrated into people’s

everyday life, so as Schwab (2016) writes “a fusion of technologies that are blurring the lines between the physical, digital, and biological spheres”. The increasing complexity of manufacturing systems requires an increasing focus on maintenance which is becoming an essential part of the complete production process. This requires attention to reducing associated costs while enhancing productivity, quality, and profitability. To achieve these goals, more complex knowledge is required, leading to predictive maintenance strategy development through improved decision-support systems, resulting in reduced machinery and equipment failures and downtimes. In the integration of MM with Industry 4.0, prescriptive maintenance is another strategy, which requires more complex knowledge and is aligned with the support of software, AI, developed sensory systems, CBM, IoT, big data, AR, and other tools. (Shaheen et al. 2022, p. 2.) Predictive maintenance considers the maintenance and performance costs, additionally according to Shaheen it “measures the efficiency and productivity and predicts remaining useful life before failure happens” and “it is an efficient strategy that can reduce the downtime of machines by 30-50% and extend their lifetime by 20-40% compared to traditional strategies”. Prescriptive maintenance goes even further than predictive maintenance when it is not examining only the equipment itself but also the surrounding environment considering the relationships between the environment and the equipment. (Fazel, Glawar & Nemeth 2019; Shaheen et al. 2022, p. 4.) Maintenance is becoming predictive covering predictive analysis and maintenance team will be reinforced by data scientists and the operational equipment effectiveness will become even higher according to a study (Poor et al. 2019).

Research on literature by Poor et al., (2019) summarizes industrial revolutions and the development of maintenance strategies according to the table 1.

Table 1. Correlation of industrial revolution and maintenance (Poor et al. 2019).

Industry revolution	**Industry 1.0**	**Industry 2.0**	**Industry 3.0**	**Industry 4.0**
Characteristics of the industrial revolution	Mechanization, steam power, weaving loom	Mass production, assembly lines, electrical energy	Automation, computers, electronics	Cyber Physical systems, IoT, networks, cloud, BDA
Type of maintenance	**Reactive maintenance**	**Planned maintenance**	**Productive maintenance**	**Predictive maintenance**
Inspection	Visual inspection	Instrumental inspection	Sensor monitoring	Predictive analysis
OEE	<50%	50-75%	75-90%	>90%
Maintenance team reinfocement	Trained craftsmen	Inspectors	Reliability engineers	Data Scientists

According to literature review done by Shaheen et. al. (2022, p. 5) industry 4.0 technologies consist of the Internet of Things, Cloud computing, Big data, Simulation, Artificial intelligence, and Cyber-physical systems and describes these as following: IoT: “represents the system in which elements such as equipment, devices, and machinery, communicate with each other and with cyber elements, such as software and data” (Shaheen et al. 2022, p. 5). Cloud computing: “comprises online resources, such as servers, applications, and networks, to offer regular services that require more investment and resources to operate locally. – cloud computing is one of the main infrastructures for big data” (Shaheen et al. 2022, p. 5). Big data: “Big data is related to the development of internet and connectivity, which have generated production related data in large volumes, with high velocity, variety, and veracity. Such data require more sophisticated systems that can handle, analyse, and transform them into useful knowledge. -- only meaningful information is extracted and knowledge is transferred efficiently to support business activities” (Shaheen et al. 2022, p. 5). Simulation: “a powerful computational tool for designing, analysing and understanding the behaviour of complex systems; it plays a key role in the successful implementation of digital manufacturing. -- complex systems can be modelled with simulation, and virtual experiments can be conducted to validate or configure processes or products to support decision making” (Shaheen et al. 2022, p. 5). Cyber physical systems: Utilization of network devices to combine the physical world that is consisting of equipment, machinery, and complete manufacturing facilities into a digital (cyber) world trough network device, “where both the cyber and the physical parts interact” (Shaheen et al. 2022, p. 5).

A Research on Zero-defect Manufacturing (ZDM), reviewing 280 research articles between 1987 and 2018 pointed out six major shortcomings of current research in ZDM, from which the one was about not having the required focus on the early stages of the equipment’s manufacturing lifecycle (Psarommatis, May, Dreyfus & Kiritsis 2020). According to Abirami and Padmakumar (2023, p. 969), the “concept of Industry 4.0 and Industry 5.0 technologies revolves around collecting, processing, monitoring, storing, and analyzing data from numerous connected sources to improve the process efficiency, make decisions, and learn on the go. The computing, information, and digital technologies come together to achieve this common goal.” Abirami et al. is evaluating the dimensions of sustainability and stating in his paper that industry 5.0 is about intelligently utilizing the data which is generated, processed, and analyzed during the last two industrial revolutions focusing on the sustainability aspects (Abirami & Padmakumar 2023, p. 969). Industry 5.0 is a future

scenario where lines between humans and machines will blur even further and innovative technologies are reshaping the landscape of industrial processes. Intelligent automation develops collaborative robots. (Eschblach 2021.)

2.1.2 Maintenance Management, Physical Asset Management

Finnish standard SFS-EN 13306 (2017, p. 9) defines maintenance management as following: "all activities of the management that determine the maintenance requirements, objectives, strategies and responsibilities, and implementation of them by such means as maintenance planning, maintenance control, and the improvement of maintenance activities and economics". Finnish standard SFS-ISO 55000 (2014, p. 11-15) defines asset management as "coordinated activity of an organization to realize value from assets" and organization as "organization is a person or a group of people that has its own functions with responsibilities, authorities, and relationships to achieve its objectives" and objectives are results to be achieved. Hastings provides an extended definition for asset management and writes: "we need a definition which is more informative to the general public than that given in ISO 55000". Asset management goes beyond only maintenance by incorporating comprehensive activities such as strategic decision-making, acquisition, logistical support, and eventual disposal, all aimed at effectively meeting business objectives throughout the entire lifecycle of asset. (Hastings 2021.)

Maintenance management (MM) can be considered as a part of physical asset management. Physical asset management consists of improving the functionality and taking care of the operational condition of the physical asset. Improving the functionality includes improving the maintainability and the reliability of the physical assets. Taking care of the operational condition includes the physical asset daily use, condition monitoring, preventive, proactive and corrective maintenance, and service. Daily use is done by the operations and when done following the instructions it is proactively maintaining the operational condition of the physical asset. Condition monitoring of the asset is mainly done both by the operating organization and maintenance team or function. Preventive and proactive maintenance is done mainly by the maintenance function/team, but some activities can be done by the operating organization. These are all proactive functions that can be planned and scheduled, which means those are manageable. Corrective maintenance is the reactive function and

needs to be done by the maintenance team. Corrective maintenance needs to be done either immediately when fault is happening or later, if possible. The management of corrective maintenance is in practice impossible and corrective maintenance in terms of total costs are over ten times more expensive than physical asset management based on proactivity. (Järviö et al. 2017, p. 15.)

Total productive maintenance (TPM) functions are like asset management mode of operation and aims to create and maintain optimal operating conditions for production machinery. TMP is originally a Japanese model, and the starting point of the philosophy is the idea of slowly changing operating conditions in an unfavourable direction and therefore the increase of the productivity demands improving of these operating considered. The core idea is that all the equipment and machinery that the production process relies on will be kept in optimal operating conditions and their performance is maximized and this will be accomplished when the operations personnel is accountable of TPM implementation. (Järviö et al. 2017, p.147-148.) TPM methodology is widely used for improving maintenance, manufacturing methods, and usage of the equipment to increase the availability of existing facilities reducing stops, defects, and downtime. The methodology promotes the employee participation in maintenance and operation and has a relevant role in reducing wastes, defects, and stoppages. (Marquez, Gomez Fernandez, Diaz & Amadi-Echendu 2023, p. 14-15.)

Some of the central goals of TPM are to develop a maintenance system that covers the entire life cycle of the machinery. This shall be done by involving all people and departments of the entire company's levels involved in the design, operation, or maintenance of the machine. Maintenance planning and implementation shall be done by those groups whose work tasks in some way is related to the machinery. The most typical such group consists of people who operate and maintain the machinery. (Leanproduction 2024.)

Reliability-centred Maintenance (RCM) is a strategic approach used to develop a tailored maintenance program for machines or their components. Geisbush and Ariaratnam describes RCM to be a maintenance strategy which is planned for optimization of the company's or mill's existing maintenance program. The RCM process evaluates assets to strengthen their functions, identifying functional failures that might appear and cause deviations to the functionality of the assets RCM also is reviewing the probabilities of functional failure, and creates the cost prevention. RCM process is planned to ensure that an asset remains

functional within its operational environment, and this is achieved by identifying the asset's primary function, potential failure modes, and prioritizing these failure modes. RCM determines the most effective preventive maintenance tasks that can be implemented in a cost effective and efficient manner to minimize risk of failure. RCM has been used and developed since the mid-twentieth century. (Geisbush & Ariaratnam, 2023.) Understanding the processes and equipment is crucial to select appropriate maintenance strategies for each component. Tools have been developed to identify critical processes, steering the selection of optimal maintenance methods. These methods are particularly relevant for processes where unreliability leads to unacceptable risks, ensuring maintenance planning prevents these risky situations. RCM corrects certain deficiencies by first identifying which processes require the most maintenance. It involves prioritizing these processes, understanding the machinery involved, and studying potential failures and their consequences. This analysis helps in ranking equipment based on the severity of potential failures. The next step involves evaluating various maintenance methods for their feasibility, leading to a revised maintenance program for the production plant. The TPM method, starts with the most challenging maintenance item and proceeds to the next, continuing until no significant improvements are observed. TPM emphasizes teamwork and cooperation between maintenance and operations teams. Unlike TPM, RCM strictly focuses on determining maintenance needs and selecting tasks, lacking TPM's emphasis on collaborative teamwork. Despite their differences, RCM and TPM are complementary, each addressing aspects the other does not. (Järviö et al. 2017, p. 165.)

2.1.3 Data, Information and Document Management

Standard SFS-EN 13460 (2009, p. 5-6) specifies "general guidelines for the technical documentation to be supplied with an item, at the latest before it is ready to put into service, to support its maintenance", document being a "specific form containing information", documentation is "information given in a specific form", item being a "any part, component, device, subsystem, functional unit, equipment, or system that can be individually considered". Information is organized collection of data and data is considered as raw facts (Birzniece 2011). According to Kortelainen, Komonen, Laitinen, Valkokari, and Hanski (2021, p. 144), Ackoff (1999, pp. 170-172) describes information and data as "symbols that represent the properties of objects and events. Information consists of processed data, the

processing directed at increasing its usefulness. Data are the products of observation. Data elements are of no use until they are in a useable (i.e., relevant) form." Decisions are made based on information that relies on data and documents. It is important to collect information from different sources and integrate them as necessary into a reliable data set. The entire decision-making process is dependent on the quality of information. (Marquez et al. 2023, p. 17.)

ERP system allows the information flow without any barriers within the company's organizations and gathers and manages the links with external stakeholders (Sarfaraz, Kouroush & D'Souza 2012; Bidgoli 2003). Computerized maintenance management systems (CMMS) aims to offer services to support the maintenance process. The maintenance process comprises according to Tretten and Karim (2014, p. 290) of "MM, maintenance support planning, maintenance planning, maintenance execution, maintenance assessment, and maintenance improvement". CMMS also supports the maintenance and operations personnel in the creation of needed work orders, managing ongoing tasks, getting instructions for the maintenance tasks, reporting deviations, and tasks that are completed, (Tretten & Ramin 2014, p. 290.) Appropriately implemented and integrated CMMS with ERP helps organizations to work more effectively. By effectively managing maintenance alarms, work orders, maintenance actions, data storage, completed tasks, status reports, tracking maintenance expenses and inventory levels, CMMS with other systems streamlines maintenance operations. Furthermore, it provides real-time insights into asset health and performance, empowering organizations to prioritize maintenance tasks and minimize unplanned machinery and equipment failure causing production downtime, thus avoiding unnecessary costs. (eWorkOrders 2023; Tretten et al. 2014; Marquez & Gupta 2006.)

Implementations of integrations with the CMMS is many occasions struggling with inadequate usability, which is leading to errors and mistakes. The systems must be easy to navigate and have the required information available to perform maintenance related tasks. Additionally, the different systems must be compatible between each other so that the has seamless access to the required information across the systems. (Tretten et al. 2014, p. 292.) Information in the form of e.g., data and documents are in the core of a successful CMMS development and usability benefits. The documents are considered as "the physical support of the information in a specific form" and "It is absolutely important to ensure that the necessary set of information is available at the right point, to the appropriate person, already

in the acquisition of any installation, equipment, system, or subsystem to make it possible to organize maintenance." (SFS-EN 13460 2009.) Information systems rely on both historical data received during the asset life cycle trough sensors and information gathered from the manufacturers, when asset is acquired, and information gathered during the operations (Marquez et al. 2006). Understanding the challenges what users are facing regarding the usage of a system, is important to be able to develop the system. When these issues are understood, the developers can enhance the system user experience, minimize errors, and further develop the related processes. (Tretten et al. 2014, p. 292.) Industries are not able to work effectively if the software, for maintenance data management is not innovative and is able to support the maintenance and operations teams related to automating the workflows (Poor et al. 2019).

System security related information is stored by many stakeholders contributing to development, manufacturing, etc. asset, in many systems in various stages during the life cycle of the asset. Few of these are the manufacturer/suppliers Product Data Management (PDM) and Product Lifecycle Management (PLM) systems. In those systems information such as product engineering, manufacturing and customer deliveries are stored. In engineering systems are stored the documents created in the design of the items, like technical specifications, diagrams, drawings, and other documents. In ERP systems are stored product or machinery related history and cost data. Enterprise Asset Management Systems (EAM), include information of maintenance plans and maintenance history of each physical asset. CMMS includes the maintenance organization related information. (Kortelainen et al. 2021.)

In an investment project or in connection with acquisitions, the user receives a considerable amount of information related to the product together with the product itself. If the form of master data delivery has not been agreed upon, the master data related to the device in the delivery content will be delivered in some format like e.g., PDF, by some way like e.g., memory stick, hard copy, etc. From the delivered documents the master data will be manually transferred to the customer's maintenance management system. Spreadsheet programs, MS excel, etc. are also used as a means of data transfer. In terms of life cycle management and planning the maintainability, key information such as maintenance instructions shall be delivered following the agreements. These instructions can be delivered in the form of a word document, where the maintenance interval is mentioned within the

text. This way delivered the data cannot be transferred automatically to the customer maintenance system and the customer must manually extract this data from delivered instructions into their own maintenance management system. (Kortelainen et al. 2021, p. 123.) Basic Maintenance information is typically provided by the manufacturer but may need adjustment based on activity levels and operating conditions. Operating rates and environmental conditions affect life cycle management plan and costs. Relevant regulatory regimes should be considered in the plan. For selecting an appropriate maintenance policy for a non-standard equipment or applications, reliability-centered maintenance can be used. (Hastings 2021, p. 207.) In delivery projects, data is still transferred by email and common data structures have not always been agreed upon. The ideal way for transferring the data would be transferring it in an "intelligent" form, i.e., via a programming interface (Application Program Interface, API from one system to another). (Kortelainen et al. 2021, s. 132.)

Utilization of the information stored in e.g. ERP and CMMS systems is specifically useful for decision making in operational and tactical level of the company functions. Situations where operational level decision making is done is related to the daily implementation maintenance task and operating the equipment and machinery. Decisions also must be made on demand, for example in fault and disturbance situations. It is typical from them that they must react quickly to situations and the time available for making decisions is short. While the impact of an individual decision is rarely highly critical considering the company's business point of view, it must be noted that in one part the system, similar events can be repeated time after time, and when repeated, the correctness of the decisions becomes highly relevant from the point of view of the business. Decisions at the tactical level are related to the development of the maintenance program and the planning of the investments and modernizations to be done in the future. (Kortelainen et al. 2021, p. 146.)

To create the first maintenance program, the equipment manufacturer's forecast of the maintenance needs of the delivered equipment is required as initial data, where the goals and boundary conditions of the system, the system structure and the usage forecast must be also considered. When using the equipment, user experience information is accumulated in the form of maintenance history and performed maintenance actions. In addition, equipment-specific measurement data, process data and condition monitoring are accumulated during the equipment use. By combining the data collected during maintenance activities with the

data provided by the equipment manufacturer, new forecasts can be created, e.g., items that fail, equipment condition and remaining useful life, maintenance costs, the need for preventive and corrective maintenance. Based on these new forecasts, the maintenance program should be updated. (Kortelainen et al. 2021, p. 154.) The life cycle asset management plans including maintenance plans, will need continuous updates. Whenever adjustments to the asset portfolio is done it typically affects modifications to systems where assets are listed, including data updates. These updates consist of actions like adding added items to the asset register and equipment hierarchy and removing data related to outdated items. While updates are made the plans and records shall also be developed accordingly for the newly added items. (Hastings 2021, p. 254.)

AI is considered as a fundamental driver in the evolution of manufacturing systems during the industry 4.0 era. By Shaheen (2022, p. 5) "AI tools, manufacturing systems are able to make factual decisions by real monitoring and analysis of their processes through real communication modules to coordinate and monitor all activities between machines, people, sensors, and other parts of the manufacturing system." AI can be utilized with maintenance management systems, such as planning, organizing, and controlling. Maintenance strategies, load forecasting, capacity, organization and scheduling related maintenance management system planning functions. In organizing of maintenance management system project management function. In controlling of maintenance management system cost control and managing for quality function. (Shaheen et al. 2022, p. 19.)

A study by Marr and Ward (2019, p. 267) on how 50 successful companies used artificial intelligence to solve problems includes three companies that utilized AI and machine learning in improving maintenance or to predict machine failure. BMW, GE and Kone are utilizing artificial intelligence in maintenance. BMW drives further efficiencies by utilizing predictive maintenance in its production lines, which means used parts of the machinery and equipment will be replaced before failure. (Marr & Ward 2019, p. 267.) At GE Power, engineers are leveraging machine learning, big data, and predictive analytics to understand better demands and stresses at work in a modern power station. By decreasing and increasing production, GE Power makes required adjustments in production based on the changes in demand, and breakdowns can be corrected with proactive maintenance before they become major problems. Ge Power's office stated that they have received results of unplanned downtime reduced by 5%, false positives by 75%, maintenance and operations costs by 25%.

(Marr et al. 2019, p. 271-272.) According to Marr et al. (2019, p. 282-284) Kone utilizes the data gathered, from the users of their machinery and the machinery itself, to build models that determines correlations and outliers by machine learning algorithms, which "leads to a build-up of the machine's "understanding" of when faults or breakdowns are likely to occur. This means maintenance work can be more efficiently scheduled, and replacement parts are more likely to be in the right place at the right time. -- Kone, as well as other engineering and maintenance businesses using the connected system, is able to better understand the operation of its machinery and more accurately predict breakdowns and failures."

2.2 Process management

In the core belief of process thinking is that value is created in a chain of event, which can be called a process, and by accepting this belief, it becomes obvious what needs to be done. The chain of events needs to be identified and modelled, and goals must be set for realization and development of the chain of events. Process management is often referred to in this context. Practical changes in the daily work must be done if an organization wants better results. Process modelling is used to try and understand what activities are critical to the value creation. If modelling is successful, benefit is often observed, such as people have a clearer understanding of the whole and their own role in the value creation, which affects their motivation and co-operation through the organization. (Laamanen & Tinnilä, 2013, p. 52.) The development of process management has been significant due to digitalization, which in turn has taken an even more significant leap due to the COVID-19 pandemic. By a literature review Andreas Gadatsch describes the revolutionary development of process management in four separate phases. First phase starts in the beginning of twentieth century where in the spirit of Taylorism, breakdown of work into functions was practiced. Taylorism was a bureaucratic organizational structure named after Frederic Winslow Taylor. Second phase starts somewhere after the mid-twentieth century where sequencing of functions was practiced which meant that data processing was mostly action-oriented, meaning that analysis of data was not only to understand the data but to utilize it to plan concrete actions. Third phase took place from the late twentieth century to the beginning of twenty-first century, according to Gadatsch (2023, p. 3) until 2015, where businesses was focusing strongly in the forming, management, and development of processes. In this phase processes were seen as a core element for businesses and the goal was to enhance the effectiveness and

productivity of the business by utilizing the existing processes as efficiently as possible. This phase process management is called Exploitative Process Management. Fourth phase started in 2015 when businesses change, where traditional processes are to be digitalized while businesses are focusing on identifying and developing new innovations and business models. This means in practice that businesses are transferring their functions from manual, traditional processes to digital platforms and software, which includes for example automation of processes. In this phase the traditional processes must be entirely and completely redesigned. This phase process management is called Explorative Process management. (Gadatsch 2023 p. 5; Hastings 2021.)

Process characteristics: According to Andreas Gadatsch, there is many definitions for business process or for simply a process (Gadatsch 2023). Scientific research in 2016 by Hilmer identifies 75 characteristics of processes, from 101 sources (Hilmer, 2016). Gadatsch divides process management in to three planes, strategic, professional, and technical. Strategic and professional process management is related to the business view of processes and the goal of technical process management is the management of workflows. By managing workflows, Gadatsch means e.g., execution of tasks by methods such as process control systems, like ERP. Basically, this means utilization of the information technology for executing and controlling processes. A process and a project are two different things, the project is a happening once, while the process is constantly ongoing and repeated. (Gadatsch, 2023, p. 5-7.) Finland ministry of finance, JUHTA - public administration information management advisory board describes process as a set of irrelated repetitive activities that transform inputs into outputs. An activity is a set of tasks that are used to achieve a certain result. Input refers to information and material that is entered into the process. Input does not mean money, equipment, or human skills, which are resources and therefore part of the process. Output is the result of a process, function, or task. JUHTA divides processes in to four description levels (process map, operating model, process flow and workflow). (JUHTA 2012.) According to Lecklin a business process refers to a set of related tasks that together produce a result that is useful for the business and categorizes different processes in six groups, which consist of core processes, supportive processes, key processes, main processes, sub processes and tasks/steps (Lecklin 2006, p. 123). A process is supporting a goal or a target of a company or organization. The company's or organization's targets and goals are in line with the strategy and according to Gadatsch (2023, p. 7) a process "consists of several individual steps, takes place regularly, is also often carried out by several people,

departments, areas or companies in a division of labor, usually requires support by one or even several software, systems and possibly other resources". By resources, Gadatsch (2023, p. 7) is referring to transport vehicles, machines, and facilities among other things, by process information, he refers to input of the process and by achieving the desired result he refers to output of the process. Gadatsch (2023, p. 10-11) categorizes processes to control processes, core processes and support processes. Core processes serve a company external customer. Support processes are company internal processes that create the conditions for the core processes. Equipment and machinery maintenance related processes are support processes for the core processes. (Laamanen 2012; Karimaa 2002.) Attention should be paid on naming the processes. Process descriptions and naming are means of communication, which helps to understand the objectives, purpose, and results of the activity. (Laamanen 2012.) According to Laamanen and Tinnilä, any function or change can be described as a process. Processes that are from the company's point of view relevant are critical for the company success, which are often called main processes, business processes or key processes. These processes, critical for the company success run horizontally through boundaries between company departments and organizations and are often presented in the company process map. (Laamanen et al. 2013, p. 121.)

Workflows are parts of business processes that can be completely or partly be executed and carried out by computer support. While business processes clarify responsibilities and actions from a business perspective, workflows represent a more detailed breakdown, with particular emphasis on related technical aspects in terms of information technology. (Gadatsch 2023, p. 12-13.)

2.2.1 Process identification

According to Laamanen processes shall be limited so that they extend from the customer to customer and categorizes processes for product, service, customer, main, core, support, key, sub, leadership, and guidance processes. Core processes refer to the processes that have immediate connection to the customer and are characterized by the processing of a product. Core processes serve a company external customer. Support processes are company internal processes that create the conditions for the core processes. Equipment and machinery maintenance related processes are support processes for the core processes. (Laamanen

2012, p. 35; Karimaa 2002.) According to JUHTA Process owner determines what is the starting point of the process and where the process ends. Once the process has been identified, processes that implement the tasks and goals of the organization shall be grouped and named. (JUHTA 2012, p. 4.) Attention should be paid on naming the processes. Process descriptions and naming are means of communication, which helps to understand the objectives, purpose, and results of the activity. (Laamanen 2012, p. 57-59.) According to both JUHTA and Laamanen the purpose of a process shall be determined when naming a process and what information is produced in the process and what is the purpose of it (JUHTA 2012, p. 4; Laamanen 2012, p. 57-59). It is possible that one process exceeds organizational boundaries. This results in different owners at different stages of the process. in such a situation you should always make sure that someone has a responsibility for the whole process. (JUHTA 2012, p. 4.)

For more easy identification of maintenance processes Finnish standard SFS-EN 17007 (2017, p. 9) classifies processes in to three main families: Management, Realization, and support processes. Management process involves identifying objectives and formulating policies to achieve them, followed by the deployment of the company's resources, and effectively allocating these resources. Management process ensures the coherence of the realization and supportive processes. Realization processes directly achieve expected results by ensuring customer needs are met throughout the product or service cycle. Support processes plays a crucial role to the functioning main processes and other processes (management, realization, and other support processes) providing required resources to them. The support processes act as a spine, which provides the basis which the successful execution of other processes depends on. (SFS-EN 17007 2017, p. 9.)

2.2.2 Process modelling

The starting point for describing the Process or modelling the process is that the organization recognizes processes and defines the owners (JUHTA 2012, p. 4). According to Laamanen process managements cannot be executed in practice without a modelled process. Thus, it is important to keep in mind that the modelled process is not the goal, but a way to model the function of an organization, so that it can be understood, analysed, and developed. The process model is a tool in the means of communication. (Laamanen 2012, p. 75.) Process

description shall be at maximum four pages long and the idea is to bring up critical items. It is crucial to make a gap between important and less important items. Long explanations obscure the important message and people can't take refuge properly in long writings. (Laamanen 2012, p. 78.)

There are six steps for modelling a process. First step is the scope of application. Second step is determining the customer, their needs and demands. Third is setting the target. Fourth is determining the services, inputs, and outputs. Fifth is modelling the process diagram. Sixth is determining the responsibilities. (Laamanen 2012, p. 89-94.)

The first step is to find where the process is applied and what is the starting point and the end point of a process. In the beginning is good to provide the reader with an overall picture of the process. Process can be applied to different situations and sometimes in this section the meaning of the process can be described. In this step it is important to describe the beginning and the end of the process keeping in mind the core and main processes. Planning in the beginning and evaluation in the end shall be considered for further development of the process. (Laamanen 2012, p. 89-94.)

Second step is to describe who are the customers and stakeholders for the process and where they use the outputs and services of the process and what requirements the customers and stakeholders set. The customers of processes are those who receive the output of the process. All processes have many outputs and customers but only the 3-5 most important shall be selected as customers for a process. Requirements is a need or expectation that is specifically stated, generally required or mandatory. To understand the requirements questions shall be asked such as "what does the customers complain about?" and "what kind of lack of action might cause a complaint?". (Laamanen 2012, p. 89-94.)

Third step is to describe what is the meaning, mission, and task of the process, what are the success factors of the process and how process performance is measured. What is the role of the process related to success of the company. Some processes might have a clear strategic connection. For example, if the selected strategy is cost effectiveness, the mission of the product development process could be the decreasing of productions costs of the products and services available in market. Success factors could relate to technology, working methods or cooperation between customers. The risk is to concentrate on general or the whole organisation's success. The goal of the process performance measurement is to

understand the cause-and-effect relationships of the processes and to focus on the control and development of those factors and their functions that are critical in terms of the core performance. Increasing information about process performance either confirms or challenges expectations, initiating a shift in attention to other factors; critical success factors are characterized by key figures specifying their name and unit of measurement. (Laamanen 2012, p. 89-94.)

The fourth step is to describe what are the inputs, outputs, and services of the process and how the information is managed. The process planning could be easiest to start from this theme because the outputs and services can be outlined very concretely, for example product documents in product development process. From this point it is easy to go both in the direction of the customer and his needs, and in the direction of the process. Outputs and services must be structured very concretely, preferably as specific documents or information. Information could be divided in to process internal information (meeting memories and action plans), other information utilized by other processes (manufacturing drawings etc.) and information delivered to customers (user manuals etc.). (Laamanen 2012, p. 89-94.)

The fifth step describes what is the process rough process phasing and what is the process diagram like. The earlier steps shall be clear before modelling a process diagram, when it is easier to understand, what is critical in the process, and it will get the needed attention in the process diagram. Idea is to bring up the critical functions and communicate their importance and make them a target for development. The operation should be described so concretely that it can be read like a story, and this can be achieved by answering the question “what this means in practice?”. (Laamanen 2012, p. 89-94.)

The sixth step is to describe what are the ground rules, roles, and the most important tasks, critical decisions, and the position of responsibility in the process. This step shall be written so that every role is presented as own wholeness. This way people identify own role and the tasks and decisions related to the role. The functions that have several ways to function can be elaborated. If a buyer can do small purchases and big purchases are done by the senior buyer, the limits shall be described in the process description. The ground rules shall be specific, for example the ground rule for bidding process may be that the customer’s contacts are answered during the same day, values such as honesty or respect for other are too general to be ground rules. (Laamanen 2012, p. 89-94.)

For specifying responsibilities, RACI Matrices can be utilized, which consists of steps to list all the tasks that need to be done and the roles available and the determining for each task the role responsible, accountable, roles to be consulted and roles to be informed. Only one accountable role shall be determined for one task. Every task shall have an accountable and at least one responsible person. First the tasks must be listed, second the roles, third the preliminary suggestion for responsibilities shall be filled, fourth the preliminary filling needs to be analysed, fifth the matric needs to be validated by a wider group, sixth they shall be communicated to all the participants and finally a plan should be made to develop and update the matrix. (juttahautanen 2018; Lehtimäki 2006.) Process modelling is process development (JUHTA 2012).

2.2.3 Process development methodologies

The role of the owners, cooperation with other parties is to develop processes and to guide the needs for change. The process owner is responsible for developing improving and maintaining the process. The development of processes is related to the planning and development of the organization, and its basis is the organization's visions, strategies, and operating principles. Process descriptions are a tool for managing, leading, and improving processes. They help manage entities, structure processes and actors' responsibilities, and find needs to improve operations. In addition, process descriptions are used for orientation, training, and development of information systems. When processes are described in a unified way, getting to know them becomes easier as well as planning and implementing cooperation within the organization and across organizational boundaries. (JUHTA 2012, p. 1-4.)

The starting point for process development is an identified problem. To solve the problem, a project group will be established, which will get to know the problem by describing the process. Change can go in both a good and a bad direction, that's why it's important to define the goals of improvement. Improvement always focuses on the process, and it prevents errors from occurring in the future. In improvement, reactive, proactive, and innovative improvement can be distinguished. Reactive improvement is characterized by the fact that something happens, someone notices it and acts. Anticipatory improvement is characterized by trying to understand trends and predict the future. Innovative improvement is characterized by searching for completely new solutions and it can happen in small and big

things. Instead of aiming for 10% improvement, aim for 100% improvement. Very tough goals force us to look for innovative ways. If an organization faces very tough goals without excellent development expertise, failure usually follows. Process development can be approached either as a social change from a human perspective or as a technical development from a systems perspective. The use of the analytical approach can be roughly evaluated in such a way that if the problem or development need is focused on systems, it is worth striving for an analytical approach. If the problem or the need for development is related to relationships between people, the analysis is only harmful. Analysis blames and digs the hole deeper. In these projects direct solution shall be aimed for. Large number of different concepts have been developed to develop the process, all of which have the same type of features, but also have their own characteristics. Laamanen has settled on three basic types, which with variations can be found in most top organizations: 1. process planning and performance improvement. 2. problem solving. 3. Benchmarking (sharing best practices). All these development concepts are characterized by describing processes, measuring, examining, and testing solutions. (Laamanen 2012, p. 208-210.)

1. Process planning and performance improvement.

   There are several methods to develop and plan processes, such as Quality Function Deployment (QFD) (Clausing 1994), Statistical process control (SPC) (SFS-EN ISO 9001 2015), Taguchi-method and a combination related to the statistical analysis Six Sigma DMAIC-process (Design, Measure, Analyze, Improve, Control). (Harry & Schroeder 2006.) Laamanen describes that in the center of continuous process development is a precise description and measurement of the available process with the help of measurement, factors that need action shall be found to improve the performance of the entire process. Typical analyzes are deviations, customer feedback and errors. (Laamanen 2012 p. 210.)

2. Problem solving

   Identifying a problem that hinders the organization's operation or prevents superior performance. The entire process is not called into question, but rather minor improvements. The problem can be related to either the process or the product. Development may be initiated by customer complaints, errors and deviations in materials, processes or products, personnel complaints or development ideas and audit

findings. The problem to be solved must be limited and defined sufficiently concretely, which can be ensured by observing the practical results for six months and answering four questions: What is the problem? What benefits will be achieved if the problem goes away? What is the desired state and when do you want to achieve it? How do you know that the desired state has been reached? When developing the ability to solve a problem, one must always first try to understand the process, based on which the work method is chosen. (Laamanen 2012, p. 211-215.)

3. Benchmarking

This method answers the questions whether we are good enough and how good we could be. Often it is only possible to benchmark some parts of the process, not the entire process. Benchmarking can target output, strategy or process, and comparison can be made based on the properties of the object and in terms of performance. In large organizations, the comparison should start with an internal comparison. For internal comparison of process performance to become possible in a large organization, the limits of the processes must be agreed in the same way, which enables measuring the performance of the processes so that the results are comparable. Describing the operation plays a significant role in benchmarking. Benchmarking is a demanding form of development, and it requires both expertise and contributions. If the maturity of the comparison organizations is quite different, the comparison can even be harmful. If the maturity of the comparison organizations is high and comparable, you most probably cannot move forward without taking benchmarking as one of the most important drivers of development. Benchmarking should be done in against a process with next level maturity. (Laamanen 2012, p.216-221.)

Numerous process improvement methodologies exist, each tailored to address specific operational challenge, coming along with different set of tools. Ensuring the optimal efficiency is depending on the methodologies and tools selected to be applied. The methods and tools that fit best the problem and resources at hand shall be selected. (Antony & Gupta 2019, p. 370.)

The common features can be summed up in Deming cycle (Figure 3), which is developed by William Deming, where an improvement is approached in four steps, where the fourth step can give feedback back to the first step takes place. (Hofmann 2021.)

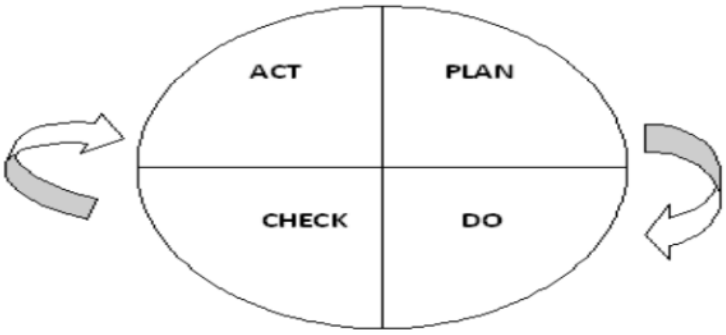


Figure 3. Deming cycle, PDCA (Plan-Do-Check-Act) (Deming 2018).

The first three steps in the Deming cycle are realized in all activities automatically, without effort. The fourth stage, which describes correction, improvement, drawing conclusions and learning, rarely takes place without conscious effort. Step one, “Plan”, consists of planning and determining the goals mainly by asking questions. What is the most important outcome? What type of change is looked for? What information is needed? Plan change or test. Decide how information is utilized. Step two, “Do”, consists of doing, by which is meant that the change or test is executed. Step three, “Check”, consists of observing the change or test effects. Step four, “Act”, consists of studying the results for determining lessons learned and predictions made based on the change or tests. (Deming 2018.)

2.3 Management of Change

The behavior towards the change is depending on if we feel it as a treat or as an opportunity, influencing project success and transformation. With customer demands, business needs, and constantly developing technology, change has become a constant. Successful implementation of change is requiring effective change management, which is involving understanding its impact, timeframe of the implementation, and promoting acceptance and adoption while minimizing uncertainty. Change management has developed into both a profession and an organizational capability, with specialists and organizations designing and implementing effective change processes, also internally. Achieving a successful organizational change requires effort from individuals, leaders, and those implementing

change processes or parts of it, while the leaders need to promote sound leadership and dedicating time to contribute to team conversations about the change. It needs to be understood how different change initiatives fit in, so the volume and pace of the change needs to be managed. Effective change project frameworks need to be integrated with strong people change processes, implementing change with input from those impacted, and managing change processes collaboratively between business and change managers. (The Change Management Institute 2022.)

The way a human mind works, how we feel, think and act are key elements to be considered in management of change. A change process is a process about feelings and how they evolve throughout the change. First step of the change is when we get to know that this way of continuing is not feasible or possible. In this phase the feelings are often agonized. When the need for change has been acknowledged and the reality has been accepted follows the figuring out and selection of the viable options. If there are no options available, follows anxiety, sickness and even depression. If, on the other hand, options and possibilities are available, follows a careful hopefulness. The next step is starts hesitation when the mind starts to seek confirmation for the decision. Actual commitment to the new model (after change) takes place first by accepting the positive effects of the change and finally only when the last serious doubt has been removed from the mind. According to Laamanen a quite common model of change is two phased, where first, the change is planned and second, the change is implemented. This way feelings are not considered so there is not forming commitment to the new operating model. (Laamanen 2012, p. 256-260.)

The most important principle is consolidation when creating commitment. This requires awareness, understanding and acceptance of change. Information itself rarely brings about change, because even though people know that smoking is dangerous, they still smoke. Personal analyzes and experiences are needed. The goal is that the person becomes the agent of change, instead of feeling that he is the object of change. It would be best if a person could participate in all stages of the change, such as recognizing the need for change, stating its meaning, ideating, and choosing different track options, experimenting, evaluating, and finally celebrating achievements. Individual change is the basis of change processes. Laamanen divides the process of change in the group into five different points. (Laamanen 2012, p. 260-264.)

- Awareness of change, where group members become aware of the possibility or need for change.
- Gathering materials, where information is gathered to implement the change, the prerequisites for the change are clarified and solution models are conceptualized together.
- Connecting, where working change ideas are identified, and a common operating method is built.
- Practical application, where the implementation is planned and agreed upon, the necessary advances and knowledge are acquired, the new operating model is followed, and the mutual support of the group members contributes to the success of the change.
- Evaluation and learning, when evaluating the group's performance in development work and the functionality of the new operating model.

Change must be taken into one's own hands. If, in connection with the change, insufficient expertise is created to ensure the results, there is a risk that after the change, the original expenditure will be returned. Usually, people do not want to deviate from familiar paths, so the leader must go ahead on unknown routes. (Laamanen 2012, p. 264-266.)

2.4 Literature review results

In the beginning of the literature review, research sub-questions supporting the research main question were structured that was intended to contribute a viewpoint for the study from the existing literature point of view. In this section the literature research questions are provided an answer.

Total 44 references are used in the literature research published between 1994-2023, of which the majority, 28 publications during 2017-2023. In total one mostly books, articles, handbooks/standards, web site articles, conference publications, and one master’s thesis.

Reference publication dates visualized in a chart presented in Figure 4.

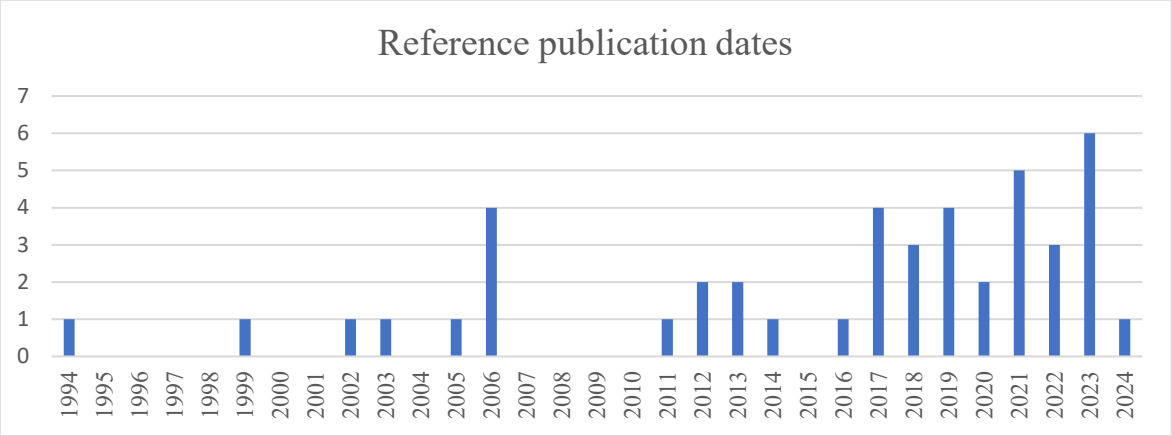


Figure 4. References used in the research

What are the prevailing maintenance strategies and practices and how have they evolved?

Maintenance strategies and practices have evolved and developed significantly over the past to meet the changing demand of industries and advancements in technologies. Maintenance strategies from the past are still utilized and new developed strategies have been integrated as part of the present. Some of the maintenance strategies are reactive maintenance, preventive maintenance, predictive maintenance, condition-based maintenance, reliability centered maintenance, proactive maintenance, total productive maintenance, and physical asset management.

Reactive maintenance is consisting of utilizing the machinery until the failure, where maintenance is performed only when the equipment breaks down. The strategy is simple but leads to costly downtime and repairs. Preventive maintenance consists of scheduled tasks at regular intervals, based on equipment manufacturer recommendations and historical data. By this approach, the unexpected breakdowns are reduced, and equipment life is extended. Predictive maintenance uses data censors, IoT devices and predictive analytics to anticipate equipment failures before they occur. By equipment condition real-time monitoring, maintenance can be scheduled precisely according to needs. This way downtime is minimized, and asset lifetime is maximized. Data analytics and sensor technology advancements gains popularity of this approach. Condition based maintenance (CBM) is like predictive maintenance but focuses on monitoring specific parameters or conditions of equipment leading to cost savings and improved reliability. CBM is tracking factors like

vibration, lubrication level, and temperature. When detecting deviations to normal conditions maintenance can be performed. RCM is aiming to optimize strategies based on the criticality classification and risks associated with and asset. RCM involves analyzing the functions and failure modes of equipment to determine the most effective maintenance tasks. TPM is optimizing the effectiveness of production equipment emphasizing employee involvement, autonomous maintenance, and continuous improvement to zero breakdowns, zero defects and zero accidents. TPM integrates maintenance practices with business goals to enhance overall equipment effectiveness. Maintenance can be considered as a part of asset management where different maintenance strategies are utilized for different assets depending on the company demands and operating environment.

Maintenance evolution is modelled in the figure 5.

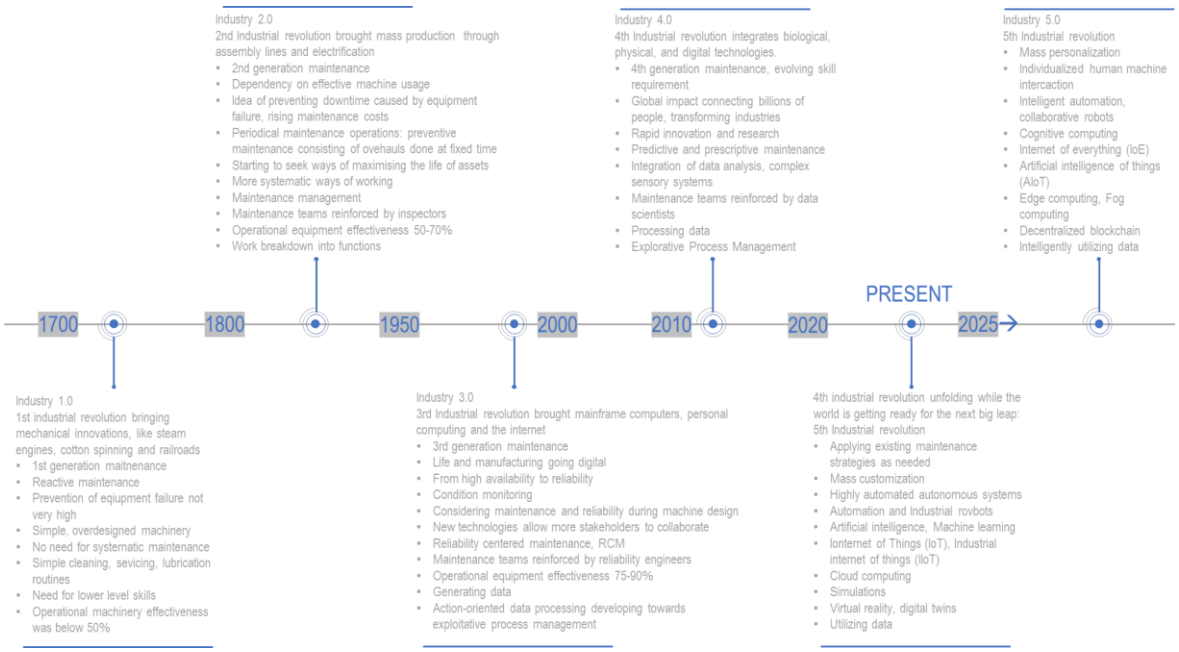


Figure 5. Prevailing maintenance strategies and how those have evolved

Industry 5.0 is a future scenario where lines between humans and machines will blur even further and innovative technologies are reshaping the landscape of industrial processes. Intelligent automation develops collaborative robots. (Eschblach 2021.)

What should be considered in projects so that when commissioning new equipment and machinery, the maintenance system would be updated, considering the information of the equipment manufacturer and the end user?

Since all the maintenance strategies in the first literature review research question answer mentioned rely heavily on the manufacturer requirements, equipment specifications, operational environment requirements, and equipment criticality classification, it is important to review the maintenance requirements in early stages of the asset lifecycle in detail. Also, it is important to agree the product related information deliveries so that those will be received considering the operations and maintenance organization requirements and not delivered as a set of suppliers determined information in a phase when the purchaser's possibility to impact the delivered information is minimal.

When focusing on the reliability and maintainability of an asset acquired in an investment/project, the conceptual and development phase should be implemented carefully, as studies are showing how during this early stage of the project 95% of the LCC are determined for an asset. Once new machinery and equipment reaches the manufacturing and installation stage in the implementation of the project, there is only a 5% opportunity left, where the maintainability and the reliability of the machinery and equipment can effectively be improved (Houshyar 2005).

The opportunity to influence the costs are decreasing significantly during the purchasing, manufacturing, delivering, installation, and commissioning phases regarding the asset lifecycle. Best time to affect the costs during the asset life cycle is during the planning period. The opportunity to influence costs and cumulative costs can be seen in figure 2 (in section 2.1), where they are presented over time. (Hastings 2021.)

Appropriately implemented and integrated CMMS with ERP helps organizations to work more effectively. By effectively managing maintenance alarms, work orders, maintenance actions, data storage, completed tasks, status reports, tracking maintenance expenses and inventory levels, CMMS with other systems streamlines maintenance operations. Furthermore, it provides real-time insights into asset health and performance, empowering organizations to prioritize maintenance tasks and minimize unplanned machinery and equipment failure causing production downtime, thus avoiding unnecessary costs. (eWorkOrders 2023; Tretten et al. 2014; Marquez et al. 2006.)

A CMMS database enables asset registry or equipment hierarchy, which includes:

- technical information related to the asset, such as manufacturer, model, serial number and equipment class and type.
- Associated documentation, such as repair and operation manuals, safety procedures, warranties, related drawings

This information is received and created during the planning, manufacturing, and installation phase of the project where the asset is taken to production.

Implementations of integrations with the CMMS is many occasions struggling with inadequate usability, which is leading to errors and mistakes. The systems must be easy to navigate and have the required information available to perform maintenance related tasks. Additionally, the different systems must be compatible between each other so that the has seamless access to the required information across the systems. (Tretten et al. 2014, p. 292.)

In an investment project or in connection with acquisitions, the user receives a considerable amount of information related to the product together with the product itself. If the form of master data delivery has not been agreed upon, the master data related to the device in the delivery content will be delivered in some format like e.g., PDF, by some way like e.g., memory stick, hard copy, etc. From the delivered documents the master data will be manually transferred to the customer's maintenance management system. Spreadsheet programs, MS excel, etc. are also used as a means of data transfer. In terms of life cycle management and planning the maintainability, key information such as maintenance instructions shall be delivered following the agreements. These instructions can be delivered in the form of a word document, where the maintenance interval is mentioned within the text. This way delivered the data cannot be transferred automatically to the customer maintenance system and the customer must manually extract this data from delivered instructions into their own maintenance management system. (Kortelainen et al. 2021, p. 123.)

What are the principles of process and change management? How can these principles be utilized in the development of the maintenance data management process?

The Maintenance data management process in the target company consists of several individual steps regularly and is conducted by several people and stakeholders and requires

support by software systems. This process utilizes manufacturer and operating environment and organization information and knowledge as input to keep the company SAP Plant maintenance module up to date as output.

A process is supporting a goal or a target of a company or organization. The company's or organization's targets and goals are in line with the strategy and according to Gadatsch (2023, p. 7) a process "consists of several individual steps, takes place regularly, is also often carried out by several people, departments, areas or companies in a division of labor, usually requires support by one or even several software, systems and possibly other resources". By resources, Gadatsch (2023, p. 7) is referring to transport vehicles, machines, and facilities among other things, by process information, he refers to input of the process and by achieving the desired result he refers to output of the process. Gadatsch (2023, p. 10-11.) categorizes processes to control processes, core processes and support processes. Core processes serve a company external customer. Support processes are company internal processes that create the conditions for the core processes. Equipment and machinery maintenance related processes are support processes for the core processes. (Laamanen 2012; Karimaa 2002.) Attention should be paid on naming the processes. Process descriptions and naming are means of communication, which helps to understand the objectives, purpose, and results of the activity. (Laamanen 2012.)

The six steps could be utilized to model the maintenance data management process. Determine the scope of application, customer, their needs and demands (in the case where the process is a support process the customer would be the process which this process is supporting), target, inputs, outputs, and services, process diagram, and responsibilities. (Laamanen 2012.) For specifying the responsibilities, a RACI matrix could be utilized (JUHTA 2012). Methodologies stated by Laamanen could be utilized for developing the process further in the future, but for process planning and performance improvement a precise description and measurement of the process shall be available. (Laamanen 2012.)

When facing changes in the way of working related to maintenance data management in projects change management principles can be considered to successfully implement the change. (Laamanen 2012.)

1. Members affected by the change to become aware of the change.
2. Gathering information for implementing the change

3. Identifying ideas and building a common operating method
4. Planning the implementation of the change
5. Evaluating and learning from the change and the new operating model

Usually, people do not want to deviate from familiar paths, so the leader must go ahead on unknown routes. (Laamanen 2012.)

The most important finding in this literature review is the importance of considering the maintainability of the asset in early stage of the planning of new assets to ensure the reliability and maintainability during the life cycle of the machinery and equipment as cost-efficiently as possible. The document deliveries shall be agreed on upon, to ensure those are delivered according to the requirements.

3 Methods, Implementation of the Research

This chapter will focus on the reviewing the methodologies of the empirical research, while the second chapter was about conducting the theoretical research, the literature review. Empirical research consists of two parts, case studies and focused interviews. Case studies are implemented to understand how the maintenance data management process is now implemented and managed in production process change projects and how the supportive tools, and related instructions are followed. The focused interviews are implemented to gather information how the maintenance data management process, supportive tools, and related instructions could be developed.

This chapter defines the target group, presents the study data collection methods, case studies and focused interviews, generalizability, and analysis of the research results.

3.1 Maintenance aspects in the target company to be considered in this study

Target company internal Physical Fixed Asset Management business rules, listed in appendix 2, as maintenance business rule, divide the maintenance tasks into two groups: core activities and other activities. The core activities in the target company consist of possible equipment malfunctions that have an impact on pulp quality, production efficiency, and costs. Target company own personnel primarily focuses on performing core activities. External labour can be used for other activities, but under target company's maintenance guidelines. The core activities include maintenance planning of pulp production machines and equipment, life cycle planning, advance maintenance and predictive maintenance of pulp production equipment, shutdown planning, management of service providers, procurement, and monitoring and steering of activities. The other activities, non-core activities are special services, basic maintenance of equipment and components, and maintenance support services (e.g., scaffolding, construction, vehicles, HVAC, lifts, cranes, lighting maintenance and other building technology).

Maintenance strategy for the target company is described in detail in research target company internal Physical Fixed Asset Management business rules. The rules describe maintenance as it is described in standard SFS-EN 13306 (2017, p. 8). Physical fixed assets

management consider the life cycle management of buildings and production machinery. Physical fixed asset management controls the operation of the organization, goal setting and monitoring, life cycle planning and reliability management. The rules are steering maintenance to common best practice operating methods and efficiency improvement and development. Maintenance types are classified based on Finnish standard PSK 6201. The principles of Reliability Centered Maintenance (RCM) are followed in the planning and implementation of maintenance. RCM analysis is used to reach better reliability, greater maintenance cost-effectiveness, longer life for equipment, unified database, clarity of tasks, improved co-operation, and improved spare parts security. The goal is that the productions processes remain operational, and that there will not occur any unforeseen downtimes. To reach this goal the most suitable preventive maintenance method is selected on a case-by-case basis based on equipment criticality. Applied preventive maintenance methods are time-based maintenance, performance-based maintenance, condition-based maintenance.

In the research target company, the ultimate purpose of maintenance is not to repair damage just when that has occurred, but to prevent damage from occurring. Successful maintenance has significant effects on business. The main goals of maintenance are overall production efficiency, safety, consideration of the environment, operational reliability, and cost efficiency. The division of maintenance into planned and unplanned maintenance follows the division according to PSK 6201 and is the basis for SAP's classification of maintenance types. (PSK 6201 2022.)

Target company implements the principles of reliability centered maintenance (RCM), in the planning and implementation of maintenance. The applied RCM strategy includes the following steps:

- Effective and applicable preventive maintenance requirements for equipment are clarified.
- The obtained results are based on the identified failure mechanisms and their resulting effects on safety, use and economy.
- The result provides the basis for doing/not doing a possible individual maintenance task.
- Maintenance measures are optimized according to the criticality classification of the equipment.

Aspects required by maintenance needs to be considered in the management of investment and maintenance- projects during the project phase by the project organization. A “project” can be either an investment project (capitalized) or a maintenance project (not capitalized). Projects are managed trough project management process. Target company project manual includes a maintenance related engineering instruction that specifies the company’s group level instruction on maintenance related engineering in projects, on maintainability of the assets. This instruction is used as a basis for creating a more detailed instruction for target company level instruction “Project Implementation, Consideration of Maintenance Aspects in Projects”. The instructions are based on the RCM strategy considering continuous improvement cycle where an RCM project is started whenever a need for improvement is detected. A need is detected always when an investment is started. The affects related to maintenance aspects shall be reviewed and the needed updates shall be planned and performed. The maintenance aspects to be reviewed are presented in appendix 4. The project organization responsible for the project implementation is also responsible for taking care of the RCM basics (maintenance aspects) during the project implementation phase.

3.2 Definition of the target group and sampling

The research is conducted for the target company where three mills are implementing more than 20 projects in total simultaneously during the study. The basic population of this study is all the personnel working in the target company within project organizations where changes are made to existing machinery or new machinery are acquired that changes the existing physical assets, i.e., production machinery. Within the research timeframe is not possible to model and study all the ongoing projects. Six projects in total were selected that fits the requirements of a suitable case for this study. Six, to have projects studied from all the three mills and more than one project from each mill. A suitable case for this study is a project that consist of mechanical changes on company physical assets that affects reviewing and updating of the maintenance data during the project. What maintenance data refers to in this context is explained earlier in chapter 1.4.

It should be possible to compare the status of the maintenance data management process between the selected case projects so the selected projects shall be at the same phase during the research. The project shall be in a phase where the project organization is, during the

research, actively working in the project and maintenance data management shall be finished to support the operations and maintenance personnel. Such a phase is when the machinery of the project is taken into production use and the closing phase of the project implementation starts.

Investment lifecycle has six main stages: idea phase, pre-feasibility study, feasibility study, investment proposal, implementation, and follow up. The implementation phase starts after the investment decision and consists of five phases: Launching, Engineering, Procurement, Site works, and Closing phase. The closing phase starts after the project machinery is taken into production use. For case studies projects in this phase shall be selected to be able to review them simultaneously and to make the studies within the research time frame. The case reviews were done between October and December of 2023, so only projects having the startup planned for that time were selected.

Focused interviews with predetermined themes were conducted for specialists within the basic population of the study. Basic population of the research consist of target company personnel working within mechanical maintenance and production related tasks on daily basis and has experience in projects maintenance data management related tasks execution point of view (Maintenance Engineer) or from the steering and responsible point of view (Project Manager).

3.3 Case studies

Case-review is both a qualitative and a quantitative method for studying the actual and theoretical state of the target company case-study projects related to maintenance data management process, supportive tools, and related instructions.

3.3.1 Representativeness and coverage

The aim was to select real case projects that are being implemented by project organizations that have experience in earlier projects as well.

As case-studies is selected projects where mechanical renewals is the main part of the project scope and the project start-up period is during the end of the year 2023 and therefore the

maintenance planning shall be ongoing in the project. Projects will be selected as case reviews from the three different mills that follows all the same processes for managing the maintenance engineering related topics in projects.

All these projects startup date is fulfilling the requirements for this research. When modelling the theoretical status of the project maintenance data management process the project is in the closing phase of the implementation. All the selected case projects main works are related to mechanical renewals/modifications. Two projects from each three mills are selected. Cases 1 and 2 are implemented in mill 1, cases 3 and 4 are implemented in mill 2 and cases 5 and 6 are implemented in mill 3. Mill 1 cases has the same Project Manager, but different maintenance planners. Mill 2 cases has the same Project Manager, but different maintenance planners. Mill 3 cases has the same project manager and same maintenance planner. From mechanical maintenance point of view all cases causes the updating need of CMMS (Computerized maintenance management system) for maintenance data including periodical maintenance plans, spare parts, equipment hierarchy and technical documents to be received from the equipment supplier and equipment manufacturer.

Considering these requirements for the case projects in total 6 case study projects was possible to investigate in this research. Since the maintenance data management process is implemented differently in the target company mills, projects from each mill shall be selected as case-review for this research to receive as accurate a sample as possible from the basic population. In one of the mills was ongoing only 2 projects fulfilling the requirements of a suitable case study, those both were selected as part of the case study of this research. The other two mills had more than two suitable projects, so the projects of those mills were selected as discretionary samples where researcher's together with target company investment coordinator and mill technical managers judgement was used to make sure the selected case studies are deliberate and suitable for the purpose, not random. (Tuomi & Sarasjärvi 2018.)

Projects selected as case studies:

- Case 1 project is about replacing an old, worn Chemically cleaned water chiller, which causes disturbances to Chlorine dioxide production on summertime, with a new chiller. With the new chiller, medium pressure steam usage will be replaced with low pressure steam. Medium pressure steam is an acquired utility while low pressure

steam is produced by the company processes more than it utilizes. Where the available water heating system needs to be renewed to ensure the cooling water capacity on hot time periods like summertime. This investment reduces the electricity consumption and carbon dioxide emissions.

- Case 2 project is about improving the cooking liquor heating by a new medium pressure heat exchanger. With this heater the steam consumption will get more optimal when the cooking liquor will be heated already in the impregnation vessel which generates reaction heat before the digester. With this the production speed can be sustained on satisfactory level on grade changes, when changing cooking production from hardwood to softwood. This investment reduces the electricity consumption and carbon dioxide emissions.
- Case 3 project is about replacing the existing chip optimizer, which is close to the end of its life cycle, with a new chip crusher, which lowers the amount of reject after batch cooking ensuring the cooking plant to run on the designed production level and improves the end-product quality.
- Case 4 project is about replacing the existing pulp storage tower mixer by a new one to improve fiber line screening availability by even consistency to screening by decreasing screening-based production losses.
- Case 5 project is about new truck unloading station which will replace the old one that will not fulfill the requirements in the future.
- Case 6 project is about ensuring the diluted natrium hydroxide availability in the mill since the supplier will not be able to ensure the deliveries in the future. To ensure the natrium hydroxide capacity unloading station, storage tanks, distribution pipelines and needed pumps and instruments are needed.

The received data needs to be reviewed and used as a basis for updating the CMMS. All case projects are ready for production on Q4/2023, for which details can be seen in the table 2. Case 1 project consists of 3 new pumps, 1 chiller, new piping, piping modifications, valves, and instruments. Case 2 project consists of one new heat exchanger, new piping, piping modifications, valves, and instruments. Case 3 project consists of a new chip crusher installation. Case 4 project consist of a new mixer and piping modifications. Case 5 project consist of one pump, piping, and hoses. Case 6 project consists of 1 mixer, 3 storage tanks,

8 pumps, 2 heat exchangers, safety shower, new piping, valves, instruments, and piping modifications.

Table 2. Case project startup dates and the case study questionnaire review date when the actual state is modelled and what is used as a time for what should be the theoretical state of the project

Case	Mill	Start-up				Project Manager	Review date	Maintenance Specialist	Review date
		9	10	11	12				
1	1					Manager 3	29/11/2023	Specialist 2	04/12/2023
2	1					Manager 3	29/11/2023	Specialist 2	04/12/2023
3	2					Manager 2	30/11/2023	Specialist 3	12/12/2023
4	2					Manager 2	30/11/2023	Specialist 4	07/12/2023
5	3					Manager 1	14/11/2023	Specialist 5	14/11/2023
6	3					Manager 1	14/11/2023	Specialist 5	14/11/2023

In the case study questionnaire and interviews about determining the case-project maintenance actual status, only person(s) responsible for project mechanical maintenance planning and technical documentation archiving will be interviewed, which means in practice the project manager and the maintenance planner in the selected case projects.

3.3.2 Data collection

The research questions for the case-study review are structured based on the research questions for the whole research. The case-study main goal is to gather information to help determining the areas needing development for implementing maintenance data management process successfully, how the supportive tools have been utilized and how the related instructions are followed. This will be done by reviewing projects theoretical status comparing that to the actual status related to maintenance data management tasks. Considering these viewpoints, the case study research aims to contribute to the main research question, by the following research case-study specific research sub-question:

- How is the existing maintenance data management process implemented in case-study projects?

- How are the existing instructions followed in case-study projects?
- How are existing software utilized in case-study projects?

To measure the successful implementation of the maintenance data management process, the theoretical status of the maintenance data management process can be modelled for the state where the machinery in the project is taken into operative production use. The instructions do not determine the detailed schedule how a project shall be implemented otherwise than that the maintenance related aspects shall be finished within the project implementation phase and aspects required for daily maintenance and operations shall be available and updated to maintenance management system when the machinery is taken into production. Rest of the information shall be finalized before the project closure which shall be done 3 months after taking the project to production use.

First the researcher needs to get familiar with the company instruction details and list all the aspects that needs to be considered related to maintenance related aspects in a project and separate all the required tasks to be done from the instructions to a template. The target company internal instructions (listed in appendix 2) was reviewed to help understand the company way of working and for modelling a theoretical state for the selected case study projects related to maintenance data management process.

When familiarized with the instructions the tasks that shall be done to successfully implement maintenance data management process in the project was compiled in a questionnaire. The questionnaire is built so that it includes all the tasks needed to be done related to a successful implementation of the maintenance data management process. The questionnaire is presented in detail in appendix 4. The questionnaire was used as a template to model the theoretical state and the actual state of the maintenance data management process in each case study project. The theoretical state was modelled based on the project technical scope and instructions review, and the actual state was modelled based on the focused interviews with project manager and maintenance engineer. This comparison provides quantitative data which tasks related to maintenance data management process have been carried out according to the company requirements in the project and which have not in total. The research finds out whether the uncompleted tasks according to the process affect each other and is there anything in common between the projects or the organizations steering the implementation of the projects in terms of the uncompleted tasks.

The questionnaire is divided in to three main categories. Each category is separately explained in the following Figures 6, 7, and 8.

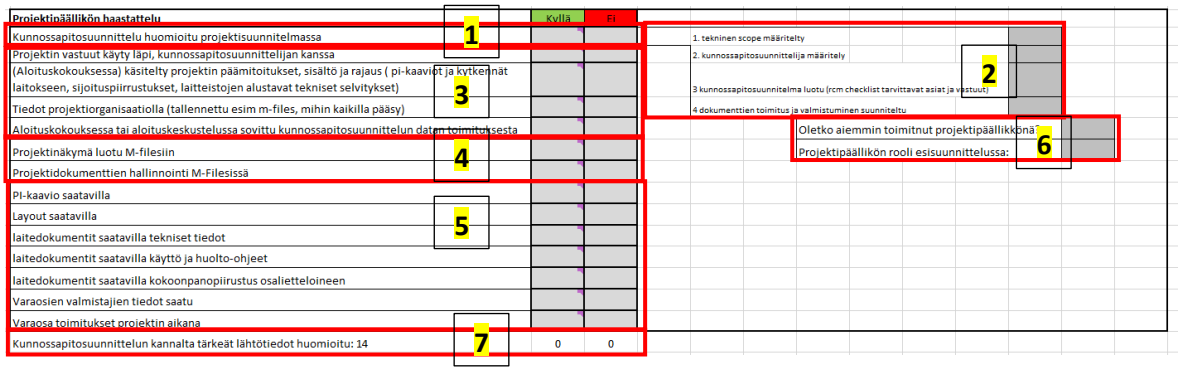


Figure 6. Case review questionnaire, project manager responsibilities

In figure 6 the project manager responsibilities considered in the project implementation phase, where in the are listed the all the tasks to be done. The area marked as 1, defines the tasks to be considered in the project plan, which is done latest after the investment decision. The are marked as 2 defines the details within the project plan, whether those are considered or not. The area marked as 3 defines the tasks to be done to make sure the project organization gets the needed information related to the project technical scope and their roles on the project especially the responsible person for maintenance related topics. The area marked with 4 defines the project document management system availability and the usability related to the project. The area marked with 5 defines the data and documentation availability needed to finish the maintenance engineering. The area 6 defines whether the project manager has earlier experience or not related to project management. The area 7 defines the status of task considered and task not considered that will be used in the results examination.

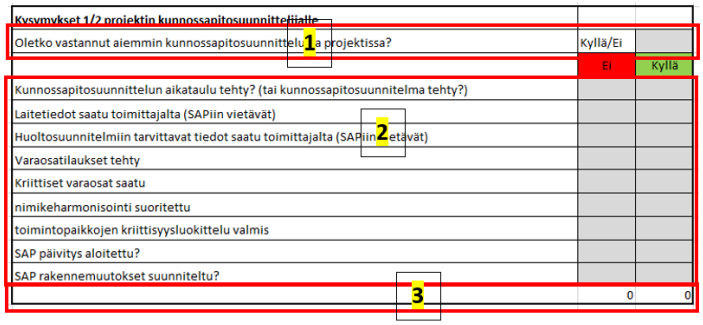


Figure 7. Case review questionnaire, tasks required for maintenance planning to be able to execute maintenance engineering task list tasks required for startup of the project machinery

In the figure 7 the project maintenance engineer responsibilities considered in the project implementation phase, where in the area is listed the all the tasks to be done. The area marked as 1, defines the tasks to be considered in the project plan, which is done latest after the investment decision. The area marked as 2 defines whether the project engineer has earlier experience or not related to project maintenance engineering. The area marked as 3 defines the status of tasks considered and tasks not considered which will be used in the results examination and calculation.

The first question of area 2 defines whether the maintenance related aspects management has been planned and scheduled. This is something that shall be done based on the instructions straight after the investment decision for ensuring the time will be reserved for these tasks within the project. The next 8 questions are related to the tasks that depends on other stakeholders input to be able to finish the maintenance data management before taking the machinery in to production use.

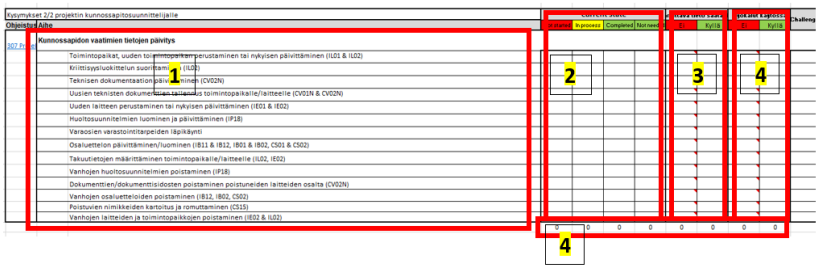


Figure 8. Case review questionnaire, maintenance engineering task list

In the figure 8 the project maintenance engineer responsibilities related to project maintenance data management process task list where: 1. is list of the tasks to be done related to the project from maintenance point of view. 2. is a list of the task state. 3. is a list of whether the information related to the implementation of the task is available or not. 4. is a list of whether the tools available are utilized for completing the task 5 defines the status of task considered and task not considered that will be used in the results examination.

Figures 6, 7 and 8 state is recorder and determined by interviewing the project manager and the project maintenance planner. Before the interview, a theoretical status of the project is modelled for each project so the actual status can be compared simultaneously during the interview to the theoretical status.

When the instructions were clear and the tasks to be done in a project was listed in the questionnaire, the project technical scopes of the selected case studies shall be reviewed in detail. This needs to be done to completely understand what maintenance aspects shall be considered in the project. When this is done, the theoretical status of the project can be modelled. to make sure the project technical scope is understood a discussion was held with the project manager and the maintenance engineer. the same discussion was held to prepare and agree on the modelling of the actual state of the project.

When the questionnaire was finished, project technical scope was clear and the case projects theoretical state was modelled, an interview was arranged with the project organization members. In total two interviews per case project was arranged. First interview was with the project manager and the second with the project maintenance engineer. The actual status of the case review project was modelled. The tasks to be done based on company instructions listed in the questionnaire, was utilized as a basis during the interview to record the information of the state of each task. The interviewer will present a question related to each the task, asking a closed question whether it is done or not. The answers of each task received from the task responsible person is recorded on the list getting a status of the project actual state.

3.3.3 Analysis of the results

Case studies will be analysed by a comparative analysis, where patterns and variations across the case studies will be uncovered. The theoretical status of projects, as outlined in company instructions is compared with the actual status observed trough case reviews with project managers and maintenance engineers. This way discrepancies, deviation, and challenges encountered in the implementation of maintenance data management process, supportive tools and related instructions will be identified. The root causes of these variations will be studied by reviewing the questionnaire and interviewing the project manager and maintenance engineer. The interview main goal is to pinpoint opportunities for developing recommendations for enhancing maintenance data management process, supportive tools, and related instructions for the target company, while recording the actual states of the projects. The comparative analysis identifies the best practices, lessons learned, and innovative approaches adopted by case studies. Key success factors, critical milestones, and replicable strategies will be researched by case studies. These results enrich the understanding of maintenance data management process in projects and informs the development possibilities for future.

For examining the case projects those will be reviewed on a step-by-step basis which part of the task list is deviating from the theoretical state. Additionally, an overall status of all projects together, separately, and mill specifically is received to see whether there are any commonalities in deviations. case specific information is gathered from each questionnaire category as presented in the figure 9, 10, and table 3.

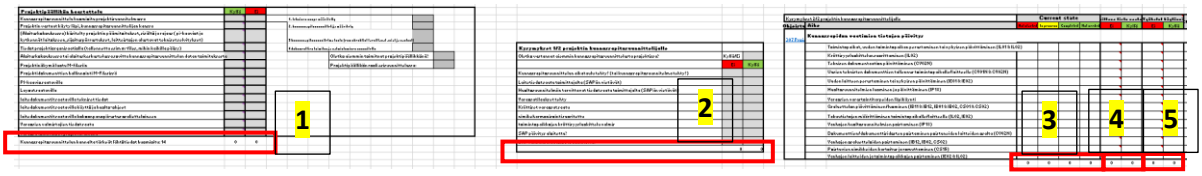


Figure 9. Case review questionnaire, summarizing the total amount of tasks done and tasks not done in a project in figures 6, 7, and 8

In the figure 9 is a summary of all the tables “3”, “4”, and “5” and how the tasks done related to one project is collected. The area marked with “1” summarizes the tasks to be completed by the project manager according to instructions. This table is the same as the table in figure 6. The area marked with “2” summarizes maintenance planning preparation completed according to instructions in the projects. This table is the same as the table in figure 7. The area marked with “3” summarizes the maintenance data management process checklist statuses. The area marked with “4” summarizes the information needed for maintenance engineering available, and the area marked with “5” summarizes the supportive tools utilized in implementation of maintenance data management process checklist tasks. The areas “3”, “4”, and “5” in figure 9 is the same as the table presented in figure 6.

The results of total tasks that should be done (theoretical status) and tasks that is done (actual status) will be gathered in a summary table as presented in table 3.

Table 3. Case review questionnaire, summary table of the case study projects theoretical and actual state

Tilanne				Case 1	**Ohjeistuksen mukainen tavoitetila**			
Projektipäällikkö huomioinut ohjeistuksen mukaan kunnossapitosuunnittelun onnistumisen kannalta tärkeät asiat								
10	Considered	73 %	17 %		14	Considered	100 %	22 %
4	Not considered	27 %	6 %		0	Not considered	0 %	0 %
Kunnossapitosuunnittelun valmistelu toteutunut ohjeistuksen mukaisesti								
2	Delayed	22 %	3 %		0	Delayed	0 %	0 %
7	Done	78 %	11 %		9	Done	100 %	14 %
Projektin kunnossapitosuunnittelun tilanne								
0	Not started	0 %	0 %		0	Not started	0 %	0 %
2	In process	14 %	3 %		0	In process	0 %	0 %
7	Completed or Yes	50 %	11 %		9	Completed or Yes	64 %	14 %
5	Not needed	36 %	8 %		5	Not needed	36 %	8 %
Kunnossapitosuunnitteluun tarvittavat tiedot saatavilla								
12	Data available	86 %	18 %		14	Data available	100 %	22 %
2	Data missing	14 %	3 %		0	Data missing	0 %	0 %
Kunnossapitosuunnitteluun olemassa olevat työkalut käytetty								
1	Tools utilized	7 %	2 %		14	Tools utilized	100 %	22 %
13	Managed other way	93 %	20 %		0	Managed other way	0 %	0 %
65	matters in the assessment		100 %		65	matters in the assessment		100 %

In the left side of the table 3 is presented the actual status of project tasks recorded separately for each theme during the reviews with project organizations. The right side of the table 3 is determining the theoretical state.

These are combined, and a result of each project will be received which is explained in figure 10.

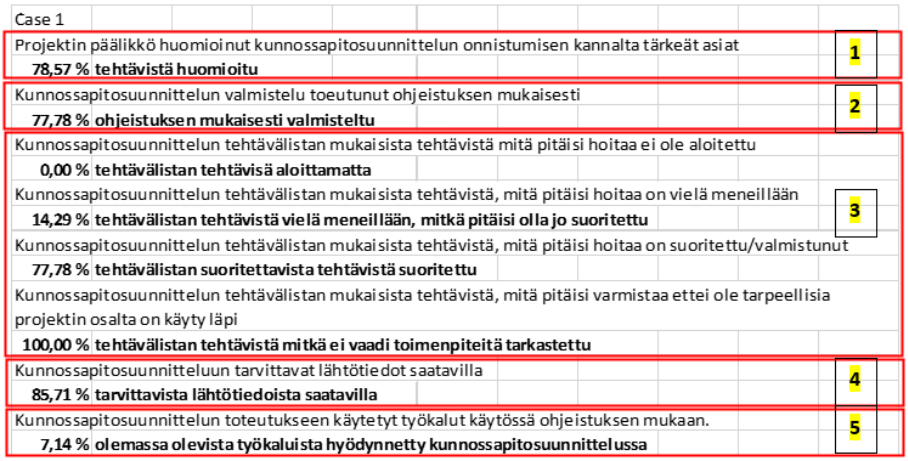


Figure 10. Case review questionnaire, example of the overall of each project actual status of compared to the theoretical status

In the Figure 10, the area marked with 1, mentions if the project manager has completed the tasks related to a successful implementation of maintenance data management. Area marked with 2 mentions if the maintenance related aspects have been planned according to instructions. Area marked with 3 mentions how many of the tasks list tasks is not yet stated, is ongoing, is completed and is reviewed and not applicable. Area marked with 4 mentions how many tasks still is missing data that it can be completed. Area marked with 5 mentions how many of the available supportive tools have been utilized for the task.

In the following figure (figure 11) is a summary of project related tables for collecting the actual state and the theoretical state of a project. The area marked with “1” summarizes on the upper table the actual state and the lower table the theoretical state of the tasks to be completed by the project manager. Tables used for modelling the state in area marked with “1” are same as the figure 6, in section 3.3.2., on page 60. The area marked with “2” summarizes on upper table the actual state and the lower table the theoretical state of the maintenance planning preparation related tasks completed according to instructions in the projects. Tables used in area “2” are same as the figure 7, in section 3.3.2., on page 61. The area marked with “3” summarizes the maintenance data management process checklist,

information delivered, and supportive tools utilized statuses. On upper level the actual state, and bottom level the theoretical state. Tables used in area “3” are same as the figure 8, in section 3.3.2., on page 61. When both actual and theoretical states are modelled the deviations is highlighted by orange color for the actual states. The table 3, figure 10, and collection of tables in figure 11 are received from each project which all will be utilized in the analysis of the case projects.

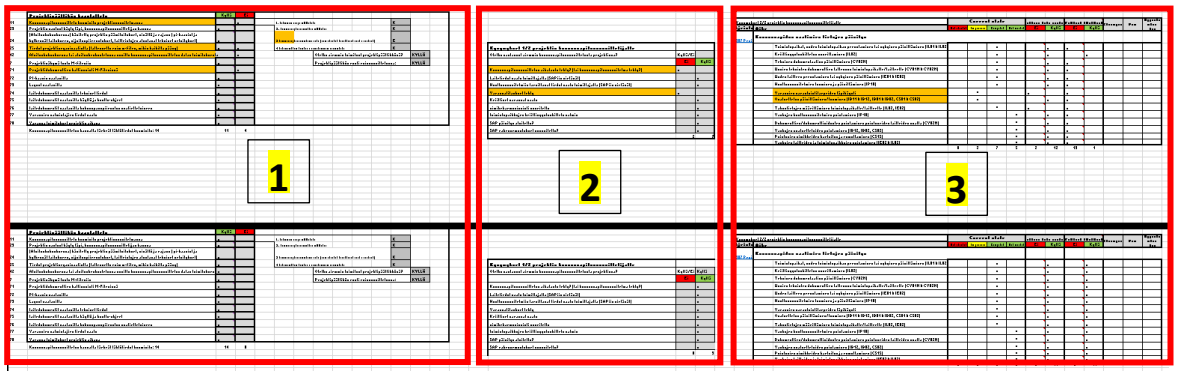


Figure 11. Case review questionnaire, collection of tables explained in figures 6, 7, and 8 actual and theoretical states visualised, where the actual status tasks deviating from the theoretical will be separately marked and reviewed for possible commonalities between projects

3.4 Focused interviews

Focused interviews are used as a qualitative method in this research for gathering and developing innovative ideas on the development of the maintenance data management process, supportive tools, and related instructions.

3.4.1 Representativeness and coverage

Focused interview was done for a total of 11 Project Managers, Maintenance Planners within the basic population, and specialists outside the research basic population, but within the field of the researched topic to gather data on developing the maintenance data management

process, supportive tools, and related instructions. The interviewees were located mainly around Finland but partly also around Europe, so the interviews were arranged online by teams by pre-arranging a suitable time together with each interviewee.

In total 5 maintenance specialists, and 3 project managers were selected to take part in the interviews from basic population consisting in a total of approximately 30 persons. The interviewed persons were determined together with the mechanical maintenance managers of each mill, everyone naming two maintenance engineers that to make sure the interviewee knows about the topic being studied and has experience with it. Additionally, the project managers responsible for the studied case study projects were interviewed to while reviewing the actual state of the studied case study project. Additionally, 4 interviews were conducted to receive development ideas from others than the basic population and not within the target company.

Before arranging the interview, a preliminary discussion was arranged with the possible interview candidates about the topics and possible free time slots for conducting the interviews. The personnel participating in the discussion was selected as discretionary samples, by so called snowball sampling, where researcher had a key person who led the researcher to another informant. The research material is this way collected in such a way that the researcher progresses from one informant to another as new ones are introduced. This sampling was utilized to find participants in the interviews from outside the research target company basic population. In total 10 discussions were arranged before selecting the 4 interviewees to take part in the focused interviews providing viewpoints from outside the basic population of the research target company. This way was made sure that the correct persons are attending the interviews and the interviewee was also able to get ready for the coming interview and ensure that they can have the full focus on the interview when it was held.

It was seen important that the procedure is clear, and the company requirements are known so the target group for these interviews were selected by the help of the other company business areas leadership that named persons that knows and has insights on how the researched topic could be developed and what shall be considered.

3.4.2 Data collection

The research questions for the focused interviews are structured based on the research questions for the whole research. The main goal of the interviews is to gather information to help develop the maintenance data management process successful implementation, the supportive tools, and the related instructions. Taking these views into account, the focused interview research aims to find answers to the following research questions:

- Why is maintenance related data not managed according to instructions in projects?
- How maintenance data management process and the data management system could be developed?

The questionnaire utilized in modelling the theoretical and actual state of the project in the case studies, was structured so that the development ideas can be noted by the interviewer during the interviews for modelling the status of the project. This way the data will be gathered by interviewing maintenance organizations maintenance specialists withing the target company basic population personnel who have been selected to take part in the interview that is at the time of the research participating in a project which is selected as a case study for the research.

In the Figure 12, area marked with “1” is about gathering of information on the challenges faced, related to the task, and on the plan made, to get the task done, even though challenges have occurred. The area marked with “2” is about gathering information for developing the task related challenges by asking an open-ended question on how that task could be developed.

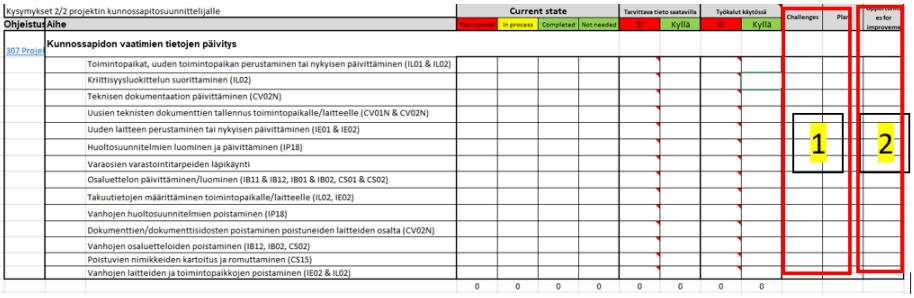


Figure 12. Case review questionnaire, project maintenance engineer responsibilities related to project maintenance data management process task list

This questionnaire was utilized as a basis for the focused interviews. Development ideas were discussed for each task with persons responsible for the task when he/she has just thought about the task in a practical example. Development ideas are gathered by asking open ended questions related to each task of the case study questionnaire in the focused interviews. An open-ended question for example for the first task list task is “How could this be developed?” Before the question related to the development ideas is asked it is discussed whether this task have been done or not, and whether the information needed for finishing this task is available or not, and whether the supportive tools related to this task are utilized or not. For named interviewees within the basic population that are not attending to any projects during the time of the research, only open-ended questions were asked utilizing the questionnaire as a basis leading the interview/discussion. For interviews conducted for specialists outside the basic population, the questions were structured separately. The questions were implemented based on the questionnaire themes. During the interviews, the question themes will be utilized in steering the discussion, so all the questions might not need to be asked.

The interviewer will take notes during the interview while interviewing. While taking notes can be difficult and is a skill worth practising as interviewer needs to make notes while talking, notes must be finalized and written clean right after the interview. (Nicholas, 2021.)

The focused interview flow chart is briefly described below in figure 13.

Figure 13. Phases of the interview execution from planning phase to analysis phase (Hirsjärvi & Hurme 2022; Grad Coach 2023).

3.4.3 Analysis of the results

Thematic analysis will be conducted for the notes (transcripts) done from the focused interviews for unveiling key themes and insights from the discussions with specialists. This systematic method will be used to identify patterns or themes within the qualitative data. The transcripts of the interviews will be reviewed for common codes, which will be concluded into themes. The themes will be finally put together in a narrative answering to the research questions. The steps of examining the interview transcripts in more detail are explained in the figure 14.

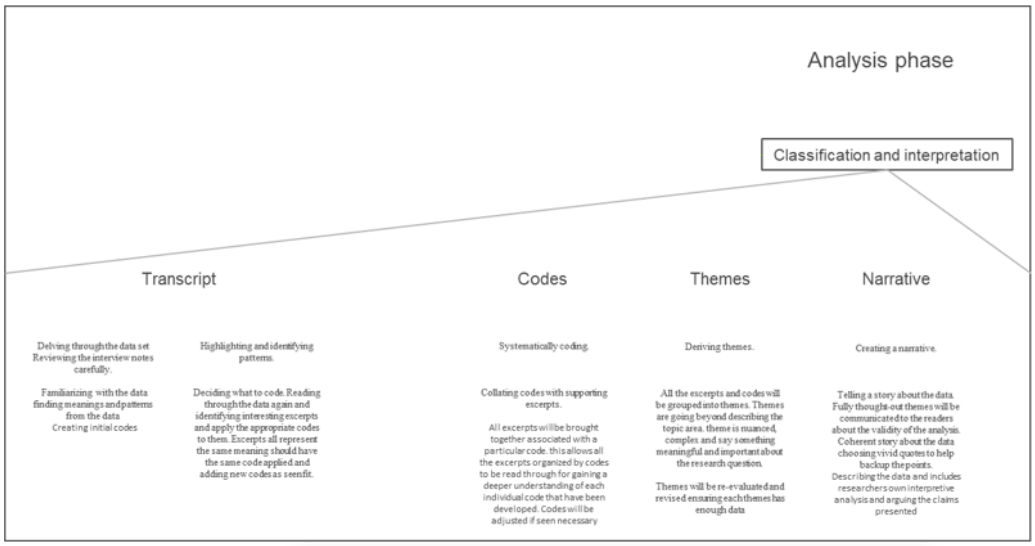


Figure 14. Phases of the executed interview analysis phase (Grad Coach 2023; Braun & Clarke 2006).

3.5 Generalizability

Combining case studies focused on different projects and focused interviews with different specialists strengthens the robustness and applicability of the research findings. Using these complementary methods, the study aims to provide insights and recommendations that can be applied to similar industrial settings, contributing to a broader understanding of maintenance data management practices in production process change projects.

4 Case Studies and Interview Results

In this chapter is reviewed the results of the case studies and focused interviews. First chapter is reviewing the case study results and the second chapter the focused interview results.

4.1 Case studies

This chapter is divided in presenting the case study theoretical status for each project, the actual status of each project and a comparison of the theoretical and actual status of each project.

The modelled theoretical and actual state is described for each case separately in appendix 5. A summary of the theoretical status for each project is described in 4.1.1-chapter tables and the actual status in 4.1.2-chapter tables. Figure 15 shows the theoretical status, and the Figure 19 shows the actual status of the tasks that should have been done by the project manager according to instructions considering the project technical scope and the state of implementation. Figure 16 and 17 shows the theoretical status, and the figure 20 and 21 shows the actual status of the tasks done by the project maintenance engineer according to instructions considering the project technical scope and the state of implementation. Figure 18 shows the theoretical and figure 22 shows the actual status of the information availability for executing successfully the task presented in figure 21. The case projects theoretical statuses are modelled all in December 2023 and the actual statuses are modelled right after. Between these times of modelling the project phase did not change. During the review 5 projects was in the closing phase and one project was facing some delays causing it to be still in the installation phase during the case reviews. For the projects that was in the closing phase, all the maintenance related tasks shall have been considered and finishing of some tasks as as-built documentation can be still ongoing and finished before the closure of the project. The one project facing delays was close to the start-up phase, so it was kept as one case in this research.

4.1.1 Theoretical status of the maintenance data management process

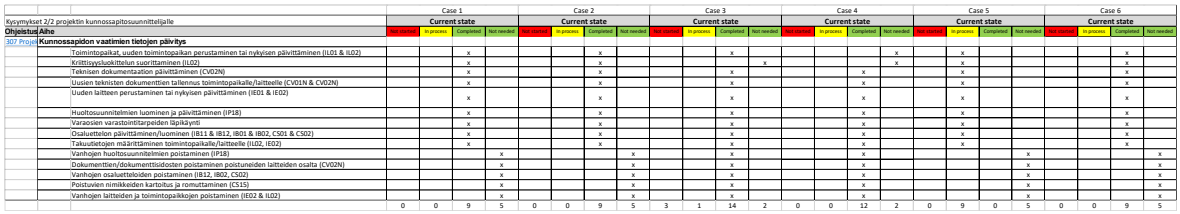
A summary of the theoretical status for each project is described in the following figures 15, 16, 17 and 18.

	Case 1 - 6	
Projektipäällikön haastattelu	Kyllä	Ei
Kunnossapitosuunnittelu huomioitu projektisuunnitelmassa	x	
1. tekninen scope määritelty	x	
2. kunnossapitosuunnittelija määritely	x	
3 kunnossapitosuunnitelma luotu (rcm checklist tarvittavat asiat ja vastuut)	x	
4 dokumenttien toimitus ja valmistuminen suunniteltu	x	
Projektin vastuut käyty läpi, kunnossapitosuunnittelijan kanssa	x	
(Aloituskokouksessa) käsitelty projektin päämitoitukset, sisältö ja rajaus (pi-kaaviot ja kytkennät laitokseen, sijoituspiirrustukset, laitteistojen alustavat tekniset selvitykset)	x	
Tiedot projektiorganisaatiolla (tallennettu esim m-files, mihin kaikilla pääsy)	x	
Aloituskokouksessa tai aloituskeskustelussa sovittu kunnossapitosuunnittelun datan toimituksesta	x	
Projektinäkymä luotu M-filesiin	x	
Projektidokumenttien hallinnointi M-Filesissä	x	
PI-kaavio saatavilla	x	
Layout saatavilla	x	
laitedokumentit saatavilla tekniset tiedot	x	
laitedokumentit saatavilla käyttö ja huolto-ohjeet	x	
laitedokumentit saatavilla kokoonpanopiirustus osaletteloineen	x	
Varaosien valmistajien tiedot saatu	x	
Varaosa toimitukset projektin aikana	x	
Kunnossapitosuunnittelun kannalta tärkeät lähtötiedot huomioitu: 14	14	0

Figure 15. Theoretical status of the tasks that should have been done by the project manager

	Case 1 - 6	
Kysymykset 1/2 projektin kunnossapitosuunnittelijalle		
Oletko vastannut aiemmin kunnossapitosuunnittelusta projektissa?	Kyllä/Ei	Kyllä
	Ei	Kyllä
Kunnossapitosuunnittelun aikataulu tehty? (tai kunnossapitosuunnitelma tehty?)		x
Laitetiedot saatu toimittajalta (SAPiin vietävät)		x
Huoltosuunnitelmiin tarvittavat tiedot saatu toimittajalta (SAPiin vietävät)		x
Varaosatilaukset tehty		x
Kriittiset varaosat saatu		x
nimikeharmonisointi suoritettu		x
toimintopaikkojen kriittisyysluokittelu valmis		x
SAP päivitys aloitettu?		x
SAP rakennemuutokset suunniteltu?		x
	0	9

Figure 16. Theoretical status of the tasks done by the project maintenance engineer (part 1/2)



Kysymykset 2/2 projektin kunnossapitosuunnittelijalle		Case 1				Case 2				Case 3				Case 4				Case 5				Case 6			
		Current state				Current state				Current state				Current state				Current state				Current state			
Ohjeistus	Aihe	Data needed	In process	Completed	Not needed	Not started	In process	Completed	Not needed	Not started	In process	Completed	Not needed	Not started	In process	Completed	Not needed	Not started	In process	Completed	Not needed	Data needed	In process	Completed	Not needed
307 Projek	**Kunnossapidon vaatimien tietojen päivitys**																								
	Toimintopaikat, uuden toimintopaikan perustaminen tai nykyisen päivittäminen (IL01 & IL02)			x				x				x					x		x				x	
	Kriittisyysluokittelun suorittaminen (IL02)			x				x					x				x		x				x	
	Teknisen dokumentaation päivittäminen (CV02N)			x				x				x				x			x				x	
	Uusien teknisten dokumenttien tallennus toimintopaikalle/laitteelle (CV01N & CV02N)			x				x				x				x			x				x	
	Uuden laitteen perustaminen tai nykyisen päivittäminen (IE01 & IE02)			x				x				x				x			x				x	
	Huoltosuunnitelmien luominen ja päivittäminen (IP1B)			x				x				x				x			x				x	
	Varaosien varastointitarpeiden läpikäynti			x				x				x				x			x				x	
	Osaluettelon päivittäminen/luominen (IB11 & IB12, IB01 & IB02, CS01 & CS02)			x				x				x				x			x				x	
	Takuutietojen määrittäminen toimintopaikalle/laitteelle (IL02, IE02)			x				x				x				x			x				x	
	Vanhojen huoltosuunnitelmien poistaminen (IP1B)				x				x			x				x				x					x
	Dokumenttien/dokumenttisidosten poistaminen poistuneiden laitteiden osalta (CV02N)				x				x			x				x				x					x
	Vanhojen osaluetteloiden poistaminen (IB12, IB02, CS02)				x				x			x				x				x					x
	Poistuvien nimikkeiden kartoitus ja nimeäminen (CS15)				x				x			x				x				x					x
	Vanhojen laitteiden ja toimintopaikkojen poistaminen (IE02 & IL02)				x				x			x				x				x					x
		0	0	9	5	0	0	9	5	3	1	14	2	0	0	12	2	0	9	0	5	0	0	9	5

Figure 17. Theoretical status of the tasks done by the project maintenance engineer (part 2/2)

Case 1-6	
Tarvittava tieto saatavilla	
Ei	Kyllä
	x
	x
	x
	x
	x
	x
	x
	x
	x
	x
	x
	x
	x
0	14

Figure 18. Theoretical status of the information availability for executing successfully the tasks presented in figure 17

4.1.2 Actual status of the maintenance data management process

A summary of the actual status for each project is described in the following figures 19, 20, 21 and 22.

	Case 1		Case 2		Case 3		Case 4		Case 5		Case 6	
Projektipäällikön haastattelu	Kyllä	Ei	Kyllä	Ei	Kyllä	Ei	Kyllä	Ei	Kyllä	Ei	Kyllä	Ei
Kunnossapitosuunnittelu huomioitu projektisuunnitelmassa		x		x		x		x			x	
1. tekninen scope määritelty	x		x		x		x		x			
2. kunnossapitosuunnittelija määritely	x		x		x			x	x			
3 kunnossapitosuunnitelma luotu (rcm checklist tarvittavat asiat ja vastuut)		x		x		x		x	x			
4 dokumenttien toimitus ja valmistuminen suunniteltu	x		x			x		x	x			
Projektin vastuut käyty läpi, kunnossapitosuunnittelijan kanssa	x	x	x		x		x		x		x	
(Aloituskokouksessa) käsitelty projektin päämitoitukset, sisältö ja rajaus (pi-kaaviot ja kytkennät laitokseen, sijoituspiirrustukset, laitteistojen alustavat tekniset selvitykset)		x	x		x		x		x		x	
Tiedot projektiorganisaatiolla (tallennettu esim m-files, mihin kaikilla pääsy)	x		x		x	x	x		x		x	
Aloituskokouksessa tai aloituskeskustelussa sovittu kunnossapitosuunnittelun datan toimituksesta		x		x	x		x		x		x	
Projektinäkymä luotu M-filesiin	x		x		x		x		x		x	
Projektidokumenttien hallinnointi M-Filesissä	x			x		x		x		x	x	
PI-kaavio saatavilla	x		x		x		x		x		x	
Layout saatavilla	x		x		x		x		x		x	
laitedokumentit saatavilla tekniset tiedot	x		x		x		x		x		x	
laitedokumentit saatavilla käyttö ja huolto-ohjeet	x		x		x		x		x		x	
laitedokumentit saatavilla kokoonpanopiirustus osaliettelolineen	x		x		x		x		x		x	
Varaosien valmistajien tiedot saatu	x		x		x		x		x		x	
Varaosa toimitukset projektin aikana	x		x		x		x		x		x	
Kunnossapitosuunnittelun kannalta tärkeät lähtötiedot huomioitu: 14	11	4	11	3	12	3	12	2	13	1	14	0

Figure 19. Actual status of the tasks that according to instructions should have been considered by the project manager

	Case 1		Case 2		Case 3		Case 4		Case 5		Case 6	
Kysymykset 1/2 projektin kunnossapitosuunnittelijalle												
Oletko vastannut aiemmin kunnossapitosuunnittelusta projektissa?	Kyllä/Ei	Kyllä	Kyllä/Ei	Kyllä	Kyllä/Ei	Kyllä	Kyllä/Ei	Kyllä	Kyllä/Ei	Kyllä	Kyllä/Ei	Kyllä
	Ei	Kyllä	Ei	Kyllä	Ei	Kyllä	Ei	Kyllä	Ei	Kyllä	Ei	Kyllä
Kunnossapitosuunnittelun aikataulu tehty? (tai kunnossapitosuunnitelma tehty?)	x		x		x		x		x		x	
Laitetiedot saatu toimittajalta (SAPiin vietävät)		x		x		x		x		x		x
Huoltosuunnitelmiin tarvittavat tiedot saatu toimittajalta (SAPiin vietävät)		x		x		x		x		x		x
Varaosatilaukset tehty	x			x		x		x		x		x
Kriittiset varaosat saatu		x		x	x			x		x		x
nimikeharmonisointi suoritettu		x		x	x			x		x		x
toimintopaikkojen kriittisyysluokittelu valmis		x	x		x			x	x		x	
SAP päivitys aloitettu?		x		x	x			x		x		x
SAP rakennemuutokset suunniteltu?		x		x	x			x		x		x
	2	7	2	7	6	3	1	8	2	7	2	7

Figure 20. Actual status of the tasks that according to instructions should have been considered by the project maintenance engineer (part 1/2)

		Case 1				Case 2				Case 3				Case 4				Case 5				Case 6			
Kysymykset 2/2 projektin kunnossapitosuunnittelijalle		Current state				Current state				Current state				Current state				Current state				Current state			
Ohjelistat	Aihe	Not started	In process	Completed	Not needed	Not started	In process	Completed	Not needed	Not started	In process	Completed	Not needed	Not started	In process	Completed	Not needed	Not started	In process	Completed	Not needed	Not started	In process	Completed	Not needed
307 Project	**Kunnossapidon vaatimien tietojen päivitys**																								
	Toimintopaikat, uuden toimintopaikan perustaminen tai nykyisen päivittäminen (IL01 & IL02)			x				x				x				x		x					x		
	Kriittisyysluokittelun suorittaminen (IL02)			x			x						x				x		x				x		
	Teknisen dokumentaation päivittäminen (CV02N)			x				x		x						x			x					x	
	Uusien teknisten dokumenttien tallennus toimintopaikalle/laitteelle (CV01N & CV02N)			x				x		x					x				x					x	
	Uuden laitteen perustaminen tai nykyisen päivittäminen (IE01 & IE02)			x				x		x						x			x					x	
	Huoltosuunnitelmien luominen ja päivittäminen (IP18)			x				x				x				x		x						x	
	Varaosien varastointitarpeiden läpikäynti		x					x				x				x			x				x		
	Osaluettelon päivittäminen/luominen (IB11 & IB12, IB01 & IB02, CS01 & CS02)		x					x				x				x			x					x	
	Takuutietojen määrittäminen toimintopaikalle/laitteelle (IL02, IE02)			x			x						x			x			x					x	
	Vanhojen huoltosuunnitelmien poistaminen (IP18)				x				x			x					x				x				x
	Dokumenttien/dokumenttisidosten poistaminen poistuneiden laitteiden osalta (CV02N)				x				x			x					x				x				x
	Vanhojen osaluetteloiden poistaminen (IB12, IB02, CS02)				x				x			x					x				x				x
	Poistuvien nimikkeiden kartoitus ja nimeäminen (CS15)				x				x			x					x				x				x
	Vanhojen laitteiden ja toimintopaikkojen poistaminen (IE02 & IL02)				x				x			x					x				x				x
		0	2	7	5	0	2	7	5	6	9	3	2	0	6	6	2	1	8	0	5	0	2	7	5

Figure 21. Actual status of the tasks that according to instructions should have been considered by the project maintenance engineer (part 2/2)

Case 1		Case 2		Case 3		Case 4		Case 5		Case 6	
Tarvittava tieto saatavilla		Tarvittava tieto saatavilla		Tarvittava tieto saatavilla		Tarvittava tieto saatavilla		Tarvittava tieto saatavilla		Tarvittava tieto saatavilla	
Ei	Kyllä	Ei	Kyllä	Ei	Kyllä	Ei	Kyllä	Ei	Kyllä	Ei	Kyllä
	x		x		x		x		x		x
	x		x		x		x		x		x
	x		x		x		x		x		x
	x		x		x		x		x		x
	x		x		x		x		x		x
	x		x		x		x		x		x
x			x		x		x		x		x
	x		x		x		x		x		x
x			x		x		x		x		x
	x		x		x		x		x		x
	x		x		x		x		x		x
	x		x		x		x		x		x
	x		x		x		x		x		x
	x		x		x		x		x		x
2	12	0	14	0	14	0	14	0	14	0	14

Figure 22. Actual status of the information availability that according to instructions should be available for executing successfully the related task presented in figure 21

4.1.3 Deviations between the theoretical and actual status of the maintenance data management process

A summary of the deviations between the theoretical and the actual status for each project is described in the following figure 23, 24, 25, and 26. In all these figures is highlighted the deviations to the theoretical status with orange.

	Case 1		Case 2		Case 3		Case 4		Case 5		Case 6	
Projektipäällikön haastattelu	Kyllä	Ei	Kyllä	Ei	Kyllä	Ei	Kyllä	Ei	Kyllä	Ei	Kyllä	Ei
Kunnossapitosuunnittelu huomioitu projektisuunnitelmassa		x		x		x		x	x		x	
1. tekninen scope määritelty	x		x		x		x		x		x	
2. kunnossapitosuunnittelija määritely	x		x		x			x	x		x	
3 kunnossapitosuunnitelma luotu (rcm checklist tarvittavat asiat ja vastuut)		x		x		x		x	x		x	
4 dokumenttien toimitus ja valmistuminen suunniteltu	x		x			x		x	x		x	
Projektin vastuut käyty läpi, kunnossapitosuunnittelijan kanssa	x	x	x		x		x		x		x	
(Aloituskokouksessa) käsitelty projektin päämitoitukset, sisältö ja rajaus (pi-kaaviot ja kytkennät laitokseen, sijoituspiirrustukset, laitteistojen alustavat tekniset selvitykset)		x	x		x		x		x		x	
Tiedot projektiorganisaatiolla (tallennettu esim m-files, mihin kaikilla pääsy)	x		x		x	x	x		x		x	
Aloituskokouksessa tai aloituskeskustelussa sovittu kunnossapitosuunnittelun datan toimituksesta		x		x	x		x		x			x
Projektinäkymä luotu M-filesiin	x		x		x		x		x		x	
Projektidokumenttien hallinnointi M-Filesissä	x			x		x		x		x	x	
PI-kaavio saatavilla	x		x		x		x		x		x	
Layout saatavilla	x		x		x		x		x		x	
laitedokumentit saatavilla tekniset tiedot	x		x		x		x		x		x	
laitedokumentit saatavilla käyttö ja huolto-ohjeet	x		x		x		x		x		x	
laitedokumentit saatavilla kokoonpanopiirustus osaliitteloineen	x		x		x		x		x		x	
Varaosien valmistajien tiedot saatu	x		x		x		x		x		x	
Varaosa toimitukset projektin aikana	x		x		x		x		x		x	
Kunnossapitosuunnittelun kannalta tärkeät lähtötiedot huomioitu: 14	11	4	11	3	12	3	12	2	13	1	13	1

Figure 23. Actual status of the tasks that according to instructions should have been considered by the project manager

	Case 1		Case 2		Case 3		Case 4		Case 5		Case 6	
Kysymykset 1/2 projektin kunnossapitosuunnittelijalle												
Oletko vastannut aiemmin kunnossapitosuunnittelusta projektissa?	Kyllä/Ei	Kyllä	Kyllä/Ei	Kyllä	Kyllä/Ei	Kyllä	Kyllä/Ei	Kyllä	Kyllä/Ei	Kyllä	Kyllä/Ei	Kyllä
	Ei	Kyllä	Ei	Kyllä	Ei	Kyllä	Ei	Kyllä	Ei	Kyllä	Ei	Kyllä
Kunnossapitosuunnittelun aikataulu tehty? (tai kunnossapitosuunnitelma tehty?)	x		x		x		x		x		x	
Laitetiedot saatu toimittajalta (SAPiin vietävät)		x		x		x		x		x		x
Huoltosuunnitelmiin tarvittavat tiedot saatu toimittajalta (SAPiin vietävät)		x		x		x		x		x		x
Varaosatilaukset tehty	x			x		x		x		x		x
Kriittiset varaosat saatu		x		x	x			x		x		x
nimikeharmonisointi suoritettu		x		x	x			x		x		x
toimintopaikkojen kriittisyysluokittelu valmis		x	x		x			x	x		x	
SAP päivitys aloitettu?		x		x	x			x		x		x
SAP rakennemuutokset suunniteltu?		x		x	x			x		x		x
	2	7	2	7	6	3	1	8	2	7	2	7

Figure 24. Actual status of the tasks that according to instructions should have been considered by the project maintenance engineer (part 1/2)

Kysymykset 2/2 projektin kunnossapitosuunnittelijalle		Case 1				Case 2				Case 3				Case 4				Case 5				Case 6			
		Current state				Current state				Current state				Current state				Current state				Current state			
Ohjeistus	Aihe	Not started	In process	Completed	Not needed	Not started	In process	Completed	Not needed	Not started	In process	Completed	Not needed	Not started	In process	Completed	Not needed	Not started	In process	Completed	Not needed	Not started	In process	Completed	Not needed
307 Projekti	**Kunnossapidon vaatimien tietojen päivitys**																								
	Toimintopaikat, uuden toimintopaikan perustaminen tai nykyisen päivittäminen (IL01 & IL02)			x			x	x				x					x		x				x	
	Kriittisyysluokittelun suorittaminen (IL02)			x									x				x		x			x			
	Teknisen dokumentaation päivittäminen (CV02N)			x				x		x						x			x					x	
	Uusien teknisten dokumenttien tallennus toimintopaikalle/laitteelle (CV01N & CV02N)			x				x		x					x				x					x	
	Uuden laitteen perustaminen tai nykyisen päivittäminen (IE01 & IE02)			x				x		x						x			x					x	
	Huoltosuunnitelmien luominen ja päivittäminen (IP18)			x				x			x					x		x						x	
	Varaosien varastointitarpeiden läpikäynti		x					x			x					x			x				x		
	Osaluettelon päivittäminen/luominen (IB11 & IB12, IB01 & IB02, CS01 & CS02)		x					x			x					x			x					x	
	Takuutietojen määrittäminen toimintopaikalle/laitteelle (IL02, IE02)			x			x					x				x			x					x	
	Vanhojen huoltosuunnitelmien poistaminen (IP18)				x				x		x				x						x				x
	Dokumenttien/dokumenttisidosten poistaminen poistuneiden laitteiden osalta (CV02N)				x				x		x				x						x				x
	Vanhojen osaluetteloiden poistaminen (IB12, IB02, CS02)				x				x		x				x						x				x
	Poistuvien nimikkeiden kartoitus ja romuttaminen (CS15)				x				x		x				x						x				x
	Vanhojen laitteiden ja toimintopaikkojen poistaminen (IE02 & IL02)				x				x		x				x						x				x
		0	2	7	5	0	2	7	5	6	9	3	2	0	6	6	2	1	8	0	5	0	2	7	5

Figure 25. Actual status of the tasks that according to instructions should have been considered by the project maintenance engineer (part 2/2)

Case 1		Case 2		Case 3		Case 4		Case 5		Case 6	
Tarvittava tieto saatavilla		Tarvittava tieto saatavilla		Tarvittava tieto saatavilla		Tarvittava tieto saatavilla		Tarvittava tieto saatavilla		Tarvittava tieto saatavilla	
Ei	Kyllä	Ei	Kyllä	Ei	Kyllä	Ei	Kyllä	Ei	Kyllä	Ei	Kyllä
	x		x		x		x		x		x
	x		x		x		x		x		x
	x		x	x			x		x		x
	x		x	x			x		x		x
	x		x	x			x		x		x
	x		x	x			x		x		x
x			x	x			x		x		x
	x		x	x			x		x		x
x		x			x		x		x		x
	x		x	x			x		x		x
	x		x	x			x		x		x
	x		x	x			x		x		x
	x		x	x			x		x		x
2	12	1	13	11	3	0	14	0	14	0	14

Figure 26. Actual status of the information availability that according to instructions should be available for successfully executing the related task presented in figure 25

Case 1 project is at the commissioning phase where the machinery is running and therefore all the maintenance related tasks listed in the checklist shall be completed.

The project manager has considered 71%, 10/14 of the tasks required for successfully implementing of the maintenance engineering according to instructions.

78%, 7/9 of the tasks required for the preparation of maintenance engineering according to instructions has been considered.

0%, 0/14 of the maintenance tasks list tasks are not started that should have been started based on the instructions.

14%, 2/9 of the maintenance tasks list tasks are still in progress that should be completed based on the instructions.

78%, 7/9 of the maintenance tasks list tasks are completed according to instructions.

100%, 5/5 of the maintenance tasks list tasks that does not require any further actions have been reviewed.

86%, 12/14 of the maintenance tasks list tasks has the required information available for executing the task.

7%, 1/14 of the existing supportive tools have been utilized for managing the task.

Detailed, visualized results are presented in appendix 5, Figure 7 and Table 1.

Spare parts and bill of material data is not completed according to instructions. The work is currently ongoing, but the information needed for doing the work is missing. The spare part acquisitions are not all completed. During the review was noted also that a maintenance engineering plan/schedule was not done for this project. Document management was not completely done in the specified project document management system. Mostly documents have been distributed to the needed stakeholders by email during the project. A kick of meeting was held with the supplier by the purchaser but in the meeting the document deliveries related to maintenance data was not discussed. Detailed, visualized results are presented in appendix 5, Figures 2, 4 and 6.

Case 2 project is at a stand-by phase where the machinery is already installed and tested, but one critical part installation is still pending, which prevents the final commissioning and taking the machinery to production use. Otherwise noting the status of the project, all the maintenance related tasks listed in the checklist shall be completed.

The project manager has considered 79%, 11/14 of the tasks required for successfully implementing of the maintenance engineering according to instructions.

78%, 7/9 of the tasks required for the preparation of maintenance engineering according to instructions has been considered.

0%, 0/14 of the maintenance tasks list tasks are not started that should have been started based on the instructions.

14%, 2/9 of the maintenance tasks list tasks are still in progress that should be completed based on the instructions.

78%, 7/9 of the maintenance tasks list tasks are completed according to instructions.

100%, 5/5 of the maintenance tasks list tasks that does not require any further actions have been reviewed.

93%, 13/14 of the maintenance tasks list tasks has the required information available for executing the task.

7%, 1/14 of the existing supportive tools have been utilized for managing the task.

Detailed, visualized results are presented in appendix 5, Figure 14 and Table 2.

During the review was noted that the criticality classification was not completed according to instructions. The work is currently in process, but the actual finishing is still pending. The mechanical warranty period is not determined for the equipment, because the information is missing. or not clear. During the review was noted also that a maintenance engineering plan/schedule was not done for this project. Document management was not completely done in the specified project document management system. Mostly documents have been distributed to the needed stakeholders by email during the project. A kick of meeting was held with the supplier by the purchaser but in the meeting the document deliveries was not discussed. Detailed, visualized results are presented in appendix 5, Figures 9, 11 and 13.

Case 3 project is at the phase where the machinery is running and therefore all the maintenance related tasks listed in the checklist shall be completed.

The project manager has considered 79%, 11/14 of the tasks required for successfully implementing of the maintenance engineering according to instructions.

33%, 3/9 of the tasks required for the preparation of maintenance engineering according to instructions has been considered.

21%, 3/14 of the maintenance tasks list tasks are not started that should have been started based on the instructions.

57%, 8/14 of the maintenance tasks list tasks are still in progress that should be completed based on the instructions.

15%, 2/13 of the maintenance tasks list tasks are completed according to instructions.

100%, 1/1 of the maintenance tasks list tasks that does not require any further actions have been reviewed.

21%, 3/14 of the maintenance tasks list tasks has the required information available for executing the task.

0%, 0/14 of the existing supportive tools have been utilized for managing the task.

Detailed, visualized results are presented in appendix 5, Figure 21 and Table 3.

During the review was noted that the technical documentation updating, equipment number creation, was not started. Also, periodical maintenance plans, spare parts, Bill of material lists, and old data removal was still in process but not completed according to instructions. The work is partly currently in process, but the information needed for doing the work is missing. For some tasks that is not yet started is the responsibilities unclear, who will do and when and where will the information be received. Critical spare parts are not received, master data management for spare part material not done, criticality classification is not done, CMMS updating have not started, and there was not done any plan for implementing the maintenance related aspects in the project. The project plan was missing the plan for document deliveries and the project document management system was not utilized in the project and most documents have been distributed to the needed project stakeholders by email during the project. A kick of meeting was held with the supplier by the purchaser but in the meeting the document deliveries was not discussed. The Final documentation was agreed in the contract to be delivered 8.1.2024. The technical documentation was created by the equipment manufacturer 25.8.2023 and was delivered to UPM 19.9.2023 by email. Detailed, visualized results are presented in appendix 5, Figures 16, 18 and 20.

Case 4 project is at the commissioning phase where the machinery is running and therefore all the maintenance related tasks listed in the checklist shall be completed.

The project manager has considered 85%, 12/14 of the tasks required for successfully implementing of the maintenance engineering according to instructions.

89%, 8/9 of the tasks required for the preparation of maintenance engineering according to instructions has been considered.

0%, 0/14 of the maintenance tasks list tasks are not started that should have been started based on the instructions.

43%, 6/14 of the maintenance tasks list tasks are still in progress that should be completed based on the instructions.

50%, 6/12 of the maintenance tasks list tasks are completed according to instructions.

100%, 2/2 of the maintenance tasks list tasks that does not require any further actions have been reviewed.

100%, 14/14 of the maintenance tasks list tasks has the required information available for executing the task.

0%, 0/14 of the existing supportive tools have been utilized for managing the task.

Detailed, visualized results are presented in appendix 5, Figure 28 and Table 4.

During the review was noted that the technical documentation updating, and old data removal was still in process but not completed according to instructions. A plan for implementing the maintenance related aspects in the project was not done and the maintenance engineering responsible or document deliveries was not noted in the project plan. The project document management system was not utilized in the project and most documents have been distributed to the needed project stakeholders by email during the project. A review of the technical scope was reviewed in a kick of meeting with the supplier by the purchaser and in the meeting the document deliveries was agreed. Detailed, visualized results are presented in appendix 5, Figures 23, 25 and 27.

Case 5 project is at final phases of installation and the commissioning of the machinery is done during the end of the year 2023 therefore all the maintenance related tasks listed in the checklist shall be completed.

The project manager has considered 93%, 13/14 of the tasks required for successfully implementing of the maintenance engineering according to instructions.

78%, 7/9 of the tasks required for the preparation of maintenance engineering according to instructions has been considered.

7%, 1/14 of the maintenance tasks list tasks are not started that should have been started based on the instructions.

0%, 0/0 of the maintenance tasks list tasks are still in progress that should be completed based on the instructions.

93%, 11/12 of the maintenance tasks list tasks are completed according to instructions.

100%, 5/5 of the maintenance tasks list tasks that does not require any further actions have been reviewed.

100%, 14/14 of the maintenance tasks list tasks has the required information available for executing the task.

7%, 1/14 of the existing supportive tools have been utilized for managing the task.

Detailed, visualized results are presented in appendix 5, Figure 33 and Table 5.

During the review was noted that the periodical maintenance plans were not in process, but all the other aspects of maintenance engineering was done except the criticality classification which was in process. The project document management system was not utilized in the project. Detailed, visualized results are presented in appendix 5, Figures 30, 32 and 34.

Case 6 project is at the commissioning phase where the machinery is running and therefore all the maintenance related tasks listed in the checklist shall be completed.

The project manager has considered 93%, 13/14 of the tasks required for successfully implementing of the maintenance engineering according to instructions.

78%, 7/9 of the tasks required for the preparation of maintenance engineering according to instructions has been considered.

0%, 0/14 of the maintenance tasks list tasks are not started that should have been started based on the instructions.

14%, 2/14 of the maintenance tasks list tasks are still in progress that should be completed based on the instructions.

86%, 12/14 of the maintenance tasks list tasks are completed according to instructions.

100%, 0/0 of the maintenance tasks list tasks that does not require any further actions have been reviewed.

100%, 14/14 of the maintenance tasks list tasks has the required information available for executing the task.

7%, 1/14 of the existing supportive tools have been utilized for managing the task.

Detailed, visualized results are presented in appendix 5, Figure 42 and Table 6.

During the review was noted that the criticality classification and spare part review was in process and not completed. A plan for maintenance related engineering was not done for the project. Data deliveries was not agreed with suppliers separately after signing the contract, so maintenance engineering is relying completely in the contracts and that the suppliers are following the delivery dates specified in the contracts. Detailed, visualized results are presented in appendix 5, Figures 37, 39 and 41.

4.2 Focused and semi-structured interviews

In this chapter is presented the results of the Focused and semi-structured interviews. In this research the interviews aim to gather information of the research target company basic population needs, expectations, values, and attitudes as accurately as possible on how the maintenance data management process, supportive tools and related instructions could be developed. Basic population is the organization personnel participating in production process change projects, so specialists and managers from the target group was named by the help of each mill technical managers and investment coordinator to participate in the interview. Specialists and Project Managers from each mill were selected to take part in the interviews. 11 Interviews were arranged in total to answer for the research questions:

- Why is maintenance related data not managed on time in projects?
- How maintenance planning process and data management software could be developed?

In the following table (table 4) is presented the interview participants titles, and units where they work and the duration of the conducted interview. Specialists and managers working in “Units”, called “Mill” are part of the research target company basic population, and

specialists and managers working in “Units” called EXT are outside the research target company basic population.

Table 4. Listing of interviewees selected to participate in the interviews

Title	**Unit**	**Interview duration**
Specialist 1	Mill 1	75 min
Specialist 2	Mill 1	120 min
Specialist 3	Mill 2	60 min
Specialist 4	Mill 2	61 min
Specialist 5, Manager 1	Mill 3	60 min
Manager 2	Mill 2	90 min
Manager 3	Mill 1	122 min
External Specialist 1	EXT*	60 min
External Manager 1	EXT*	60 min
External Manager 2	EXT*	30 min
External Specialist 2	EXT*	31 min

* Specialist within the field of the research, outside the researched target company’s unit

The research material was collected through thematic/semi-structured focused interviews, where a list of questions was used as a guiding factor. However, the list of questions was not fully followed, but rather served as a tool to guide the discussion. If necessary, additional questions were asked to clarify the answers to collect enough information for the research, this in turn affected the interviews in such a way that their durations could differ considerably. A summary was compiled of the results of the interviews, based on which the themes were concluded related to each research question.

4.2.1 Narrative of interview findings

In this chapter will be summarized the focused interview results. The chapter is structured so that the point within different themes related to the research question have been raised because of the interviews.

Why is maintenance related data is not managed according to instructions in projects?

Main themes found out to be the most usual reasons for managing the data in projects was lack of time, which depends on the lack of data availability in early enough stage of the project. So, the data required for implementing the checklist is delivered late in the project, leaving no time to deal with the task list until the machinery is installed and commissioned. Since often the projects commissioning is requiring a maintenance shutdown, that bring a lot of other responsibilities in addition to the project.

Resource constraints (Time)

Interviewees mentioned longstanding organizational resource constraints especially in production process change projects. The projects are implemented by the mill operations team, who are working parallel in the project and in the daily operational activities and simultaneously reporting to line manager, investment management and at the project organizational level to project manager and line supervisor. The resource constraints make it frustrating and difficult to be able to perform according to instructions and most often the number of tasks to be managed is at a so high level that usually maintenance related topics are not prioritized high enough to have those done within the project timeframe.

> "Sometimes it feels like the goal is to receive money to as much projects as possible, and not all of them are prepared and planned in such a way that it would be possible to achieve their realization following the instructions. Would it be better to have a few projects that need to be implemented more carefully than a lot of projects that are implemented carelessly?" [Manager 2]

> "At a short period of time a lot of new tasks have been included in the tasks list which needs to be prioritized higher than the maintenance data management related topics." [Specialist 1]

The Manager 2 refers with instructions to all the points outside the topics required for the investment decision such as possible payback calculations, description of technical scope, strategic impact, budget, causes if not implemented, environmental and safety aspects, starting and finishing dates, redundant equipment reviews, binding offer preparation. At this point the maintenance data deliveries are agreed with the supplier in the contract, so the data deliveries are not possible to change after the investment decision. The detailed project organization is named after the FID, which usually consist of discipline specialists of the area where the project is implemented.

> "Maintenance personnel shall be involved in early phase of the project taking to account maintainability of the asset. this is something that shall be studied, how it could be implemented. There is a project team doing the feasibility study aiming for receiving the FID where a maintenance responsible shall be included. Maintenance teams are usually very overloaded. How to secure the needed human resources for project and operations." [External Manager 1]

> "There was just not enough time to manage maintenance related data within the time frame and the only option would be at that moment to work extra time to be able to manage the data within the required timeframe" [Specialist 1]

> "Usually, these topics are considered as tasks to be done after installation, and those will not be focused on before the installation and shutdown period works gets lighter." [Manager 2]

> "The tasks are not that complex, when those are understood, but it takes just time to execute those in a sufficient quality. After the last mill yearly maintenance shutdown, I had over 10 maintenance data management related checklists on my table that took for me the summer and autumn to finish" [Specialist 2]

All the interviewees mentioned resource constraints to be one of the main problems for managing the maintenance related topics withing the project time frame. Also, it is noticed during the interview that the resource (project personnel) constraints are noticed during the operation of the mill when machine faults are happening and during unexpected downtime.

> "We have machine fault that in worst cases cause downtime and often the data needed for maintenance is missing, which root cause comes usually to the fact

> that during the project when the machine is installed there have been lack of resources (project personnel) to reflect project changes to technical data." [External Manager 1]

All the specialists participating the interview agreed that the maintenance data management before the project startup would be possible and a state of will, when the data would be delivered in early enough phase so that those could be managed before the most hectic time of the installation works and shutdown preparation works. Usually, the project installation works re done during the normal operation of the mill and startup of the machinery is requiring a shutdown depending on the case, sometimes for the entire mill and sometimes for a specific department. When the project is in the commissioning phase the focus is both in the finishing of the project installation works while doing preparatory works for the shutdown.

Data and information availability

In an investment project or in connection with acquisitions, the user receives a considerable amount of information related to the product together with the product itself. If the form of master data delivery has not been agreed upon, the master data related to the device in the delivery content will be delivered in some format like e.g., PDF, by some way like e.g., memory stick, hard copy, etc. From the delivered documents the master data will be manually transferred to the customer's maintenance management system. Spreadsheet programs, MS excel, etc. are also used as a means of data transfer. In terms of life cycle management and planning the maintainability, key information such as maintenance instructions shall be delivered following the agreements. These instructions can be delivered in the form of a word document, where the maintenance interval is mentioned within the text. This way delivered the data cannot be transferred automatically to the customer maintenance system and the customer must manually extract this data from delivered instructions into their own maintenance management system. (Kortelainen et al. 2021, p. 123.)

For being able to update the technical equipment registry and related data and documentation the information and data needs to be gathered from different sources during the project and put together to meet the requirements of the company. In this case information and data represents what is required for creating/updating periodical maintenance plans, spare part

inventory and technical equipment hierarchy/registry, which includes mill equipment hierarchy, equipment specific information/data, bill of materials and technical documentation. The data and information gathered needs to be reviewed considering the operational environment, supplier recommendations and local mill requirements. Usually, the supplier recommendations shall be revised for a more suitable solution taking to account the mentioned considerations.

All the interviewed specialists pointed out that receiving the information is a problem and always it is not clear who will provide information. Information and data are received from different sources during the project, mainly from mill/project engineering consultant/team, other disciplines, like process engineering and by the equipment manufacturer and supplier.

> "In the contract phase was agreed that the maintenance engineering will be done by the purchaser based on the manuals delivered." [Manager 3]
>
> "The warranty period is determined by reviewing the equipment startup date from the mill diary" [Specialist 2]
>
> "A lot of effort needs to be done to receive all the required information from the supplier. Most of the time used for managing maintenance related engineering topics is spent on finding the accurate data related to the equipment, from different systems and from installation site. Projects are usually quite complex, also confusing compared to normal operations and daily tasks. The Information related to project scope during the project revolves around the project management, equipment suppliers and the engineering but and does not always reach the maintenance planner in an early enough stage. Short meetings with related project organizations about the status would be beneficial for improving the communication in projects." [Specialist 2]

With different systems, specialist 2 refers to project document management system, maintenance management system, mill diary, meeting memos, email to name a few. With installation site, specialist 2 refers to the equipment delivered to site and being installed where the equipment tags and models of equipment is most probably accurate and correct. Those needs to be reviewed whenever some delivered data might lack of information or is not up to date.

> "Information accumulates in the form of messages and documents to email from different sources and the documents are stored in own computer folder and finally there is so many documents that those just left on the computer hard drive. If seen necessary, the information will be distributed by email for the required stakeholders." [Manager 2]

Many of the specialists interviewed pointed out that the information, needed for performing the maintenance data management, is delivered way too late to be able to review the data and utilize it for updating the maintenance management system. Going closer to the project startup or even installation phase other tasks become more critical than the maintenance related engineering.

> "Usually, the information needed for maintenance related data management is received after the project start up in electronic format as final documentation or during the equipment delivery when the installation work starts. the information might not be delivered if those are not separately requested, many times. Also, the information provided lacks in quality sometimes even it is mentioned to be final version so the supplier is asked to provide more information and it might take long to receive those. currently I am still waiting for document deliveries for started up equipment in last shutdown, which was finished 2 months ago." [Specialist 4]

> "The maintenance related topics follow up starts in the later phase of the projects when the RCM checklist is opened, and people is invited to a meeting where the state of each task is reviewed and before that most often nothing is yet done, nor any information is received from suppliers in electronic format." [Specialist 1]

Other interviewees had the same message as Specialist 4.

During the interviews was also noted that the information to start a project is done differently and usually lacking in clarifying the responsibilities during the project. Often it could be done by preparing a presentation for a meeting where the whole project organization would be gathered for reviewing the main aspects of the project. Some of the interviewees said that they might just receive an email listing tasks that needs to be done, and it remains unclear who is the responsible person for each task.

> "It is common that an email is sent for a group of people where is listed tasks to be done related to an investment, but it is not determined who will take care of which tasks or who is responsible for what." [Specialist 2]

> "It is not clearly determined what should be done for the equipment that will be left out of production use. Now the old equipment is left in the equipment hierarchy with related documents and bill of material lists." [Specialist 4]

> "Sometimes when the investment decision is received the relevant project personnels is met at the office and the maintenance specialist of the area is noted for the investment and that he/she will be responsible for arranging the maintenance data when the information is delivered with the equipment delivery" [Manager 2]

When the information is delivered together with the equipment delivery it usually comes as a paper binder which needs to be reviewed for necessary information and is a time-consuming task.

The delivery schedule is in a significant role and if that is not carefully prepared the project personnel is not able to demand the supplier to provide information at least not without having consequences (extra cost, affecting other deliveries etc.). Since the data delivery is agreed during the contract preparation phase and during the Investment decision contract shall be binding the information most probably is determined to be delivered in a phase that is too late for the maintenance engineer to be able to finish the required tasks.

> "During the feasibility study phase information is gathered that will be specified more later. This way the issues are brought back on the table on the implementation phase of the project and at that phase those are not getting any easier, vice versa." [Specialist 5, Manager 1]

<u>Document management system is seen as too complex system compared to traditional folder structure.</u>

The document management system is felt to be time consuming when documents need to be uploaded there.

> "Filling all the metadata for the document is very time consuming. The documents pile up in the email in email attachments and from there those are

> stored to own personal computer project folders. Finally, when the project is about to be closed the folder is full of documents and those should be uploaded to the system all at once." [Manager 2]

It is usual that project documentation is delivered by email to project organization and later uploaded to project document management system.

> "Usually engineering department uploads the updated engineering documentation to the system. Also, the documents are delivered by email. It is not always clear if the latest version of the document is available in the system since it might be uploaded there after it is delivered by email." [Manager 2]

How maintenance planning process and the data management system could be developed?

Interviewing both managers and specialists it seems clear what needs to be done during a project, or at least what are the key tasks that needs to be considered during a project. What is not clear is that when the tasks should be done and who is responsible for which task and further who is responsible for delivering the needed information for being able to perform a task. The current process is taking to account what are the tasks that needs to be done before the project can be finished. Some of the tasks could be done before the investment decision and some during and some after the investment decision. Some of the tasks are not possible to be done before the project is at the final stages and the final information is available, such as determining the exact warranty period. This way the process at an abstract level has a lot of stuff that needs to be done but not when those should be done. During the focused interviews, the goal was to gather on how the process could be developed. When analyzing the focused interview transcripts a few themes stood up and those were related to timing specification, checklist development, responsibility determination, meeting practicalities, strategy development and need for training of the process.

<u>Timing</u>

During the interviews was noted quite common idea of the possible positive effects of starting to consider maintenance topics already before the investment decision. This would benefit the project in later phases when the responsibilities and a basic idea on how the maintenance related topics could be managed in the project based on the technical scope.

> "When a project investment decision is made, it should be defined what needs to be taken into account and who is responsible for which point, e.g., according to the RCM check list" [Specialist 1]

> "If the information is received in good time for the project, then the maintenance engineering related topics can be taken care of easily. Procurements are made a year or well before commissioning, so if the data is provided about 9 or 6 months before the shutdown, you would have plenty of time to update this data. These topics would preferably always be done in advance but there is just a risk that the information provided may be incomplete." [specialist 3]

> "With maintenance engineering checklist it is possible to include the maintenance point of view topics in the project early phase and plan the coming tasks. The maintenance insights would be considered in the project planning phase by involving the maintenance team in the project early phase. The project organization would present the technical scope for the maintenance team and based on that the maintenance team could give their feedback when the needed data and at what level it should be delivered to them so that they are able to update the system to be available when new machinery is taken to production." [External Specialist 1]

Checklist

A project manager checklist would be a valuable tool to have, while now there is a maintenance related aspects checklist. In the checklist, the project manager tasks to be done would be listed. One interviewee emphasizes the helpfulness of a list they have been utilizing, where a listing together with main equipment supplier was made and the manager have found this way of working helpful.

> "Together with the main equipment supplier representative we created a checklist of things that needs to be done related to the project and marked who is responsible for each task. In a project this size that are smaller this type of to do list following up is found the most suitable and helpful for me at least." [Manager 3]

> “Always when I hear I am responsible in a project for the maintenance engineering, I make a checklist for that specific project and follow it up until I have all the information needed and all the tasks have been completed in the list.” [Specialist 1]

It might not be always clear for everyone what each task in the checklist means, therefore the checklist shall be reviewed in early stage of the project for how it shall be utilized based on the project technical scope.

> “The check list is good, but it doesn't necessarily tell everyone what each point really means. It is important to highlight that getting the project decision and approval and its completion is also important in terms of ensuring usability, that the documentation is received on time and that it is processed before the project is closed.” [Manager 1]

> “Official protocol where someone from affected maintenance organization side would share the insight related to the technical scope as a standard protocol, which is required for investment decision. This is the maintenance responsible and gives insights for what needs to be taken in to account for.” [External Manager 1]

External manager 1 believes that the project manager should review the maintenance related aspects related to the project technical scope based on the checklist together with the maintenance personnel of the mill or department where the project is implemented.

<u>Responsibilities</u>

The responsibilities seemed unclear for the specialists participating in projects and the Managers was not sure always who can do and which task in the checklist.

> “RCM check list is well structured, and it would be good to go through this in the context of assigning responsibilities after the project's investment decision.” [Manager 3]

> “When a project investment decision is made, it should be defined what needs to be taken into account and who is responsible for which point, e.g., according to the RCM check list” [Specialist 1]

> "The checklist shall be reviewed in early stages of the project and determined who will take care of which topic." [Specialist 3]

There was also project lead by Manager 1 that were able manage the project in an effective way. This time the project manager is aware of the local maintenance requirements and importance in projects and were able to arrange a project team consisting of engineering personnel that knew the responsibilities they had in the project.

> "The situation regarding the project was good when there was a team of designers who knew the environment and that their responsibility is documentation and therefore, they knew how to approach the issue correctly during the project. During the last months of the project, there was no overwhelming caused by tasks that have not been considered. Knowing throughout the project that the project is ready when targets are met, and a part of the target is that the maintenance related tasks (Check-list items) must be finished. It was clear to the project organization the importance of easy access to information and documentation." [Manager 1]

Meeting practicalities

The maintenance related engineering is usually started to follow up on late stages of the project to ensure the possibility to close all the open points related to the project during the project time frame. specialists were pointing out that it would be helpful if these topics would be followed up in meetings when the project topics are reviewed.

> "Maintenance related engineering topics shall be reviewed in the kick-off meeting of the project, after which the topics would be actively followed up during the project and state of the tasks would be discussed in the project meetings. The topics of the Checklist with responsibilities would be reviewed in the kick-off meeting, and a follow up meeting would be arranged after the sourcing phase, and a review just before the commissioning phase and finally after the startup a review of the pending tasks to ensure everything would be finished within the project time frame." [Manager 3]

> "Implementation of maintenance related aspects during the project timeframe would require monitoring of the progress of these issues during the project and

> careful planning beforehand so that these are taken into account in good time" [Specialist 1]

One manager pointed out the possibilities of developing the project opening form to more support the kick-off meeting. Another Manager stated that the key points are usually taken from the opening form and utilized in the project kick-off meeting.

> "It has not been in mind that the project opening form would be used for anything other than the project related systems (SAP PS and M-Files) opening and a so-called "official" launch of the project. Creating a project plan somehow more to serve the project's starting meeting could bring an additional benefit to this opening form." [Manager 2]

> "Project opening form is utilized at least in more complex projects as a basis for the presentation used in kick-off meetings where the technical scope, schedule and budget of the project is reviewed with the project organization." [Manager 3]

One Specialist pointed out that it would be beneficial to arrange a meeting where the area, for which the project is implemented, the maintenance team would be gathered in a meeting where the scope is reviewed to avoid performing any unnecessary works.

> "Pretty important thing I want to point out. At an early stage before the planned shutdown, the project should include everyone in a meeting of the area where the project is implemented. The maintenance personnel of the area to a meeting where would be informed that these things will be taken care of in the project. Coordinating maintenance work and project work so that, for example, no maintenance would be performed or prepared for machinery that will be replaced in the project." [Specialist 3]

This point would be partly covered when the affected area maintenance personnel would be included in checking how the project scope is affecting the maintenance planning of the area before the project final investment decision. This FID shall of course be communicated to the participants when done, so that they know whether the project is going to happen or not.

<u>Training planning/implementation based on described process.</u>

Lack of knowledge of the available instructions was noticed within the Managers and the Specialists during the interviews. A training plan based on the updated project instructions for MOP project organizations and people participating in MOP projects would be beneficial to arrange. This way the people would become aware of the main practices, instructions and software that are utilized in the implementation of MOP projects.

> "I have not attended in any project related trainings. There should be clear documents with which to demand information from suppliers." [Specialist 4]

The training could be at first for project personnel only, whenever an investment is decided, this way the project organization would have available all the support for the project in project early phase and support could be provided if needed.

Data management tools utilization in small scale projects

During the interviews when asking about the available data management tools, most of the interviewees considered those not to be useful in small scale projects. The tools require training and advising of the suppliers to be able to get reliable information and usually suppliers are gathering the data to the tables straight from the manuals, so it is much easier to just get the final equipment manual and find the required data from there. This insight is about the periodical maintenance plan and equipment data table. the spare pat data is usually received for critical spare parts in the contract phase of the project and the additional spare parts can be determined by the help of the manual delivered later.

> "Information gathered from equipment manuals, what was used to update maintenance data systems. Data tables have not been used for data collection in smaller projects since those are too complex and does not provide more help than extra work." [Manager 1, Specialist 5]

Document delivery schedule is important and that shall be prepared carefully to ensure the data delivery on a sufficient time.

> "Document delivery schedule -contract appendix should be done together with everything else, carefully by paying extra attention taking into account the entire project targets." [Manager 1, Specialist 5]

Some interviewees mentioned about the sufficient quality of the data provided that are used for updating the maintenance management system and the external specialist 1 clearly stated

that it would be beneficial to review the created maintenance plans after a while when the project machinery is in operation to ensure that the maintenance plans are accurate and meets the maintenance requirements.

> "Maintenance plans shall be reviewed for possible updated after the startup to review if those are accurate enough for future maintenance based on any possible updates in documents after the equipment is taken into production." [External Specialist 1]

Development of users' skills through training and support

All the interviewed Managers and Specialist pointed out that the main reason for the system is the lack of usage. Lack of usage depends on the fact that it is not that often that there are ongoing projects where participation is needed and therefore the project document management system is needed very seldom, so the skills needed for the system is not at a level that the system could be utilized.

> "We do not completely understand the functions of the document management system" [Manager 2]

> "M-Files user training has not provided the necessary lessons for using and understanding M-Files. At the beginning of the project, there could be a review where we agree with the project organization how the project specific documentation management folder would be built and where and how it will be used in the project. We are always in a hurry at the beginning of a project, and then it is frustrating to figure a suitable way how the documents could be managed. We need more practical training and experience." [Manager 3]

> "In theory the document management system is good, but the role should be clearly defined, and more training should be arranged." [Specialist 3]

Structure and document search improvement

Two interviewees mentioned about the project DMS that it is not clear to navigate to the location where the document should be stored. When the location is found there still needs to be added some information, which often is not even relevant for the related file or document.

> “The first level on the folder structure is clear but the following levels becomes unclear” [Manager 2]

> “Hard to find the documents that are added to the system. In some projects the system is not seen necessary to be used. The hierarchy is unclear. How the permissions are working is unclear. Finding specific documents is unclear.” [Manager 3]

For 1 interviewee it is better system to navigate and look for documents compared to the used ERP module for document management system (SAP DMS)

> “The project document management system is good, and it is easier to find documents there than from the SAP DMS system.” [Specialist 2]

Software integration

Currently the documents are received to Project DMS where those shall be reviewed and after reviewing the document required for CMMS DMS system shall be downloaded from the Project DMS system and uploaded to the CMMS DMS system. This procedure is mostly not clear how it works in the easiest way and some participants point out a need for automating this process/workflow, which is currently done manually. The interviewee believes that this would enhance the usability.

> “It would be great if the documents could be moved from the Project DMS to CMMS DMS system somehow by a mass transfer or some automated way.” [Specialist 4]

This workflow is automated by other businesses units successfully. For example, External Manager 1 and External Specialist 1 has the system working in a way, where documents are stored in Project DMS and when the documents have been given a field stating the related functional location, a link is automatically generated to CMMS DMS system. If this kind of an integration is done, attention shall be paid to the viewpoints of the technicians so that the documents linked to CMMS is really linked properly with necessary metadata so that the document can be found.

> “Documentation is in M-Files, in the app SAP Fiori is a link to M-Files. Shop floor technicians can open all documents related to a functional location trough the link in SAP that opens the documents in M-Files. In M-Files every

document is linked for functional locations in SAP. Functional locations are updated to M-Files frequently from SAP." [External Specialist 1]

"Documentation is made available for factory teams from M-Files. For project work M-Files works well. Development is needed for M-Files metadata so that it is helping the users on field so that they find the needed documentation. Metadata filling instruction are not always followed." [Specialist 3]

5 Discussion

In this chapter is discussed the research topic. In the first chapter the research questions are provided an answer. In the second chapter is a comparison of the results made to the results by other research and literature review. In the third chapter is discussed the research objectivity. The fourth chapter is discussing the research reliability and validity. In the fifth chapter is made error checking for the research. In the sixth chapter is presented the key findings of the research, where an answer is provided for the main research question. The results from methodology triangulation methods are combined. In the seventh chapter is discussed the novelty value of the results. In the eighth chapter is discussed the usability and generalizability of the results. Finally in the ninth chapter is discussed the possible further research topics based on this research.

The main research question of the study was:

How and on what basis could the target company develop the existing maintenance data management process to ensure that the production process change projects implementation meets the company maintenance requirements?

Answer for this question was studied by utilizing different research methods literature review, case studies and focused interview. Based on the main research question, sub-questions were utilized for each research method. Based on the answers for each research sub-questions the main research question can be answered. The sub-questions for case studies and focused interviews were for case studies:

- How is the existing maintenance data management process implemented in case-study projects?
- How are the existing instructions followed in case-study projects?
- How are existing software utilized case-study projects?

For focused interviews:

- Why is maintenance related data not managed according to instructions in projects?

- How maintenance data management process and the data management system could be developed?

5.1 Answering the research questions

How is the existing maintenance data management process implemented in case-study projects?

The implementation varies across cases, with some of the cases achieving higher levels of completion for completion of maintenance tasks according to instructions. A few noteworthy points stand out.

1. The implementation of the process in most of the cases by the project organizations are brought up in the late phases of the project.
2. Usually there is not planned in the early stage of the project related to maintenance data management that would be followed, the task list items usually are reviewed and done in the closing stage of the project.
3. The document management system in many cases is not utilized.
4. The criticality classification is pending to be done in many of the cases when the machinery is taken to production use.

How are the existing instructions followed in case-study projects?

The case review project members are not all aware of the instruction or where those can be found. Mainly the reason is lack of available time or knowledge when the instructions could be utilized. Mainly the critical points are known how the project will be successfully implemented but this way there is a list of details that is left without attention causing extra work in the later stages of the equipment life cycle. The basics of the instructions are followed, where the project plan is made when the investment decision is made. This is done mostly because to be able to get the project opened in SAP ERP system where all the purchase requisites are done, for which to be possible the document “project plan” needs to be done. According to the instructions the project plan shall be utilized as a basis for the whole project implementation. In some of the case projects this document is utilized as a baseline when planning and executing the project kick-off meeting where the project scope,

responsibilities (organization), time schedule, project budget and budget allocation is reviewed together with the project organization. This is done in one specific mill (Mill 3) where there is no such backlog than there is in the other mills (Mill 1 and 2) for finishing the maintenance aspects related to the project.

How are existing software utilized case-study projects?

There is a consistent low utilization of existing supportive tools across all cases, suggesting a potential area for improvement in enhancing software utilization for managing tasks listed in the maintenance data checklist. Additionally, the project document management system is not utilized according to instructions for project phase document management. For all the case project a project specific project document management storage is created and available for the utilization to store project phase documents and gather the supplier documentation from equipment manufacturers. The reasons including the development ideas for this among other development ideas are reviewed in the focused interviews.

In case studies, overall, none of the case projects have been implemented completely according to instructions still being a high variability between cases and tasks to be done.

The tasks required by the project manager for successfully implementing the maintenance engineering according to instructions varies from 71% to 93%, so in each case there is some tasks not considered. The most common task not considered is reviewing the maintenance requirements in the early stage of the project, and also in those projects where something has been reviewed, are not in such a detail that the information could be informed to the maintenance engineer in the project, and in each case the maintenance planner have to start from a scratch, meaning they will depend on the contracts and contract related document deliveries when executing the maintenance engineering tasks related to the project. Also, a very common lack is the project document management system is not utilized in the project, which causes the documentation to be unorganized and piling up in emails and memory sticks. In half of the cases the maintenance related document deliveries were not agreed with the equipment supplier.

The tasks required for the preparation of maintenance engineering according to instructions has been considered according to instruction with a variety of 33% to 79% between the cases. The most common task not considered is to make a detailed plan for the maintenance data

management in the project. The second common lack is the criticality classification is not done.

Tasks not even started in the maintenance task list varies from 0% to 21% between the cases. With these tasks there is no commonalities the tasks not considered varies between technical documentation, equipment data and maintenance plan updating. Tasks in progress and not completed that should be completed varies from 15% to 93 % with an average of 67%. All the task list items that do not need actions have been reviewed. 3 cases have all the required information available to finish all the required tasks and for the three cases is a variety of 21% to 92% of information available, so there is still some information not available so that the tasks could be finished. The supportive tools utilization for each task varies from 0% to 7%. And based on the discussions the tools are not useful for this kind of small-scale projects.

Comparing the cases with each other there is noticed mainly the same deviations which are the maintenance document management software is not utilized, maintenance data deliveries are not planned, nor followed up or reviewed by the target company in early enough stage. Maintenance planning is done based on the delivered manuals.

Why is maintenance related data not managed according to instructions in projects?

Time constraints arise from the lack of availability of data early in the project's lifecycle, leading to difficulties in managing maintenance-related tasks within the project timeframe. This scarcity of resources is exacerbated by the parallel responsibilities of mill operations teams, who struggle to balance project work with daily operational activities.

The challenge of obtaining timely and accurate information, crucial for effective maintenance planning, from various sources involved in the project was highlighted. Receiving the equipment related information in late phases lead to a lack of clarity regarding responsibilities and a scramble to manage tasks during critical project phases, such as installation and commissioning. The complexity of document management systems further compounds these challenges, with individuals resorting to storing documents locally rather than navigating cumbersome systems.

Additionally, competence plays a significant role, as the effective management of maintenance-related data requires specialized skills and knowledge. Limited access to training opportunities further exacerbates this issue, with individuals relying on personal experience and rational thinking to navigate project complexities.

How maintenance data management process and the data management system could be developed?

Few themes emerged in the focused interview to need development, which were the timing of the tasks to be done, checklist development, responsibility determination, meeting practicalities, strategy development, and the need for training the themes reviewed in more detail.

There is a consensus on the benefits related to consider the maintenance engineering related topics before the investment decision. At this phase it is still possible to affect for example the document deliveries so that those could be delivered and received in sufficient time. An official protocol where someone from the maintenance organization, where the change is implemented, would provide their insights on which parts of the checklist shall be considered in the project, to ensure all the aspects could be planned well in advance. However, clarity on responsibilities remains a challenge, with suggestions for early review and assignment of tasks. For the current maintenance aspects check list tasks shall be determined the responsibilities after latest right after the investment decision when the project technical scope is clear. Practicalities of meetings are highlighted for effective follow-up on maintenance-related engineering tasks throughout the project lifecycle.

Improvements in the project DMS are suggested, including clearer structure, better search functionality, and integration with existing systems like CMMS. Automation of workflows is recommended to streamline processes and improve usability, with successful examples cited from other business units. Training planning and implementation are commented to be necessary to address knowledge gaps. While some interviewees express skepticism about the usefulness of the supportive tools and the document management system usage in small-scale projects, others advocate for thorough training and support to enhance their efficiency. Some interviewees mention such development needs for the system structure and document search improvement, which is not actually issues on the system and this is showing that the system is not currently understood completely, which means clearer instruction and further training could be provided.

Also, some interviewees commented about need for general project implementation training, not only training on how to manage the maintenance data or documents in projects.

How and on what basis could the target company develop the existing maintenance data management process to ensure that the production process change projects implementation meets the company maintenance requirements?

1. Project Management (in terms of maintenance data management) process development for target company

    a. Continuous improvement model utilization in available instructions considering process management theories and local technical requirements.

    b. Maintenance data checklist reviewing in the beginning of the project (even before investment decision). Reviewing together with maintenance personnel if the project scope causes any update needs related to checklist tasks.

    c. Maintenance data checklist task responsibilities to be determined right after the investment decision. A RACI-matrix could be modelled for task lists tasks and project organization participants. This way when the project manager knows which tasks (determined in phase “b”) needs attention, he/she can name people to do those tasks.

    d. Project meeting practicalities could be agreed to ensure information flow and improve communication and utilization of supportive software and so help the project implementation (kick off meeting, follow up meeting, end meeting, where the whole project organization will participate and project manager steers).

    e. Training planning related to project management (including maintenance engineering, project document management as topics included). All the topics and parts revised based on these suggestions shall be put together and training shall be planned and implemented.

2. Instructions development

    a. Available company maintenance strategy related instructions shall be updated. By this it is ensured to be in line with the current organizational structure, and can be utilized in future development, training, and instructing.

b. Maintenance aspects consideration related instruction shall be updated. By this it is ensured to be in line with the updated maintenance data management process.

3. Maintenance data management process related supportive tools and software development

   a. Project document management system development. Enhance usability by planning and arranging training. Interviews showed the development shall include clearer structure, better search functionality, and integration with existing systems like CMMS. Automation of workflows between project DMS and CMMS DMS is recommended to streamline processes and improve usability, with successful examples cited from other business units.

   b. Maintenance data delivery templates shall be modified to support smaller project needs, tables to be informative what needs to be delivered related to preventive maintenance instructions, equipment data, spare part master data. In practice this would mean just partly delivered the maintenance manuals which describe the maintenance plans, spare parts, and technical specification. No extra templates would be needed for simple cases where only 5 or less equipment is delivered per supplier.

   c. Document delivery templates preparation process shall be improved. The templates could be commented by maintenance engineer/ maintenance department representative related to the maintenance data deliveries before signing the contract. The final maintenance related data shall be delivered depending on the case before the startup of the machinery to ensure the data could be updated successfully to the system. If the supplier is not able to deliver before the required date, they shall know that the machinery cannot be maintained properly after the startup and this way they shall understand that the delivery is not complete. The document delivery template shall be part of all equipment purchasing contracts, the document deliveries shall be followed and reviewed from quality point of view.

   d. CMMS updating process. When the data is up to date in the target company CMMS and when changes occur, the data is updated accordingly following a

working process, it would be possible to clean up the system from outdated data. Deleting equipment, periodical maintenance plans and spare parts master data and technical documentation, after the investment is completed, is important regarding assets that will no longer be part of the production process. This is important to not make wrong maintenance related activities, plans or procurement decisions based on outdated data.

5.2 Comparison of the results to results by other research and literature review

Not any completely similar research has been found that would be studying the same topic in this detail. Literature review shows the importance of a clear maintenance strategy that can be used as a basis for creating process descriptions and working instruction, when possible, by including the organization in the implementation of the processes and work instructions. In this research is noted that the maintainability and reliability of a new or modified production process machinery depends highly on the received data from manufacturer, so it is important to ensure the delivery of required information is agreed in the planning phase.

Various references (Marquez et al. 2006; eWorkOrders 2023; Tretten et al. 2014), suggests that appropriately implemented CMMS integration can enhance organizational effectiveness by streamlining maintenance activities and providing real-time insights into asset health and performance. The CMMS integration in the target company is an ERP system module “Plant maintenance”, PM, provided by SAP. Activities such as managing maintenance alarms, work orders, actions, data storage, completed tasks, status reports, tracking maintenance expenses and inventory levels works in integration. Document management, currently working as project document management system could be developed and integrated as well to yield optimal outcomes and help to ensure the latest document are available always in the system. While currently the project DMS is not integrated with the CMMS in the target company, it would be a task to executed which would lead to streamline the tasks to be done when documentation in the project is delivered. Currently documents are stored in project DMS from where the needed documentation wis manually exported and imported to CMMS DMS. By an integration, this process could be automated, and the documentation would be updated in CMMS more easily.

The main finding in the literature review of this study is the importance of considering the maintainability of the asset in early stage in the planning of new assets to ensure the reliability and maintainability during the life cycle of the machinery and equipment as cost-efficiently as possible. This could be done by utilizing process management principles considering that processes might need to be fundamentally redesigned as it was noted by Gadatsch, (2023) in literature review section 2.2 Process Management. In case studies, the actual state compared with the theoretical state of the projects shows that the deviation is depending highly on the information delivered by the manufacturer and the knowledge of the operating and maintenance personnel. The data availability could be enhanced by preparing the data delivery temples related to the supply, as mentioned several times during the interviews and case studies and in literature review (Kortelainen et al. 2021). Considering these it is important to agree on the delivery of the required data with the equipment supplier and the maintenance and operations personnel insights would be important to be noted. From the interview results, ideas on what could be done to enhance this shortcoming were identified. As a summary all the equipment purchases document and data deliveries shall be agreed upon, followed up and reviewed to ensure the required information is included in the delivery.

Case studies of this research states that the deletion old data in many cases are noted, but it is not discussed or brought up in the focused interviews, this is a field that should need some attention in the future to ensure the outdated data will be removed together with the machinery when those are not anymore utilized. It is important to keep the CMMS hierarchy up to date whenever changes occur to the hierarchy (Hastings 2021).

5.3 Research objectivity

The company, where the research is carried out, have struggled on keeping the maintenance related data up to date in maintenance management system, whenever new assets are replacing old ones as well when old assets are renewed. The goal would be that the maintenance management system is up to date when the equipment is taken in production use, but currently the desired state is reached with a delay. To figure out how this could be prevented, finding information on how maintenance planning and data management process could be developed in projects became the main objective of the research.

For ensuring the objectivity of the research methodology triangulation was utilized which included literature review, case studies and focused interviews. Literature review methodology was conducted to find out information on maintenance strategies, maintenance data management, process management and change management from also peer-reviewed articles, conference publications and books from databases such as Scopus Elsevier and google scholar and science library LUT Pub. Findings from diverse sources facilitated the identification of gaps and emerging trends in the existing body of knowledge. Case study methodology was conducted to find out how the current process, instructions and software are utilized in ongoing projects in all company units. The case studies were implemented for being able to compare how maintenance processes, instructions and software have been utilized in projects, to the theoretical way and this way point out the pain points that needs development. Focused interviews were conducted to figure out how the process, instructions, software could be developed. Interview participants were selected based on their role, area of responsibility, and knowledge areas related to the research objectives. Open-ended questions were prepared to encourage respondents to freely express their opinions, beliefs, and experiences. The data collected through focused interviews were analysed thematically, identifying common patterns.

A questionnaire was created for the case studies where the company internal instructions were reviewed to be able to model the theoretical state of the project. The points that should have been done related to maintenance engineering until that state of the project was reviewed first with the project manager and then by the maintenance responsible person. With this tool it was possible to notify what should have been done and what is done. The tool was tested and developed together with a person having experience within the researched field for ensuring it will be able to provide the wanted data. The questions created for the interviews were tested with a person outside the research before starting the interviews but who still had the knowledge of the researched topic. Also, the transcribing method was tested during the testing interview to see whether the interviews need to be recorded or not.

5.4 Research reliability and validity

Literature review, case studies and focused interviews is selected as research methods for this study. Literature review is the theoretical part in this study. The literature research is carried out as a qualitative study. The case studies are carried out as a multi-method research, where there are principles of both qualitative and quantitative research methods. The focused interview research is carried out as a qualitative study. All these methods together are utilized to find the answer for the research question presented in the introduction, objectives section (1.3) of this study report. In the following figure 27 is presented the multimethodologies utilized in this research in a methodology triangulation. In the figure the relations of the selected research methods between quantitative, qualitative, theoretical, and empirical research methodologies are presented. The combination of several research methods in the same study and their relations are presented in figure 27. The method triangulation is intended to mitigate the inherent limitations and biases associated with individual research methods by integrating multiple approaches.

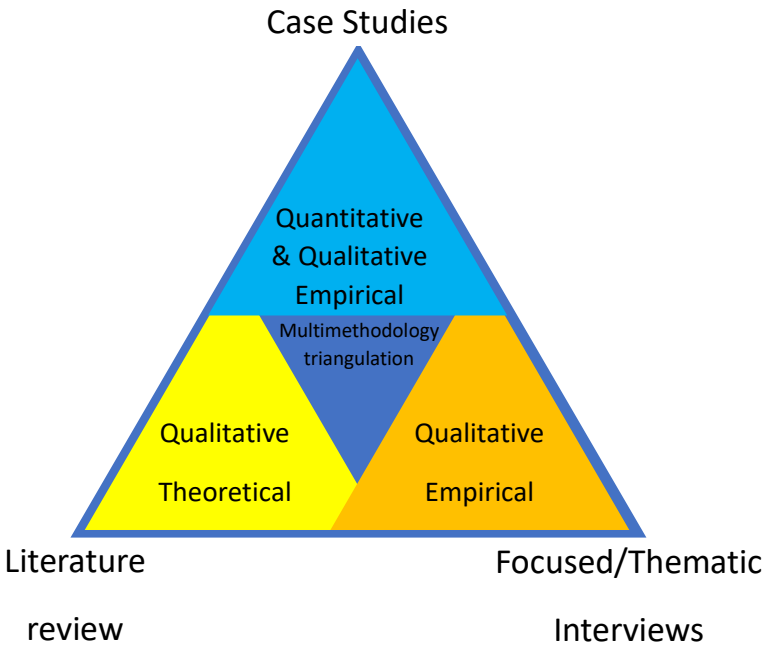


Figure 27. Multimethodology triangulation utilized in this research

A peer-review was conducted for the case review template to ensure it is working, and providing the information that is required. A specialist not participating in the research did the peer-review. The peer-review and testing of the template was done with the aim to ensure questions can be made clearly based on the logic of the template and that the topics included in the template are relevant for gathering the wanted information for the research. This was done with the aim to improve the reliability and validity of the selected research method and the template.

Focused interview thematic analysis allows diving deeply into the nuances of participants' experiences, perspectives, and opinions on the maintenance data management in projects to identify current practices, challenges, opportunities, and potential improvements, related to researched topics.

Thematic analysis will be done for the written texts from the interviews. Initial codes will be created to represent meaning and patterns in the data. Decision will be made on what to code and new codes will be added for identifying excerpts and applying appropriate codes to them. Codes will be collated with supporting data to bring together the excerpts with the codes. Codes will be grouped into themes as an iterative process to review and revise the themes, even deleting, or combining excerpt themes. A narrative will be written where a story of the data will be told including discussing the narrative of the analysis. (Braun et. al., 2006.)

Thematic and comparative analysis together offers a comprehensive and nuanced approach to data analysis. The goal is to uncover insights, current practices, challenge, and opportunities for improvement and out of those generate evidence-based actionable recommendations for improvement and development of the maintenance data management process, supportive tools and related instructions used in target company projects.

Focused interviews were structured, and the transcripts received from the interview phase were analyzed based on the figure 28.

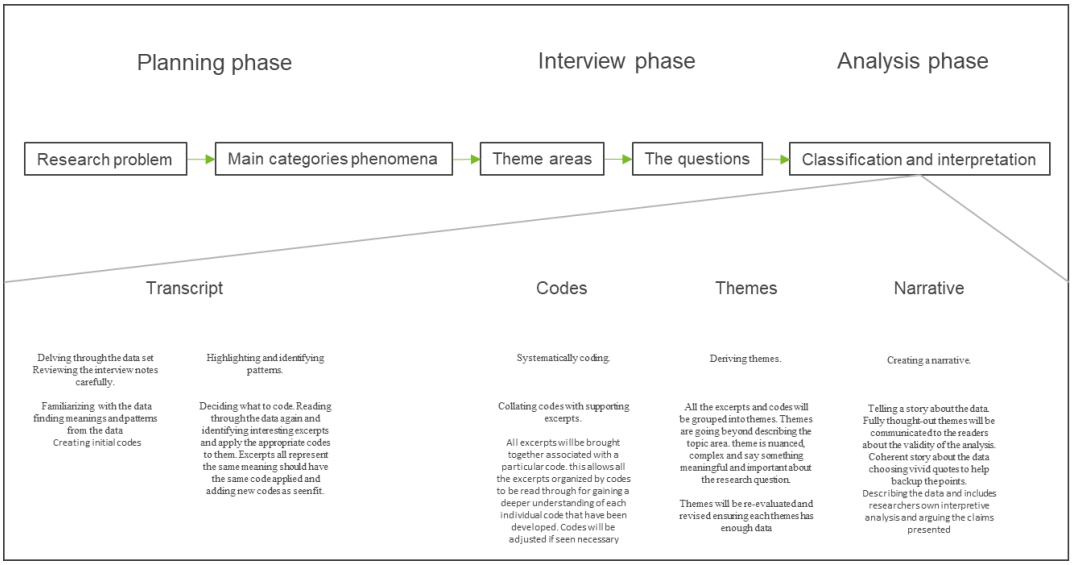


Figure 28. Phases of the interview execution from planning phase to analysis phase (Hirsjärvi et. al., 2022; Grad Coach 2023; Braun et. al. 2006).

5.5 Error checking

The study's limitations and uncertainties are primarily due to its focus on a specific context, potentially limiting the generalizability of the results to other than the target company. The research's reliance on mainly qualitative research methods can cause subjectivity into the interpretation of the results, which raises questions about the reliability of the conclusions drawn. The scope of the study does not cover all possible factors affecting project management and project maintenance data management process in production process change projects, which leaves room for further investigation in future studies.

Implementing peer-review processes where independent experts review the research methodology, data analysis techniques, and interpretations of the results was done to validate the accuracy and credibility of the research. A robust research design, methodology triangulation (figure 27) of multiple data sources and methods, was utilized in the research with the aim to enhance the reliability of the results and minimize the potential for biases or errors.

The mentioned possible limitations and uncertainties highlight the need to interpret the findings with caution and highlight areas that may need to be refined and expanded in later

research. By applying these error checking measures accurately, researchers can ensure the integrity and reliability of their results, enhancing the credibility and impact of their research outcomes.

5.6 Key findings

The key findings of this study emphasize the development and diversity of maintenance strategies and practices, from reactive maintenance to advanced predictive maintenance techniques, and how there is no single correct strategy to be implemented. The selection of strategy always depends on the situation. In particular, the study emphasizes the importance of early consideration of the issues required by equipment maintenance in the planning phase of equipment acquisition and in the effective management of maintenance data in maintenance and project systems. In addition, the study emphasizes the importance of clear process and change management principles in the development of sustainable maintenance data management processes. However, the research also finds challenges, such as the late start of the implementation of the new equipment maintenance data management process in projects and the low utilization rate of the systems and tools that support the process, such as project DMS and templates utilized for manufacturer data delivery (maintenance data delivery templates and document delivery templates), which are the areas suggested for improvement. These findings have significant implications for companies engaged in small-scale manufacturing process change projects, providing insights to improve operational efficiency and reduce downtime through improved maintenance data management practices.

Overall, if before or right after the investment decision, the investment proposal creator shall present the technical scope of the project for the maintenance team who could mark which checklist items shall be reviewed and updated related to the project and after that the named project manager would name an responsible person for each task and follow up the status from the beginning of the project until the closure of the project, this process would be more systematical and the affects would be noted in early phase of the project making it possible to have everything done in the late stage of the project. To ensure the needed data is delivered the process shall include reviewing of the document delivery related contract templates, which shall be included in also equipment acquisitions made only by simple purchasing

process where usually no contract appendixes are included. The document deliveries shall be followed up also to ensure the required data is delivered meets agreements.

5.7 The novelty value of the results

The research is offering a throughout perspective on maintenance data management in production process change projects, focusing on both theoretical concepts and practical challenges. Theoretical concepts by conducting the literature review and modelling theoretical statuses of ongoing projects based on the research target company instructions and investment/change project guidelines. Practical challenges by modelling actual states of ongoing projects and interviewing experts for maintenance data management process development.

5.8 Usability and generalizability of the results

The findings offer practical implications for companies planning the implementation of production process change projects, providing actionable recommendations for improving maintenance data management processes also what shall be considered and when during the project to ensure the maintainability of the acquired machinery. While the research focuses on a specific context, the principles and insights derived from the study are applicable to various industries facing similar challenges within maintenance data management in projects. While the research focuses on projects, managed by mills operations organization and studying the investment projects which in the target company has a more structured way of management, the principles and recommendations can be adapted to projects of different scales, with appropriate adjustments.

The research findings contribute to both academic literature and industry practice, filling a gap between theoretical concepts and real-world challenges in maintenance data management related to taking into use new machinery and equipment.

5.9 Further research topics

In the literature review was noted that there is a lot of information available on how to utilize data and generate data into useful information to detect the state of equipment and help to prevent breakdowns or to replace the equipment before breakdown. Not a lot of information is available about the manufacturer documentation and its importance and how that could be possibly integrated to the data collected during the operation and what possibilities the integration would bring.

Would it be possible to build such a system where data collection from the daily operation by the operators and maintenance personnel and from the sensors built to follow the state of equipment, help to figure out the state of equipment health and compare that information to the available manufacturer documentation (operating and maintenance instructions) related to the equipment where work instructions could be generated to know how the equipment manufacturer documentation suggests to act based on the current state of the equipment to prevent inefficiency or even possible breakdown? Also, this type of system could be built to help other disciplines, like operators on how to run the machinery and how to ensure the efficiency based on the current state. Also, safety and environmental aspects could be improved in this means. Co-pilots are an AI powered service that uses large language models to boost efficiency and productivity in a simple chat experience. Enhancing a co-pilot for maintenance could use large language models to utilize data from different sources such as mill diary, computerized maintenance management system, document management system, and process data to provides information. A co-pilot works alongside a human, it could help to summarise, create, analyse, but it does not do the tasks.

Research to review more carefully the possibility to utilize external engineering resources for executing maintenance engineering related tasks during the project phase to have all data available when the project machinery is taken into production. This would be done to review what parts of the process could be outsourced.

For enhancing the maintenance strategy, A research would be done to review what are the maintenance related works, costs during the past few years for different criticality classified projects. The cost could and effects on the downtime could be researched with an aim to figure out would it be enough to leave some equipment completely out of preventive maintenance planning and those would be repaired only when those breaks.

1. Study a wider range of projects for further developing the complete investment management process.
2. Study on possibility to outsource the maintenance data management process partly or completely in production change projects. Also partly study the possibility of optimizing maintenance strategies, if some of the machinery, currently classified by some criticality classification, could be left completely without maintenance attention, and only repaired during breakdown.
3. When the maintenance data management process is implemented successfully, a study could be conducted identifying and deleting the outdated data and documents in the target company CMMS. By ensuring no outdated data or information is remaining in the system and the system is kept up to date, it's reliability will be enhanced.
4. Study advantages of AI-powered maintenance/operations co-pilot, which would utilize data from available sources related to assets.

6 Summary

This study aimed to investigate maintenance data management process, supportive tools and related instructions in production process change projects to improve the process effectiveness. The findings of this study showed that while maintenance strategies and practices have evolved significantly over time, there are still challenges in implementing effective maintenance data management process, particularly in smaller scale projects. The most important findings in this study reveal the importance of early integration of maintenance considerations, the utilization of project document management system and the need for clear process and change management principles. Another notable finding is for the target company to have the possibility to execute maintenance data management according to needs by developing mentioned actions before needing to look for more human resources.

The results of the research affect companies involved in small projects. By implementing the given recommendations, maintenance data management processes in projects can be improved, which improves operational efficiency and reduces downtime. The main contribution of the study is the offering of a perspective on maintenance data management, bringing theoretical concepts with practical challenges faced in actual projects. A limitation of the study is the focus on a specific part of a project which may limit the generalizability of the findings to other industries and companies, where the whole project implementation phase shall be studied, but for sure the findings can provide insights on helping to solve same type of shortcomings in those industries and companies as well.

A suggestion for the target company future research would be to study a wider range of projects for further developing the complete investment management process. More general further research would be to develop a copilot for operations and maintenance personnel that utilizes generative AI to generate suggestions based on information and data gathered from various available sources.

References

Abirami, R. J. & Padmakumar, M. 2023. Industry 5.0 or Industry 4.0S? Introduction to Industry 4.0 and a Peek into the Prospective Industry 5.0 Technologies. International Journal on Interactive Design and Manufacturing, 17: 2. Pp. 947–979.

Ackoff, R. L. 1999. Ackoff's Best: His Classic Writings on Management. First edition. New York: John Wiley & Sons, 368 p.

Antony, J. & Gupta, S. 2019. Top Ten Reasons for Process Improvement Project Failures. International Journal of Lean Six Sigma, 10: 2. Pp. 367–374.

Basson, M. 2019. RCM3: Risk-Based Reliability Centered Maintenance. South Norwalk, Connecticut: Industrial Press Inc, 576 p.

Bidgoli, H. 2003. Encyclopedia of Information Systems. California, San Diego: Academic Press. 807 p.

Birzniece, I. 2011. Artificial Intelligence in Knowledge Management: Overview and Trends. Rīgas Tehniskās universitātes zinātniskie raksti. Scientific proceedings of Riga Technical university. Vol. 5. Pp. 5–11.

Bonaldi, E., Lambert-Torres, G. & Oliveira, L. E. 2023. Maintenance Management: Current Challenges, New Developments, and Future Directions. London: IntechOpen. 164 p.

Braun, V. & Clarke, V. 2006. Using thematic analysis in psychology. Qualitative Research in Psychology, 3: 2. Pp. 77-101.

Deming, W. E. 2018. Out of the crisis Reissued edition. Massachusetts, Cambridge: Massachusetts Institute of Technology, Mit Press. 448 p.

Eschblach, A. 2021. How Industry 5.0 Will Transform Process Manufacturing as We Know It [web document]. Forbes technology Council. Published 13.7.2021. [Referred 14.3.2024]. Available: https://www-forbes-com.cdn.ampproject.org/c/s/www.forbes.com/sites/forbestechcouncil/2021/07/13/how-industry-50-will-transform-process-manufacturing-as-we-know-it/amp/

eWorkOrders 2023. [eWorkOrders webpage]. Last modified 11.12.2023 [Referred 11.12.2023] Available: https://eworkorders.com/cmms-industry-articles-eworkorders/integrating-erp-with-mms/

Fazel, A., Glawar, R. & Nemeth, T. 2019. PriMa: A Prescriptive Maintenance Model for Cyber-Physical Production Systems. International journal of computer Integrated manufacturing, 32: 4–5. Pp. 482–503.

Gadatsch, A. 2023. [Chapter 1:] Introduction to business Process Management. In: Gadatsch, Andreas. Business Process Management Analysis, Modelling, Optimisation and Controlling of Processes. First edition. Wiesbaden: Springer Fachmedien Wiesbaden GmbH. Pp. 1-22.

Garcia, M., Fausto, P. & Mayorkinos P. 2020. Maintenance Management. London: IntechOpen. 182 p.

Geisbush, J. & Ariaratnam, S. T. 2023. Reliability Centered Maintenance (RCM): Literature Review of Current Industry State of Practice. Journal of quality in maintenance engineering, 29: 2. Pp. 313–337.

Grad Coach. 2023. Thematic Analysis in Qualitative Research. Simple Explanation with Examples. Grad Coach. Youtube-video. Published 7.6.2023. Referred 12.1.2024. Available https://www.youtube.com/watch?v=NLelCELbwCY

Harry, M. & Schroeder R. 2006. Six Sigma. The breakthrough management strategy revolutionizing the world's top corporations. New York: Random House Inc. 320 p.

Hastings, N. A. J. 2021. Physical Asset Management: with an Introduction to the ISO 55000 Series of Standards. Third edition. Cham, Switzerland: Springer. 635 p.

Hilmer, C. 2016. Prozessmanagement in indirekten Bereichen. Bamberg, Germany: Springer Fachmedien, Wiesbaden. 302 p.

Hirsjärvi, S. & Hurme, H. 2022. Tutkimushaastattelu, teemahaastattelun teoria ja käytäntö. Second edition. Helsinki: Gaudeamus. 203 p.

Hofmann, M. 2021. [Chapter 3:] Process Improvement Methods. In: Hoffmann, Martin. A Holistic Approach to Process Optimisation. First edition. Wiesbaden: Springer Fachmedien Wiesbaden GmbH. Pp. 29-59.

Houshyar, A. 2005. Reliability and Maintainability of Machinery and Equipment, Part 1: Accessibility and Assessing Machine Tool R&M Performance. International journal of modelling & simulation, 24: 4, Pp. 201–210.

Järviö, J. & Lehtiö, T. 2017. Kunnossapito. Sixth edition. Helsinki: Kunnossapitoyhdistys, Promaint ry. 292 p.

JUHTA-Julkisen hallinnon tietohallinnon neuvottelukunta. 2012. JHS 152 Prosessien kuvaaminen [web document]. [Referred 12.1.2024]. Available: http://docs.jhs-suositukset.fi/jhs-suositukset/JHS152/JHS152.pdf. Pp. 1-12.

Juttahautanen. 2023. Rooli- ja vastuumatriisin 7 vaihetta. [juttahautanen webpage]. Updated September, 6, 2018. [Referred 30.1.2024]. Available: https://www.juttahautanen.fi/rooli-ja-vastuumatriisin-7-vaihetta/

Karimaa, E. 2002. Julkisen sektorin prosessien kuvaukset. Yleinen rakenne, esitysmuoto ja käsitteet. First edition. Helsinki: Suomen kuntaliitto. 45 p.

Kortelainen, H., Komonen, K., Laitinen, J., Valkokari, P. & Hanski, J. 2021. Tietämysperusteinen elinjakson hallinta. First edition. Helsinki: Kunnossapitoyhdistys Promaint ry. 241 p.

Laamanen, K. & Tinnilä, M. 2013. Prosessijohtamisen käsitteet = Terms and concepts in business process management. Fifth edition. Helsinki: Teknologia teollisuus Oy. 156 p.

Laamanen, K. 2012. Johda liiketoimintaa prosessien verkkona. Nineth edition. Espoo: Redfina. 300 p.

Lecklin, O. 2006. [Chaper 4:] Prosessien hallinta ja kehittäminen. In: Lecklin, Olli. Laatu yrityksen menestystekijänä. Fifth edition. Hämeenlinna: Karisto Oy. Pp. 123-211.

Lehtimäki, T. 2006. Ohjelmistoprojektit käytännössä. Helsinki: Readme.fi, 2006. 204 p.

Marquez, A. C. 2022. Digital Maintenance Management: Guiding Digital Transformation in Maintenance. Cham, Switzerland: Springer International Publishing. 183 p.

Marquez, A. C., Gomez Fernandez, J. F., Diaz, V. G-P. & Amadi-Echendu, J. 2023. 16th WCEAM Proceedings. First edition. Cham, Switcherland: Springer International Publishing. Pp. 14-22.

Marquez, A. C. & Gupta, J. 2006. Contemporary Maintenance Management: Process, Framework and Supporting Pillars. Omega (Oxford), 34: 3. Pp. 313–326.

Marr, B. & Ward, M. 2019. Artificial Intelligence in Practice: How 50 Successful Companies Used Artificial Intelligence to Solve Problems. First edition. Chichester, West Sussex, United Kingdom: John Wiley & Sons Ltd. 341 p.

Leanproduction. 2024. TPM (TOTAL PRODUCTIVE MAINTENANCE). [juttahautanen webpage]. Updated March, 5, 2024. [Referred 30.3.2024]. Available: https://www.leanproduction.com/tpm/

Poor, P., Basl, J. & Zenisek, D. 2019. Predictive Maintenance 4.0 as Next Evolution Step in Industrial Maintenance Development. International Research Conference on Smart Computing and Systems Engineering (SCSE). Colombo, Sri Lanka. 28.3.2019. University of Kelaniya. IEEE. Pp. 245–253.

Psarommatis, F., May G., Dreyfus, P. A. & Kiritsis, D. 2020. Zero Defect Manufacturing: State-of-the-Art Review, Shortcomings and Future Directions in Research. International journal of production research, 58: 1. Pp. 1–17.

PSK 6201. 2022. Maintenance. Terms and definitions. 4th edition. Helsinki: PSK Standardisointiyhdistys ry. 44 p.

Sarfaraz, A., Kouroush J., & D'Souza, A. C. 2012. Evaluating ERP Implementation Choices on the Basis of Customisation Using Fuzzy AHP. International journal of production research, 50: 23. Pp. 7057–7067.

Schwab, K. 2016. The Fourth Industrial Revolution. Switzerland, Cologny/Geneva: World Economic Forum. 172 p.

SFS-EN 13306. 2017. Maintenance. Maintenance Terminology. Helsinki: Finnish Standards Association SFS. 94 pages.

SFS-EN 13460. 2009. Maintenance. Documentation for Maintenance. Helsinki: Finnish Standards Association. SFS. 25 pages.

SFS-EN 17007. 2017. Maintenance process and associated indicators. Helsinki: Finnish Standards Association SFS. 79 pages.

SFS-EN ISO 9001. 2015. Quality management systems. Requirements. Helsinki: Finnish Standards Association SFS. 77 pages.

SFS-ISO 55000. 2014. Asset Management – Oberview, Principles and terminology. Helsinki: Finnish Standards Association SFS. 20 pages.

Shaheen, B. W. & István, N. 2022. Integration of Maintenance Management System Functions with Industry 4.0 Technologies and Features—A Review. Processes, 10: 2173. Pp. 1-27.

The Change Management Institute. 2022. The Effective Change Manager: The Change Management Body of Knowledge. Second edition. Vivid Publishing. 196 p.

Tretten, P. & Ramin K. 2014. Enhancing the Usability of Maintenance Data Management Systems. Journal of quality in maintenance engineering, 20: 3. Pp. 290–303.

Tuomi J. & Sarasjärvi A. 2018 Laadullinen tutkimus ja sisältöanalyysi. Third edition. Helsinki: Tammi. 204 p.

UPM. 2023. Investors. [UPM webpage]. Referred 30.11.2023. Available: https://www.upm.com/investors/upm-as-an-investment/business-model/

Vartiainen, T. 2023. Life Cycle Cost Analysis on a Pulp Mill’s Recovery System from Maintenance Point of View. Lappeenranta University of Technology. School of Business and Management. 67 p.

Velmurugan, R. S., & Dhingra, T. 2021. Asset Maintenance Management in Industry: A Comprehensive Guide to Strategies, Practices and Benchmarking. First edition. Cham, Switzerland: Springer. 193 p.

Appendix 1. Earlier studies related to maintenance data management in target company

1. 2013, Kunnossapito-ohjelman rakentaminen RCM – menetelmän avulla
2. 2017, Sähkö- ja automaatiolaitteiden luotettavuuden PA-rakentaminen ennakoivan kunnossapidon keinoin
3. 2018, Omaisuuden elinkaaren hallinnan varmistaminen ja optimointi projekteissa

Appendix 2. UPM internal documents related to this research

The maintenance data management process supportive tools are listed below.

1. Project document management software
2. Templates related to equipment manufacturer data management.
    a. Document delivery template
    b. Equipment data template
    c. Periodical maintenance planning templates
    d. Spare part master data template

The maintenance data management process supportive instructions are listed below.

3. Investment handbook
4. Project manual
5. Maintenance engineering instruction (UPM global)
6. Maintenance business rule
7. Project document management (305)
8. Maintenance planning in projects (307)

Appendix 3. Research flow chart

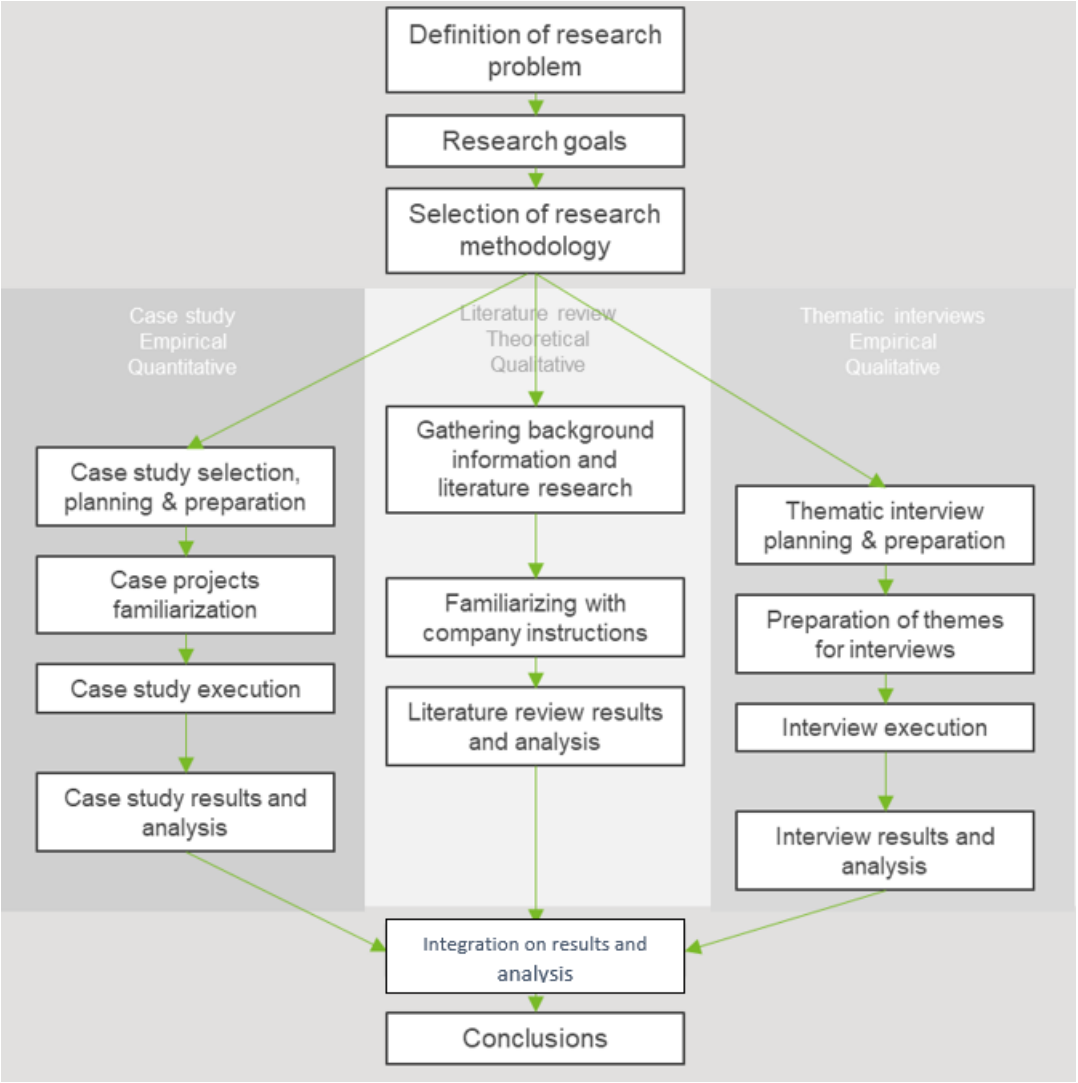
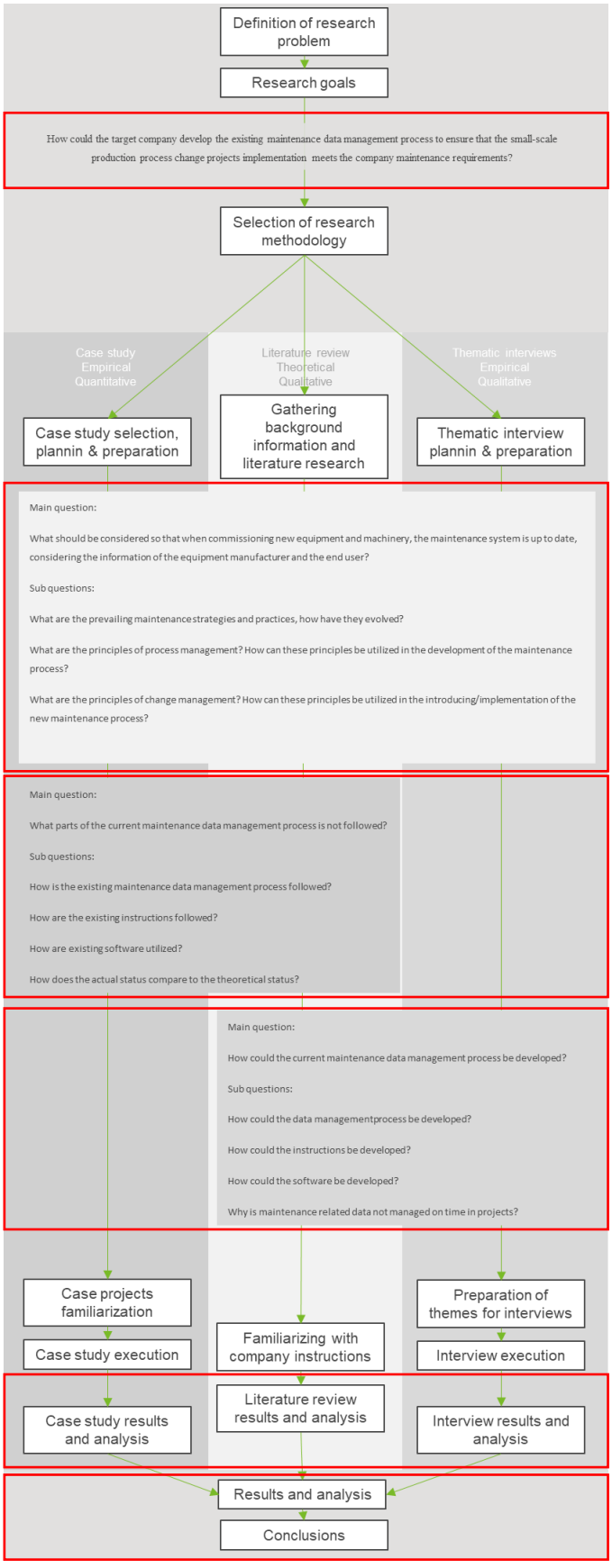


Figure 1. Research flow chart

Research flow chart and research questions



The main research question is formulated to figure out the answer to a problem stated by the target company.

A literature review main research question is answered by looking for answers for literature review sub questions.

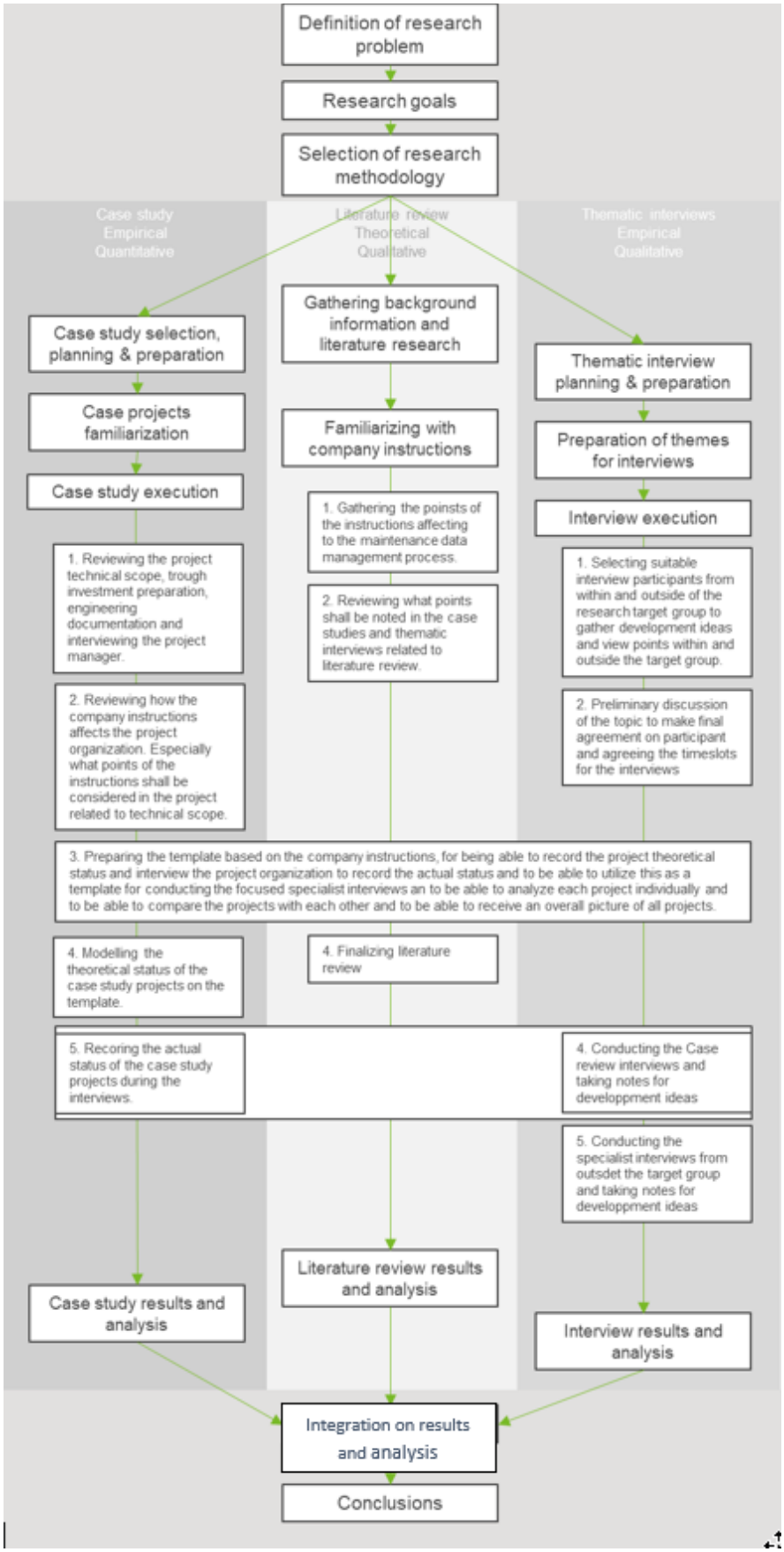
A case-study main research question is answered by looking for answers for case-study sub questions.

A thematic interview main research question is answered by looking for answers for literature review sub questions.

The method specific research questions are answered.

The answers are put together to answer the main research question.

Research flow chart with detailed steps for each method and visually explained the order.



Appendix 4. Questionnaire arranged for project case reviews

1. 1st part of the questionnaire: Project manager responsibilities considered related to a successful implementation of maintenance data management process.

	Projektipäällikön haastattelu	Kyllä	Ei			
11	Kunnossapitosuunnittelu huomioitu projektisuunnitelmassa			1. tekninen scope määritelty		
23	Projektin vastuut käyty läpi, kunnossapitosuunnittelijan kanssa			2. kunnossapitosuunnittelija määritely		
24	(Aloituskokouksessa) käsitelty projektin päämitoitukset, sisältö ja rajaus (pi-kaaviot ja kytkennät laitokseen, sijoituspiirrustukset, laitteistojen alustavat tekniset selvitykset)			3 kunnossapitosuunnitelma luotu (rcm checklist tarvittavat asiat ja vastuut)		
25	Tiedot projektiorganisaatiolla (tallennettu esim m-files, mihin kaikilla pääsy)			4 dokumenttien toimitus ja valmistuminen suunniteltu		
42	Aloituskokouksessa tai aloituskeskustelussa sovittu kunnossapitosuunnittelun datan toimituksesta				Oletko aiemmin toimitnut projektipäällikkönä?	
7	Projektinäkymä luotu M-filesiin				Projektipäällikön rooli esisuunnittelussa:	
71	Projektidokumenttien hallinnointi M-Filesissä					
72	PI-kaavio saatavilla					
73	Layout saatavilla					
74	laitedokumentit saatavilla tekniset tiedot					
75	laitedokumentit saatavilla käyttö ja huolto-ohjeet					
76	laitedokumentit saatavilla kokoonpanopiirustus osaluetteloineen					
77	Varaosien valmistajien tiedot saatu					
78	Varaosa toimitukset projektin aikana					
	Kunnossapitosuunnittelun kannalta tärkeät lähtötiedot huomioitu: 14	0	0			

2. 2nd part of the questionnaire: Project Maintenance planner awareness on the project and technical scope (Communication from Project manager to maintenance planner) related to successful implementation of maintenance data management process.

Also, the maintenance planner is interviewed for specific information about the project technical scope, schedule, and objectives.

Kysymykset 1/2 projektin kunnossapitosuunnittelijalle		
Oletko vastannut aiemmin kunnossapitosuunnittelusta projektissa?	Kyllä/Ei	Kyllä
	Ei	Kyllä
Kunnossapitosuunnittelun aikataulu tehty? (tai kunnossapitosuunnitelma tehty?)		
Laitetiedot saatu toimittajalta (SAPiin vietävät)		
Huoltosuunnitelmiin tarvittavat tiedot saatu toimittajalta (SAPiin vietävät)		
Varaosatilaukset tehty		
Kriittiset varaosat saatu		
nimikeharmonisointi suoritettu		
toimintopaikkojen kriittisyysluokittelu valmis		
SAP päivitys aloitettu?		
SAP rakennemuutokset suunniteltu?		
	0	0

3. 3rd part of the questionnaire: Project maintenance data management process checklist status (Was discussed first preliminary with project manager and later recorded with maintenance planner)

The questionnaire consists of 14 items that needs to be handled in a project by the named maintenance planner. The current state is marked in the table based on the interview.

			Current state			
Ohjeistus	**Aihe**		Not started	In process	Completed	Not needed
307 Projektin toteutus, Kunn	**Kunnossapidon vaatimien tietojen päivitys**					
		Toimintopaikat, uuden toimintopaikan perustaminen tai nykyisen päivittäminen (IL01 & IL02)	x			
		Kriittisyysluokittelun suorittaminen (IL02)		x		
		Teknisen dokumentaation päivittäminen (CV02N) - PI-kaaviot, Layout-piirustukset, piirikaaviot jne....		x		
		Uusien teknisten dokumenttien tallennus toimintopaikalle/laitteelle (CV01N & CV02N) - Manuaalit, kokoonpanokuvat, osakuvat ja -luettelot jne...		x		
		Uuden laitteen perustaminen tai nykyisen päivittäminen (IE01 & IE02)		x		
		Huoltosuunnitelmien luominen ja päivittäminen (IP18) - Voitelukierrokset - Kunnonvalvontakierrokset - Kalibroinnit - Seisokkihuollot - ODR-kierrokset - Jne...		x		
		Varaosien varastointitarpeiden läpikäynti - Varaosasuositus (S9.3.3 taulukko) - Hankittavien varaosien määritys - Nimikeharmonisointi - Varaosien tilaus		x		
		Osaluettelon päivittäminen/luominen (IB11 & IB12, IB01 & IB02, CS01 & CS02) - Nimikkeiden etsiminen - Uusien nimikkeiden luominen			x	
		Takuutietojen määrittäminen toimintopaikalle/laitteelle (IL02, IE02) - ml. sijaintitiedot (PIE)			x	
		Vanhojen huoltosuunnitelmien poistaminen (IP18)			x	
		Dokumenttien/dokumenttisidosten poistaminen poistuneiden laitteiden osalta (CV02N)			x	
		Vanhojen osaluetteloiden poistaminen (IB12, IB02, CS02)			x	
		Poistuvien nimikkeiden kartoitus ja romuttaminen (CS15)		x		
		Vanhojen laitteiden ja toimintopaikkojen poistaminen (IE02 & IL02)				x
			1	7	5	1

Case project maintenance planning status is visualized as example:

1	Not started	7 %
7	In process	50 %
5	Completed or Yes	36 %
1	Not needed	7 %
14	Number of matters in the assessment	100 %

4. 4th part of the questionnaire: Information availability for being able to successfully complete the required tasks and tools utilization for completing the tasks.

The availability of the needed information that is needed for carrying out the required tasks are reviewed. and commented whether the maintenance engineer has it or not. Also, the usage of the available software is checked.

Informaatio, mitä tarvitaan aiheen suorittamiseen	Saatavilla	Työkalut ja ohjeet, mitä olemassa aiheen suorittamiseen	käytössä olevat työkalut, noudatetut ohjeistukset
	Kyllä/Ei		
Prosessisuunnittelu valmis/PI-kaavio		Wishuttle, functional location hierarchy export, and preparation, M-Files	
Toiminopaikat		rcm functional location criticality classification, M-Files	
Suunnitteludokumentaatio		dms document numbers by mass export and import, m-files for document receiving and preparation for SAP during the project	
laitetoimittaja/valmistajan dokumentaatio		SAP dms, m-files for preparation	
laitetiedot toimittajalta		S9.3.1 table for requesting data from supplier, sap mass import excel, M-Files (incl. workflow for data management)	
kriittisyysluokittelu, laitevalmistajan huolto-ohjeistus, olemassa oelvat huoltosuunnitelmat		S9.3.2 table for requesting data from supplier, sap mass import excel, M-Files workflow for data management, maintenance plan rcm table	
Varaosasuositukset, varaosien valmistajien tiedot		S9.3.3 table for requesting data from supplier, sap mass import excel with the help of pmmd team, M-Files workflow for data management, maintenance	
laitekohtainen osaluettelo toimittajalta		kriittisyysluokittelutaulukko tätä varten, yleisiä laitekohtaisia osaluetteloita??, M-Files	
toimintopaikka luotu SAPpiin ja vastaanotto on tehty (takuu on 24 kk vastaanotosta)		wishuttle ajo taulukko datan keruuta varten, M-Files	
käytöstä poistuvat laitteet selvillä		käsityötä, massana suoritettavissa winshuttle taulukoilla, M-Files	
käytöstä poistuvat laitteet selvillä		SAP dms, M-Files	
käytöstä poistuvat laitteet selvillä		winshuttlella massana, tai käsipeliä, M-Files	
käytöstä poistuvat laitteet selvillä		winshuttlella massana, tai käsipeliä, M-Files	
käytöstä poistuvat laitteet selvillä		winshuttlella massana, tai käsipeliä, M-Files	

5. 5th part of the questionnaire: If not meeting the theoretical state, what are the challenges, what is the plan and what are the opportunities for improvement related to the task.

Finally, the task related challenges, plan and opportunities for improvement is asked for development.

Challenges	Plan	Opportunitied for improvement

Appendix 5. The detailed results of the case study project actual states and the theoretical states including the deviations highlighted

Content:

1. Case 1

	Projektipäällikön haastattelu	Kyllä	Ei
11	Kunnossapitosuunnittelu huomioitu projektisuunnitelmassa	x	
23	Projektin vastuut käyty läpi, kunnossapitosuunnittelijan kanssa	x	
24	(Aloituskokouksessa) käsitelty projektin päämitoitukset, sisältö ja rajaus (pi-kaaviot ja kytkennät laitokseen, sijoituspiirrustukset, laitteistojen alustavat tekniset selvitykset)	x	
25	Tiedot projektiorganisaatiolla (tallennettu esim m-files, mihin kaikilla pääsy)	x	
42	Aloituskokouksessa tai aloituskeskustelussa sovittu kunnossapitosuunnittelun datan toimitukse	x	
7	Projektinäkymä luotu M-filesiin	x	
71	Projektidokumenttien hallinnointi M-Filesissä	x	
72	PI-kaavio saatavilla	x	
73	Layout saatavilla	x	
74	laitedokumentit saatavilla tekniset tiedot	x	
75	laitedokumentit saatavilla käyttö ja huolto-ohjeet	x	
76	laitedokumentit saatavilla kokoonpanopiirustus osaliitteloineen	x	
77	Varaosien valmistajien tiedot saatu	x	
78	Varaosa toimitukset projektin aikana	x	
	Kunnossapitosuunnittelun kannalta tärkeät lähtötiedot huomioitu: 14	14	0

1. tekninen scope määritelty	K
2. kunnossapitosuunnittelija määritely	K
3 kunnossapitosuunnitelma luotu (rom checklist tarvittavat asiat ja vastuut)	K
4 dokumenttien toimitus ja valmistuminen suunniteltu	K

Oletko aiemmin toimitnut projektipäällikkönä?	KYLLÄ
Projektipäällikön rooli esisuunnittelussa:	KYLLÄ

Figure 1. Modelled theoretical status of the project manager tasks related to instructions.

	Projektipäällikön haastattelu	Kyllä	Ei
11	Kunnossapitosuunnittelu huomioitu projektisuunnitelmassa		x
23	Projektin vastuut käyty läpi, kunnossapitosuunnittelijan kanssa	x	
24	(Aloituskokouksessa) käsitelty projektin päämitoitukset, sisältö ja rajaus (pi-kaaviot ja kytkennät laitokseen, sijoituspiirrustukset, laitteistojen alustavat tekniset selvitykset)	x	
25	Tiedot projektiorganisaatiolla (tallennettu esim m-files, mihin kaikilla pääsy)	x	x
42	Aloituskokouksessa tai aloituskeskustelussa sovittu kunnossapitosuunnittelun datan toimituksesta		x
7	Projektinäkymä luotu M-filesiin	x	
71	Projektidokumenttien hallinnointi M-Filesissä		x
72	PI-kaavio saatavilla	x	
73	Layout saatavilla	x	
74	laitedokumentit saatavilla tekniset tiedot	x	
75	laitedokumentit saatavilla käyttö ja huolto-ohjeet	x	
76	laitedokumentit saatavilla kokoonpanopiirustus osaliitteloineen	x	
77	Varaosien valmistajien tiedot saatu	x	
78	Varaosa toimitukset projektin aikana	x	
	Kunnossapitosuunnittelun kannalta tärkeät lähtötiedot huomioitu: 14	11	4

1. tekninen scope määritelty	K
2. kunnossapitosuunnittelija määritelty	K
3 kunnossapitosuunnitelma luotu (rom checklist tarvittavat asiat ja vastuut)	E
4 dokumenttien toimitus ja valmistuminen suunniteltu	K

Oletko aiemmin toimitnut projektipäällikkönä?	KYLLÄ
Projektipäällikön rooli esisuunnittelussa:	KYLLÄ

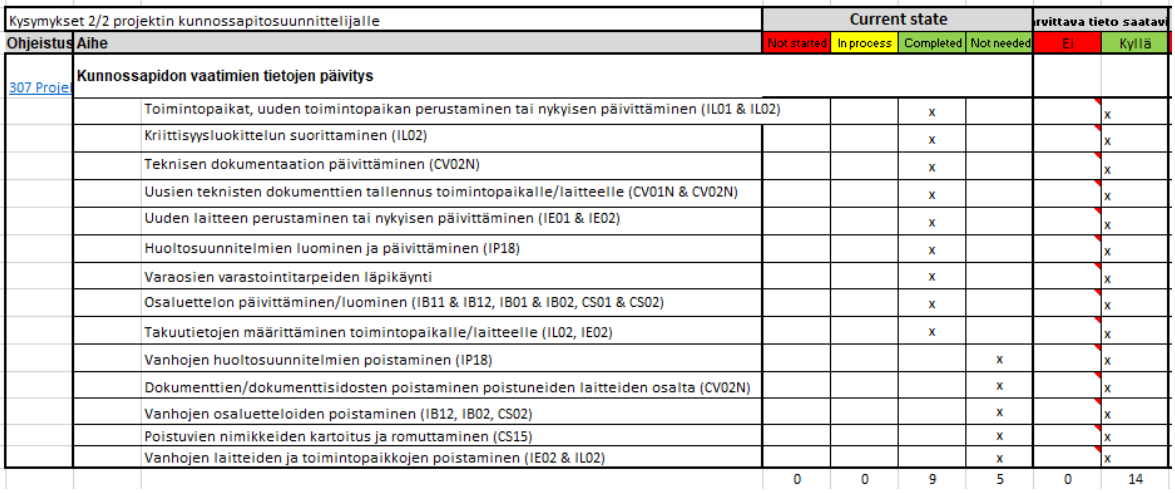
Figure 2. Recorded actual status of the project manager tasks where the deviations are highlighted.

Kysymykset 1/2 projektin kunnossapitosuunnittelijalle		
Oletko vastannut aiemmin kunnossapitosuunnittelusta projektissa?	Kyllä/Ei	Kyllä
	Ei	Kyllä
Kunnossapitosuunnittelun aikataulu tehty? (tai kunnossapitosuunnitelma tehty?)		x
Laitetiedot saatu toimittajalta (SAPiin vietävät)		x
Huoltosuunnitelmiin tarvittavat tiedot saatu toimittajalta (SAPiin vietävät)		x
Varaosatilaukset tehty		x
Kriittiset varaosat saatu		x
nimikeharmonisointi suoritettu		x
toimintopaikkojen kriittisyysluokittelu valmis		x
SAP päivitys aloitettu?		x
SAP rakennemuutokset suunniteltu?		x
	0	9

Figure 3. Modelled theoretical status of the Maintenance Engineer tasks related to instructions.

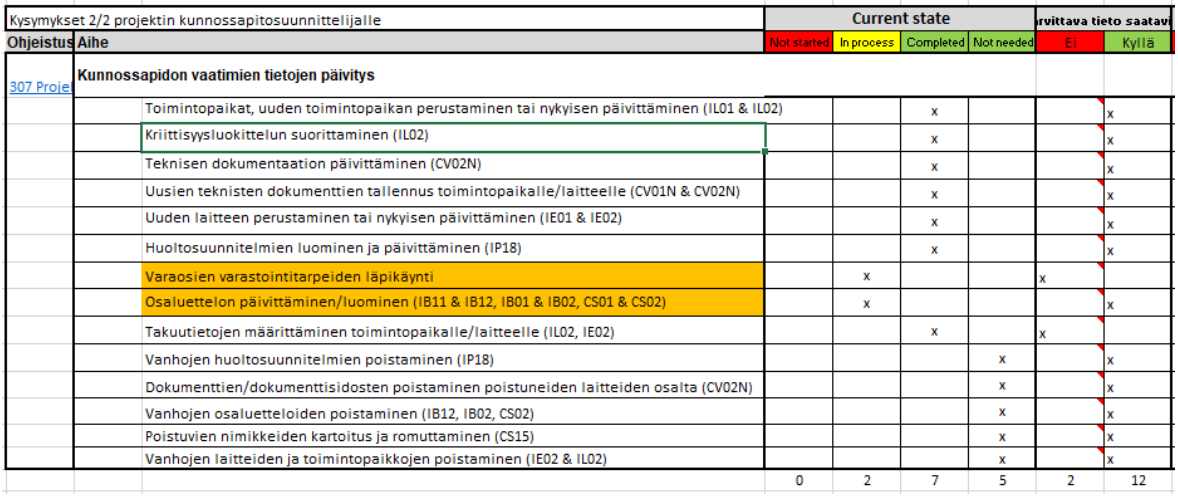
Kysymykset 1/2 projektin kunnossapitosuunnittelijalle		
Oletko vastannut aiemmin kunnossapitosuunnittelusta projektissa?	Kyllä/Ei	
	Ei	Kyllä
Kunnossapitosuunnittelun aikataulu tehty? (tai kunnossapitosuunnitelma tehty?)	x	
Laitetiedot saatu toimittajalta (SAPiin vietävät)		x
Huoltosuunnitelmiin tarvittavat tiedot saatu toimittajalta (SAPiin vietävät)		x
Varaosatilaukset tehty	x	
Kriittiset varaosat saatu		x
nimikeharmonisointi suoritettu		x
toimintopaikkojen kriittisyysluokittelu valmis		x
SAP päivitys aloitettu?		x
SAP rakennemuutokset suunniteltu?		x
	2	7

Figure 4. Recorded actual status of the Maintenance Engineer tasks where the deviations are highlighted.



Kysymykset 2/2 projektin kunnossapitosuunnittelijalle		Current state				rvittava tieto saatavi	
Ohjeistus	Aihe	Not started	In process	Completed	Not needed	Ei	Kyllä
307 Proje	**Kunnossapidon vaatimien tietojen päivitys**						
	Toimintopaikat, uuden toimintopaikan perustaminen tai nykyisen päivittäminen (IL01 & IL02)			x			x
	Kriittisyysluokittelun suorittaminen (IL02)			x			x
	Teknisen dokumentaation päivittäminen (CV02N)			x			x
	Uusien teknisten dokumenttien tallennus toimintopaikalle/laitteelle (CV01N & CV02N)			x			x
	Uuden laitteen perustaminen tai nykyisen päivittäminen (IE01 & IE02)			x			x
	Huoltosuunnitelmien luominen ja päivittäminen (IP18)			x			x
	Varaosien varastointitarpeiden läpikäynti			x			x
	Osaluettelon päivittäminen/luominen (IB11 & IB12, IB01 & IB02, CS01 & CS02)			x			x
	Takuutietojen määrittäminen toimintopaikalle/laitteelle (IL02, IE02)			x			x
	Vanhojen huoltosuunnitelmien poistaminen (IP18)				x		x
	Dokumenttien/dokumenttisidosten poistaminen poistuneiden laitteiden osalta (CV02N)				x		x
	Vanhojen osaluetteloiden poistaminen (IB12, IB02, CS02)				x		x
	Poistuvien nimikkeiden kartoitus ja romuttaminen (CS15)				x		x
	Vanhojen laitteiden ja toimintopaikkojen poistaminen (IE02 & IL02)				x		x
		0	0	9	5	0	14

Figure 5. Modelled theoretical status of the project related maintenance data management process related maintenance data check-list tasks.



Kysymykset 2/2 projektin kunnossapitosuunnittelijalle		Current state				rvittava tieto saatavi	
Ohjeistus	Aihe	Not started	In process	Completed	Not needed	Ei	Kyllä
307 Proje	**Kunnossapidon vaatimien tietojen päivitys**						
	Toimintopaikat, uuden toimintopaikan perustaminen tai nykyisen päivittäminen (IL01 & IL02)			x			x
	Kriittisyysluokittelun suorittaminen (IL02)			x			x
	Teknisen dokumentaation päivittäminen (CV02N)			x			x
	Uusien teknisten dokumenttien tallennus toimintopaikalle/laitteelle (CV01N & CV02N)			x			x
	Uuden laitteen perustaminen tai nykyisen päivittäminen (IE01 & IE02)			x			x
	Huoltosuunnitelmien luominen ja päivittäminen (IP18)			x			x
	Varaosien varastointitarpeiden läpikäynti		x			x	
	Osaluettelon päivittäminen/luominen (IB11 & IB12, IB01 & IB02, CS01 & CS02)		x				x
	Takuutietojen määrittäminen toimintopaikalle/laitteelle (IL02, IE02)			x		x	
	Vanhojen huoltosuunnitelmien poistaminen (IP18)				x		x
	Dokumenttien/dokumenttisidosten poistaminen poistuneiden laitteiden osalta (CV02N)				x		x
	Vanhojen osaluetteloiden poistaminen (IB12, IB02, CS02)				x		x
	Poistuvien nimikkeiden kartoitus ja romuttaminen (CS15)				x		x
	Vanhojen laitteiden ja toimintopaikkojen poistaminen (IE02 & IL02)				x		x
		0	2	7	5	2	12

Figure 6. Recorded actual status of the project related maintenance data management process related maintenance data check-list tasks.

Tilanne	Case 1					Ohjeistuksen mukainen tavoitetila				
Projekti päällikkö huomioinut ohjeistuksen mukaan kunnossapitosuunnittelun onnistumisen kannalta tärkeät asiat										
11	Considered		73 %	17 %		14	Considered		100 %	22 %
4	Not considered		27 %	6 %		0	Not considered		0 %	0 %
Kunnossapitosuunnittelun valmistelu toteutunut ohjeistuksen mukaisesti										
2	done		22 %	3 %		0	done		0 %	0 %
7	Delayed		78 %	11 %		9	Delayed		100 %	14 %
Projektin kunnossapitosuunnittelun tilanne										
0	Not started		0 %	0 %		0	Not started		0 %	0 %
2	In process		14 %	3 %		0	In process		0 %	0 %
7	Completed or Yes		50 %	11 %		9	Completed or Yes		64 %	14 %
5	Not needed		36 %	8 %		5	Not needed		36 %	8 %
Kunnossapitosuunnitteluun tarvittavat tiedot saatavilla										
12	Data available		86 %	18 %		14	Data available		100 %	22 %
2	Data missing		14 %	3 %		0	Data missing		0 %	0 %
Kunnossapitosuunnitteluun olemassa olevat työkalut käytetty										
1	Tools utilized		7 %	2 %		14	Tools utilized		100 %	22 %
13	Managed other way		93 %	20 %		0	Managed other way		0 %	0 %
66	matters in the assessment			100 %		65	matters in the assessment			100 %

Figure 7. Compilation of the actual status including the theoretical status of all the project maintenance data management process related tasks

Case 1	
Projektin päälikkö huomioinut kunnossapitosuunnittelun onnistumisen kannalta tärkeät asiat	
78,57 %	**tehtävistä huomioitu**
Kunnossapitosuunnittelun valmistelu toeutunut ohjeistuksen mukaisesti	
77,78 %	**ohjeistuksen mukaisesti valmisteltu**
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä mitä pitäisi hoitaa ei ole aloitettu	
0,00 %	**tehtävälistan tehtävisä aloittamatta**
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä, mitä pitäisi hoitaa on vielä meneillään	
14,29 %	**tehtävälistan tehtävistä vielä meneillään, mitkä pitäisi olla jo suoritettu**
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä, mitä pitäisi hoitaa on suoritettu/valmistunut	
77,78 %	**tehtävälistan suoritettavista tehtävistä suoritettu**
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä, mitä pitäisi varmistaa ettei ole tarpeellisia projektin osalta on käyty läpi	
100,00 %	**tehtävälistan tehtävistä mitkä ei vaadi toimenpiteitä tarkastettu**
Kunnossapitosuunnitteluun tarvittavat lähtötiedot saatavilla	
85,71 %	**tarvittavista lähtötiedoista saatavilla**
Kunnossapitosuunnittelun toteutukseen käytetyt työkalut käytössä ohjeistuksen mukaan.	
7,14 %	**olemassa olevista työkaluista hyödynnetty kunnossapitosuunnittelussa**

Table 1. Mill 1 case 1 results.

2. Case 2

	Projektipäällikön haastattelu	Kyllä	Ei
11	Kunnossapitosuunnittelu huomioitu projektisuunnitelmassa	x	
23	Projektin vastuut käyty läpi, kunnossapitosuunnittelijan kanssa	x	
24	(Aloituskokouksessa) käsitelty projektin päämitoitukset, sisältö ja rajaus (pi-kaaviot ja kytkennät laitokseen, sijoituspiirrustukset, laitteistojen alustavat tekniset selvitykset)	x	
25	Tiedot projektiorganisaatiolla (tallennettu esim m-files, mihin kaikilla pääsy)	x	
42	Aloituskokouksessa tai aloituskeskustelussa sovittu kunnossapitosuunnittelun datan toimituks	x	
7	Projektinäkymä luotu M-filesiin	x	
71	Projektidokumenttien hallinnointi M-Filesissä	x	
72	PI-kaavio saatavilla	x	
73	Layout saatavilla	x	
74	laitedokumentit saatavilla tekniset tiedot	x	
75	laitedokumentit saatavilla käyttö ja huolto-ohjeet	x	
76	laitedokumentit saatavilla kokoonpanopiirustus osaliitteloineen	x	
77	Varaosien valmistajien tiedot saatu	x	
78	Varaosa toimitukset projektin aikana	x	
	Kunnossapitosuunnittelun kannalta tärkeät lähtötiedot huomioitu: 14	14	0

1. tekninen scope määritelty	K
2. kunnossapitosuunnittelija määritelty	K
3 kunnossapitosuunnitelma luotu (rom checklist tarvittavat asiat ja vastuut)	K
4 dokumenttien toimitus ja valmistuminen suunniteltu	K
Oletko aiemmin toimitnut projektipäällikkönä?	KYLLÄ
Projektipäällikön rooli esisuunnittelussa:	Kyllä

Figure 8. Modelled theoretical status of the project manager tasks related to instructions.

	Projektipäällikön haastattelu	Kyllä	Ei
1	Projektisuunnitelma luotu	x	
11	Kunnossapitosuunnittelu huomioitu projektisuunnitelmassa		x
23	Projektin vastuut käyty läpi, kunnossapitosuunnittelijan kanssa	x	
24	kytkennät laitokseen, sijoituspiirrustukset, laitteistojen alustavat tekniset selvitykset)	x	
25	Tiedot projektiorganisaatiolla (tallennettu esim m-files, mihin kaikilla pääsy)	x	
42	Aloituskokouksessa tai aloituskeskustelussa sovittu kunnossapitosuunnittelun datan toimituksesta		x
7	Projektinäkymä luotu M-filesiin	x	
71	Projektidokumenttien hallinnointi M-Filesissä		x
72	PI-kaavio saatavilla	x	
73	Layout saatavilla	x	
74	laitedokumentit saatavilla tekniset tiedot	x	
75	laitedokumentit saatavilla käyttö ja huolto-ohjeet	x	
76	laitedokumentit saatavilla kokoonpanopiirustus osaliitteloineen	x	
77	Varaosien valmistajien tiedot saatu	x	
78	Varaosa toimitukset projektin aikana	x	
	Kunnossapitosuunnittelun kannalta tärkeät lähtötiedot huomioitu: 14	11	3

1. tekninen scope määritelty	K
2. kunnossapitosuunnittelija määritelty	K
3 kunnossapitosuunnitelma luotu (rom checklist tarvittavat asiat ja vastuut)	E
4 dokumenttien toimitus ja valmistuminen suunniteltu	K
Oletko aiemmin toimitnut projektipäällikkönä?	KYLLÄ
Projektipäällikön rooli esisuunnittelussa:	Kyllä

Figure 9. Recorded actual status of the project manager tasks where the deviations are highlighted.

Kysymykset 1/2 projektin kunnossapitosuunnittelijalle		
Oletko vastannut aiemmin kunnossapitosuunnittelusta projektissa?	Kyllä/Ei	Kyllä
	Ei	Kyllä
Kunnossapitosuunnittelun aikataulu tehty? (tai kunnossapitosuunnitelma tehty?)		x
Laitetiedot saatu toimittajalta (SAPiin vietävät)		x
Huoltosuunnitelmiin tarvittavat tiedot saatu toimittajalta (SAPiin vietävät)		x
Varaosatilaukset tehty		x
Kriittiset varaosat saatu		x
nimikeharmonisointi suoritettu		x
toimintopaikkojen kriittisyysluokittelu valmis		x
SAP päivitys aloitettu?		x
SAP rakennemuutokset suunniteltu?		x
	0	9

Figure 10. Modelled theoretical status of the Maintenance Engineer tasks related to instructions.

Kysymykset 1/2 projektin kunnossapitosuunnittelijalle		
Oletko vastannut aiemmin kunnossapitosuunnittelusta projektissa?	Kyllä/Ei	Kyllä
	Ei	Kyllä
Kunnossapitosuunnittelun aikataulu tehty? (tai kunnossapitosuunnitelma tehty?)	x	
Laitetiedot saatu toimittajalta (SAPiin vietävät)		x
Huoltosuunnitelmiin tarvittavat tiedot saatu toimittajalta (SAPiin vietävät)		x
Varaosatilaukset tehty		x
Kriittiset varaosat saatu		x
nimikeharmonisointi suoritettu		x
toimintopaikkojen kriittisyysluokittelu valmis	x	
SAP päivitys aloitettu?		x
SAP rakennemuutokset suunniteltu?		x
	2	7

Figure 11. Recorded actual status of the Maintenance Engineer tasks where the deviations are highlighted.

Kysymykset 2/2 projektin kunnossapitosuunnittelijalle		Current state					
Ohjeistu	Aihe	Not started	In process	Completed	Not needed	Ei	Kyllä
307 Proj	**Kunnossapidon vaatimien tietojen päivitys**						
	Toimintopaikat, uuden toimintopaikan perustaminen tai nykyisen päivittäminen (IL01 & IL02)			x			x
	Kriittisyysluokittelun suorittaminen (IL02)			x			x
	Teknisen dokumentaation päivittäminen (CV02N)			x			x
	Uusien teknisten dokumenttien tallennus toimintopaikalle/laitteelle (CV01N & CV02N)			x			x
	Uuden laitteen perustaminen tai nykyisen päivittäminen (IE01 & IE02)			x			x
	Huoltosuunnitelmien luominen ja päivittäminen (IP18)			x			x
	Varaosien varastointitarpeiden läpikäynti			x			x
	Osaluettelon päivittäminen/luominen (IB11 & IB12, IB01 & IB02, CS01 & CS02)			x			x
	Takuutietojen määrittäminen toimintopaikalle/laitteelle (IL02, IE02)			x			x
	Vanhojen huoltosuunnitelmien poistaminen (IP18)				x		x
	Dokumenttien/dokumenttisidosten poistaminen poistuneiden laitteiden osalta (CV02N)				x		x
	Vanhojen osaluetteloiden poistaminen (IB12, IB02, CS02)				x		x
	Poistuvien nimikkeiden kartoitus ja romuttaminen (CS15)				x		x
	Vanhojen laitteiden ja toimintopaikkojen poistaminen (IE02 & IL02)				x		x
		0	0	9	5	0	14

Figure 12. Modelled theoretical status of the project related maintenance data management process related maintenance data check-list tasks.

Kysymykset 2/2 projektin kunnossapitosuunnittelijalle		Current state					
Ohjeistu	Aihe	Not started	In process	Completed	Not needed	Ei	Kyllä
307 Proj	**Kunnossapidon vaatimien tietojen päivitys**						
	Toimintopaikat, uuden toimintopaikan perustaminen tai nykyisen päivittäminen (IL01 & IL02)			x			x
	Kriittisyysluokittelun suorittaminen (IL02)		x				x
	Teknisen dokumentaation päivittäminen (CV02N)			x			x
	Uusien teknisten dokumenttien tallennus toimintopaikalle/laitteelle (CV01N & CV02N)			x			x
	Uuden laitteen perustaminen tai nykyisen päivittäminen (IE01 & IE02)			x			x
	Huoltosuunnitelmien luominen ja päivittäminen (IP18)			x			x
	Varaosien varastointitarpeiden läpikäynti			x			x
	Osaluettelon päivittäminen/luominen (IB11 & IB12, IB01 & IB02, CS01 & CS02)			x			x
	Takuutietojen määrittäminen toimintopaikalle/laitteelle (IL02, IE02)		x			x	
	Vanhojen huoltosuunnitelmien poistaminen (IP18)				x		x
	Dokumenttien/dokumenttisidosten poistaminen poistuneiden laitteiden osalta (CV02N)				x		x
	Vanhojen osaluetteloiden poistaminen (IB12, IB02, CS02)				x		x
	Poistuvien nimikkeiden kartoitus ja romuttaminen (CS15)				x		x
	Vanhojen laitteiden ja toimintopaikkojen poistaminen (IE02 & IL02)				x		x
		0	2	7	5	1	13

Figure 13. Recorded actual status of the project related maintenance data management process related maintenance data check-list tasks.

Tilanne	Case 2					Ohjeistuksen mukainen tavoitetila			
Projekti päällikkö huomioinut ohjeistuksen mukaan kunnossapitosuunnittelun onnistumisen kannalta tärkeät asiat									
11	Considered		79 %	17 %		14	Considered	100 %	22 %
3	Not considered		21 %	5 %		0	Not considered	0 %	0 %
Kunnossapitosuunnittelun valmistelu toteutunut ohjeistuksen mukaisesti									
2	done		22 %	3 %		0	done	0 %	0 %
7	Delayed		78 %	11 %		9	Delayed	100 %	14 %
Projektin kunnossapitosuunnittelun tilanne									
0	Not started		0 %	0 %		0	Not started	0 %	0 %
2	In process		14 %	3 %		0	In process	0 %	0 %
7	Completed or Yes		50 %	11 %		9	Completed or Yes	64 %	14 %
5	Not needed		36 %	8 %		5	Not needed	36 %	8 %
Kunnossapitosuunnitteluun tarvittavat tiedot saatavilla									
13	Data available		93 %	20 %		14	Data available	100 %	22 %
1	Data missing		7 %	2 %		0	Data missing	0 %	0 %
Kunnossapitosuunnitteluun olemassa olevat työkalut käytetty									
1	Tools utilized		7 %	2 %		14	Tools utilized	100 %	22 %
13	Managed other way		93 %	20 %		0	Managed other way	0 %	0 %
65	matters in the assessment			100 %		65	matters in the assessment		100 %

Figure 14. Compilation of the actual status including the theoretical status of all the project maintenance data management process related tasks

Case 2									
Projektin päälikkö huomioinut kunnossapitosuunnittelun onnistumisen kannalta tärkeät asiat									
78,57 %	**tehtävistä huomioitu**								
Kunnossapitosuunnittelun valmistelu toeutunut ohjeistuksen mukaisesti									
77,78 %	**ohjeistuksen mukaisesti valmisteltu**								
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä mitä pitäisi hoitaa ei ole aloitettu									
0,00 %	**tehtävälistan tehtävisä aloittamatta**								
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä, mitä pitäisi hoitaa on vielä meneillään									
14,29 %	**tehtävälistan tehtävistä vielä meneillään, mitkä pitäisi olla jo suoritettu**								
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä, mitä pitäisi hoitaa on suoritettu/valmistunut									
77,78 %	**tehtävälistan suoritettavista tehtävistä suoritettu**								
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä, mitä pitäisi varmistaa ettei ole tarpeellisia projektin osalta on käyty läpi									
100,00 %	**tehtävälistan tehtävistä mitkä ei vaadi toimenpiteitä tarkastettu**								
Kunnossapitosuunnitteluun tarvittavat lähtötiedot saatavilla									
92,86 %	**tarvittavista lähtötiedoista saatavilla**								
Kunnossapitosuunnittelun toteutukseen käytetyt työkalut käytössä ohjeistuksen mukaan.									
7,14 %	**olemassa olevista työkaluista hyödynnetty kunnossapitosuunnittelussa**								

Table 2. Mill 1 case 2 results.

3. Case 3

	Projektipäällikön haastattelu	Kyllä	Ei
11	Kunnossapitosuunnittelu huomioitu projektisuunnitelmassa	x	
23	Projektin vastuut käyty läpi, kunnossapitosuunnittelijan kanssa	x	
24	(Aloituskokouksessa) käsitelty projektin päämitoitukset, sisältö ja rajaus (pi-kaaviot ja kytkennät laitokseen, sijoituspiirrustukset, laitteistojen alustavat tekniset selvitykset)	x	
25	Tiedot projektiorganisaatiolla (tallennettu esim m-files, mihin kaikilla pääsy)	x	
42	Aloituskokouksessa tai aloituskeskustelussa sovittu kunnossapitosuunnittelun datan toimitukse	x	
7	Projektinäkymä luotu M-filesiin	x	
71	Projektidokumenttien hallinnointi M-Filesissä	x	
72	PI-kaavio saatavilla	x	
73	Layout saatavilla	x	
74	laitedokumentit saatavilla tekniset tiedot	x	
75	laitedokumentit saatavilla käyttö ja huolto-ohjeet	x	
76	laitedokumentit saatavilla kokoonpanopiirustus osaluetteloineen	x	
77	Varaosien valmistajien tiedot saatu	x	
78	Varaosa toimitukset projektin aikana	x	
	Kunnossapitosuunnittelun kannalta tärkeät lähtötiedot huomioitu: 14	14	0

1. tekninen scope määritelty	K
2. kunnossapitosuunnittelija määritely	K
3 kunnossapitosuunnitelma luotu (rom checklist tarvittavat asiat ja vastuut)	k
4 dokumenttien toimitus ja valmisturninen suunniteltu	k

Oletko aiemmin toimitnut projektipäällikkönä?	Kyllä
Projektipäällikön rooli esisuunnittelussa:	Kyllä

Figure 15. Modelled theoretical status of the project manager tasks related to instructions.

	Projektipäällikön haastattelu	Kyllä	Ei
11	Kunnossapitosuunnittelu huomioitu projektisuunnitelmassa		x
23	Projektin vastuut käyty läpi, kunnossapitosuunnittelijan kanssa	x	
24	(Aloituskokouksessa) käsitelty projektin päämitoitukset, sisältö ja rajaus (pi-kaaviot ja kytkennät laitokseen, sijoituspiirrustukset, laitteistojen alustavat tekniset selvitykset)	x	
25	Tiedot projektiorganisaatiolla (tallennettu esim m-files, mihin kaikilla pääsy)	x	x
42	Aloituskokouksessa tai aloituskeskustelussa sovittu kunnossapitosuunnittelun datan toimitukse	x	
7	Projektinäkymä luotu M-filesiin	x	
71	Projektidokumenttien hallinnointi M-Filesissä		x
72	PI-kaavio saatavilla	x	
73	Layout saatavilla	x	
74	laitedokumentit saatavilla tekniset tiedot	x	
75	laitedokumentit saatavilla käyttö ja huolto-ohjeet	x	
76	laitedokumentit saatavilla kokoonpanopiirustus osaluetteloineen	x	
77	Varaosien valmistajien tiedot saatu	x	
78	Varaosa toimitukset projektin aikana	x	
	Kunnossapitosuunnittelun kannalta tärkeät lähtötiedot huomioitu: 14	12	3

1. tekninen scope määritelty	K
2. kunnossapitosuunnittelija määritely	K
3 kunnossapitosuunnitelma luotu (rom checklist tarvittavat asiat ja vastuut)	E
4 dokumenttien toimitus ja valmisturninen suunniteltu	E

Oletko aiemmin toimitnut projektipäällikkönä?	Kyllä
Projektipäällikön rooli esisuunnittelussa:	Kyllä

Figure 16. Recorded actual status of the project manager tasks where the deviations are highlighted.

Kysymykset 1/2 projektin kunnossapitosuunnittelijalle		
Oletko vastannut aiemmin kunnossapitosuunnittelusta projektissa?	Kyllä/Ei	Kyllä
	Ei	Kyllä
Kunnossapitosuunnittelun aikataulu tehty? (tai kunnossapitosuunnitelma tehty?)		x
Laitetiedot saatu toimittajalta (SAPiin vietävät)		x
Huoltosuunnitelmiin tarvittavat tiedot saatu toimittajalta (SAPiin vietävät)		x
Varaosatilaukset tehty		x
Kriittiset varaosat saatu		x
nimikeharmonisointi suoritettu		x
toimintopaikkojen kriittisyysluokittelu valmis		x
SAP päivitys aloitettu?		x
SAP rakennemuutokset suunniteltu?		x
	0	9

Figure 17. Modelled theoretical status of the Maintenance Engineer tasks related to instructions.

Kysymykset 1/2 projektin kunnossapitosuunnittelijalle		
Oletko vastannut aiemmin kunnossapitosuunnittelusta projektissa?	Kyllä/Ei	Kyllä
	Ei	Kyllä
Kunnossapitosuunnittelun aikataulu tehty? (tai kunnossapitosuunnitelma tehty?)	x	
Laitetiedot saatu toimittajalta (SAPiin vietävät)		x
Huoltosuunnitelmiin tarvittavat tiedot saatu toimittajalta (SAPiin vietävät)		x
Varaosatilaukset tehty		x
Kriittiset varaosat saatu	x	
nimikeharmonisointi suoritettu	x	
toimintopaikkojen kriittisyysluokittelu valmis	x	
SAP päivitys aloitettu?	x	
SAP rakennemuutokset suunniteltu?	x	
	6	3

Figure 18. Recorded actual status of the Maintenance Engineer tasks where the deviations are highlighted.

Kysymykset 2/2 projektin kunnossapitosuunnittelijalle		Current state				rvittava tieto saatavi	
Ohjeistus	Aihe	Not started	In process	Completed	Not needed	Ei	Kyllä
307 Proje	**Kunnossapidon vaatimien tietojen päivitys**						
	Toimintopaikat, uuden toimintopaikan perustaminen tai nykyisen päivittäminen (IL01 & IL02)			x			x
	Kriittisyysluokittelun suorittaminen (IL02)				x		x
	Teknisen dokumentaation päivittäminen (CV02N)			x			x
	Uusien teknisten dokumenttien tallennus toimintopaikalle/laitteelle (CV01N & CV02N)			x			x
	Uuden laitteen perustaminen tai nykyisen päivittäminen (IE01 & IE02)			x			x
	Huoltosuunnitelmien luominen ja päivittäminen (IP18)			x			x
	Varaosien varastointitarpeiden läpikäynti			x			x
	Osaluettelon päivittäminen/luominen (IB11 & IB12, IB01 & IB02, CS01 & CS02)			x			x
	Takuutietojen määrittäminen toimintopaikalle/laitteelle (IL02, IE02)			x			x
	Vanhojen huoltosuunnitelmien poistaminen (IP18)			x			x
	Dokumenttien/dokumenttisidosten poistaminen poistuneiden laitteiden osalta (CV02N)			x			x
	Vanhojen osaluetteloiden poistaminen (IB12, IB02, CS02)			x			x
	Poistuvien nimikkeiden kartoitus ja romuttaminen (CS15)			x			x
	Vanhojen laitteiden ja toimintopaikkojen poistaminen (IE02 & IL02)			x			x
		0	0	13	1	0	14

Figure 19. Modelled theoretical status of the project related maintenance data management process related maintenance data check-list tasks.

Kysymykset 2/2 projektin kunnossapitosuunnittelijalle		Current state				rvittava tieto saatavi	
Ohjeistus	Aihe	Not started	In process	Completed	Not needed	Ei	Kyllä
307 Proje	**Kunnossapidon vaatimien tietojen päivitys**						
	Toimintopaikat, uuden toimintopaikan perustaminen tai nykyisen päivittäminen (IL01 & IL02)			x			x
	Kriittisyysluokittelun suorittaminen (IL02)				x		x
	Teknisen dokumentaation päivittäminen (CV02N)	x				x	
	Uusien teknisten dokumenttien tallennus toimintopaikalle/laitteelle (CV01N & CV02N)	x				x	
	Uuden laitteen perustaminen tai nykyisen päivittäminen (IE01 & IE02)	x				x	
	Huoltosuunnitelmien luominen ja päivittäminen (IP18)		x			x	
	Varaosien varastointitarpeiden läpikäynti		x			x	
	Osaluettelon päivittäminen/luominen (IB11 & IB12, IB01 & IB02, CS01 & CS02)		x			x	
	Takuutietojen määrittäminen toimintopaikalle/laitteelle (IL02, IE02)			x			x
	Vanhojen huoltosuunnitelmien poistaminen (IP18)		x			x	
	Dokumenttien/dokumenttisidosten poistaminen poistuneiden laitteiden osalta (CV02N)		x			x	
	Vanhojen osaluetteloiden poistaminen (IB12, IB02, CS02)		x			x	
	Poistuvien nimikkeiden kartoitus ja romuttaminen (CS15)		x			x	
	Vanhojen laitteiden ja toimintopaikkojen poistaminen (IE02 & IL02)		x			x	
		3	8	2	1	11	3

Figure 20. Recorded actual status of the project related maintenance data management process related maintenance data check-list tasks.

Tilanne	Case 3					Ohjeistuksen mukainen tavoitetila			
Projekti päällikkö huomioinut ohjeistuksen mukaan kunnossapitosuunnittelun onnistumisen kannalta tärkeät asiat									
12	Considered		80 %	18 %		14	Considered	100 %	22 %
3	Not considered		20 %	5 %		0	Not considered	0 %	0 %
Kunnossapitosuunnittelun valmistelu toteutunut ohjeistuksen mukaisesti									
6	done		67 %	9 %		0	done	0 %	0 %
3	Delayed		33 %	5 %		9	Delayed	100 %	14 %
Projektin kunnossapitosuunnittelun tilanne									
3	Not started		21 %	5 %		0	Not started	0 %	0 %
8	In process		57 %	12 %		0	In process	0 %	0 %
2	Completed or Yes		14 %	3 %		13	Completed or Yes	93 %	20 %
1	Not needed		7 %	2 %		1	Not needed	7 %	2 %
Kunnossapitosuunnitteluun tarvittavat tiedot saatavilla									
3	Data available		21 %	5 %		14	Data available	100 %	22 %
11	Data missing		79 %	17 %		0	Data missing	0 %	0 %
Kunnossapitosuunnitteluun olemassa olevat työkalut käytetty									
0	Tools utilized		0 %	0 %		14	Tools utilized	100 %	22 %
14	Managed other way		100 %	21 %		0	Managed other way	0 %	0 %
66	matters in the assessment			100 %		65	matters in the assessment		100 %

Figure 21. Compilation of the actual status including the theoretical status of all the project maintenance data management process related tasks

Case 3	
Projektin päälikkö huomioinut kunnossapitosuunnittelun onnistumisen kannalta tärkeät asiat	
85,71 %	**tehtävistä huomioitu**
Kunnossapitosuunnittelun valmistelu toeutunut ohjeistuksen mukaisesti	
33,33 %	**ohjeistuksen mukaisesti valmisteltu**
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä mitä pitäisi hoitaa ei ole aloitettu	
21,43 %	**tehtävälistan tehtävisä aloittamatta**
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä, mitä pitäisi hoitaa on vielä meneillään	
57,14 %	**tehtävälistan tehtävistä vielä meneillään, mitkä pitäisi olla jo suoritettu**
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä, mitä pitäisi hoitaa on suoritettu/valmistunut	
15,38 %	**tehtävälistan suoritettavista tehtävistä suoritettu**
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä, mitä pitäisi varmistaa ettei ole tarpeellisia projektin osalta on käyty läpi	
100,00 %	**tehtävälistan tehtävistä mitkä ei vaadi toimenpiteitä tarkastettu**
Kunnossapitosuunnitteluun tarvittavat lähtötiedot saatavilla	
21,43 %	**tarvittavista lähtötiedoista saatavilla**
Kunnossapitosuunnittelun toteutukseen käytetyt työkalut käytössä ohjeistuksen mukaan.	
0,00 %	**olemassa olevista työkaluista hyödynnetty kunnossapitosuunnittelussa**

Table 3. Mill 2 case 3 results.

4. Case 4

	Projektipäällikön haastattelu	Kyllä	Ei				
11	Kunnossapitosuunnittelu huomioitu projektisuunnitelmassa	x		1. tekninen scope määritelty		k	
23	Projektin vastuut käyty läpi, kunnossapitosuunnittelijan kanssa	x		2. kunnossapitosuunnittelija määritely		K	
24	(Aloituskokouksessa) käsitelty projektin päämitoitukset, sisältö ja rajaus (pi-kaaviot ja kytkennät laitokseen, sijoituspiirrustukset, laitteistojen alustavat tekniset selvitykset)	x		3 kunnossapitosuunnitelma luotu (rom checklist tarvittavat asiat ja vastuut)		K	
25	Tiedot projektiorganisaatiolla (tallennettu esim m-files, mihin kaikilla pääsy)	x		4 dokumenttien toimitus ja valmistuminen suunniteltu		K	
42	Aloituskokouksessa tai aloituskeskustelussa sovittu kunnossapitosuunnittelun datan toimitukse	x			Oletko aiemmin toimitnut projektipäällikkönä?		Kyllä
7	Projektinäkymä luotu M-filesiin	x			Projektipäällikön rooli esisuunnittelussa:		Kyllä
71	Projektidokumenttien hallinnointi M-Filesissä	x					
72	PI-kaavio saatavilla	x					
73	Layout saatavilla	x					
74	laitedokumentit saatavilla tekniset tiedot	x					
75	laitedokumentit saatavilla käyttö ja huolto-ohjeet	x					
76	laitedokumentit saatavilla kokoonpanopiirustus osaliettelоineen	x					
77	Varaosien valmistajien tiedot saatu	x					
78	Varaosa toimitukset projektin aikana	x					
	Kunnossapitosuunnittelun kannalta tärkeät lähtötiedot huomioitu: 14	14	0				

Figure 22. Modelled theoretical status of the project manager tasks related to instructions.

	Projektipäällikön haastattelu	Kyllä	Ei				
11	Kunnossapitosuunnittelu huomioitu projektisuunnitelmassa		x	1. tekninen scope määritelty		k	
23	Projektin vastuut käyty läpi, kunnossapitosuunnittelijan kanssa	x		2. kunnossapitosuunnittelija määritely		e	
24	(Aloituskokouksessa) käsitelty projektin päämitoitukset, sisältö ja rajaus (pi-kaaviot ja kytkennät laitokseen, sijoituspiirrustukset, laitteistojen alustavat tekniset selvitykset)	x		3 kunnossapitosuunnitelma luotu (rom checklist tarvittavat asiat ja vastuut)		e	
25	Tiedot projektiorganisaatiolla (tallennettu esim m-files, mihin kaikilla pääsy)	x		4 dokumenttien toimitus ja valmistuminen suunniteltu		e	
42	Aloituskokouksessa tai aloituskeskustelussa sovittu kunnossapitosuunnittelun datan toimitukse	x			Oletko aiemmin toimitnut projektipäällikkönä?		Kyllä
7	Projektinäkymä luotu M-filesiin	x			Projektipäällikön rooli esisuunnittelussa:		Kyllä
71	Projektidokumenttien hallinnointi M-Filesissä		x				
72	PI-kaavio saatavilla	x					
73	Layout saatavilla	x					
74	laitedokumentit saatavilla tekniset tiedot	x					
75	laitedokumentit saatavilla käyttö ja huolto-ohjeet	x					
76	laitedokumentit saatavilla kokoonpanopiirustus osaliettelоineen	x					
77	Varaosien valmistajien tiedot saatu	x					
78	Varaosa toimitukset projektin aikana	x					
	Kunnossapitosuunnittelun kannalta tärkeät lähtötiedot huomioitu: 14	12	2				

Figure 23. Recorded actual status of the project manager tasks where the deviations are highlighted.

Kysymykset 1/2 projektin kunnossapitosuunnittelijalle		
Oletko vastannut aiemmin kunnossapitosuunnittelusta projektissa?	Kyllä/Ei	Kyllä
	Ei	Kyllä
Kunnossapitosuunnittelun aikataulu tehty? (tai kunnossapitosuunnitelma tehty?)		x
Laitetiedot saatu toimittajalta (SAPiin vietävät)		x
Huoltosuunnitelmiin tarvittavat tiedot saatu toimittajalta (SAPiin vietävät)		x
Varaosatilaukset tehty		x
Kriittiset varaosat saatu		x
nimikeharmonisointi suoritettu		x
toimintopaikkojen kriittisyysluokittelu valmis		x
SAP päivitys aloitettu?		x
SAP rakennemuutokset suunniteltu?		x
	0	9

Figure 24. Modelled theoretical status of the Maintenance Engineer tasks related to instructions.

Kysymykset 1/2 projektin kunnossapitosuunnittelijalle		
Oletko vastannut aiemmin kunnossapitosuunnittelusta projektissa?	Kyllä/Ei	Kyllä
	Ei	Kyllä
Kunnossapitosuunnittelun aikataulu tehty? (tai kunnossapitosuunnitelma tehty?)	x	
Laitetiedot saatu toimittajalta (SAPiin vietävät)		x
Huoltosuunnitelmiin tarvittavat tiedot saatu toimittajalta (SAPiin vietävät)		x
Varaosatilaukset tehty		x
Kriittiset varaosat saatu		x
nimikeharmonisointi suoritettu		x
toimintopaikkojen kriittisyysluokittelu valmis		x
SAP päivitys aloitettu?		x
SAP rakennemuutokset suunniteltu?		x
	1	8

Figure 25. Recorded actual status of the Maintenance Engineer tasks where the deviations are highlighted.

Kysymykset 2/2 projektin kunnossapitosuunnittelijalle			Current state				Tarvittava tieto saatavilla	
Ohjeistus	Aihe		Not started	In process	Completed	Not needed	Ei	Kyllä
307 Projek	**Kunnossapidon vaatimien tietojen päivitys**							
		Toimintopaikat, uuden toimintopaikan perustaminen tai nykyisen päivittäminen (IL01 & IL02)				x		x
		Kriittisyysluokittelun suorittaminen (IL02)				x		x
		Teknisen dokumentaation päivittäminen (CV02N)			x			x
		Uusien teknisten dokumenttien tallennus toimintopaikalle/laitteelle (CV01N & CV02N)			x			x
		Uuden laitteen perustaminen tai nykyisen päivittäminen (IE01 & IE02)			x			x
		Huoltosuunnitelmien luominen ja päivittäminen (IP18)			x			x
		Varaosien varastointitarpeiden läpikäynti			x			x
		Osaluettelon päivittäminen/luominen (IB11 & IB12, IB01 & IB02, CS01 & CS02)			x			x
		Takuutietojen määrittäminen toimintopaikalle/laitteelle (IL02, IE02)			x			x
		Vanhojen huoltosuunnitelmien poistaminen (IP18)			x			x
		Dokumenttien/dokumenttisidosten poistaminen poistuneiden laitteiden osalta (CV02N)			x			x
		Vanhojen osaluetteloiden poistaminen (IB12, IB02, CS02)			x			x
		Poistuvien nimikkeiden kartoitus ja romuttaminen (CS15)			x			x
		Vanhojen laitteiden ja toimintopaikkojen poistaminen (IE02 & IL02)			x			x
			0	0	12	2	0	14

Figure 26. Modelled theoretical status of the project related maintenance data management process related maintenance data check-list tasks.

Kysymykset 2/2 projektin kunnossapitosuunnittelijalle			Current state				rvittava tieto saatavi	
Ohjeistus	Aihe		Not started	In process	Completed	Not needed	Ei	Kyllä
307 Projek	**Kunnossapidon vaatimien tietojen päivitys**							
		Toimintopaikat, uuden toimintopaikan perustaminen tai nykyisen päivittäminen (IL01 & IL02)				x		x
		Kriittisyysluokittelun suorittaminen (IL02)				x		x
		Teknisen dokumentaation päivittäminen (CV02N)			x			x
		Uusien teknisten dokumenttien tallennus toimintopaikalle/laitteelle (CV01N & CV02N)		x				x
		Uuden laitteen perustaminen tai nykyisen päivittäminen (IE01 & IE02)			x			x
		Huoltosuunnitelmien luominen ja päivittäminen (IP18)			x			x
		Varaosien varastointitarpeiden läpikäynti			x			x
		Osaluettelon päivittäminen/luominen (IB11 & IB12, IB01 & IB02, CS01 & CS02)			x			x
		Takuutietojen määrittäminen toimintopaikalle/laitteelle (IL02, IE02)			x			x
		Vanhojen huoltosuunnitelmien poistaminen (IP18)		x				x
		Dokumenttien/dokumenttisidosten poistaminen poistuneiden laitteiden osalta (CV02N)		x				x
		Vanhojen osaluetteloiden poistaminen (IB12, IB02, CS02)		x				x
		Poistuvien nimikkeiden kartoitus ja romuttaminen (CS15)		x				x
		Vanhojen laitteiden ja toimintopaikkojen poistaminen (IE02 & IL02)		x				x
			0	6	6	2	0	14

Figure 27. Recorded actual status of the project related maintenance data management process related maintenance data check-list tasks.

Tilanne	Case 4					Ohjeistuksen mukainen tavoitetila			
Projekti päällikkö huomioinut ohjeistuksen mukaan kunnossapitosuunnittelun onnistumisen kannalta tärkeät asiat									
12	Considered		86 %	18 %		14	Considered	100 %	22 %
2	Not considered		14 %	3 %		0	Not considered	0 %	0 %
Kunnossapitosuunnittelun valmistelu toteutunut ohjeistuksen mukaisesti									
1	done		11 %	2 %		0	done	0 %	0 %
8	Delayed		89 %	12 %		9	Delayed	100 %	14 %
Projektin kunnossapitosuunnittelun tilanne									
0	Not started		0 %	0 %		0	Not started	0 %	0 %
6	In process		43 %	9 %		0	In process	0 %	0 %
6	Completed or Yes		43 %	9 %		13	Completed or Yes	93 %	20 %
2	Not needed		14 %	3 %		1	Not needed	7 %	2 %
Kunnossapitosuunnitteluun tarvittavat tiedot saatavilla									
14	Data available		100 %	22 %		14	Data available	100 %	22 %
0	Data missing		0 %	0 %		0	Data missing	0 %	0 %
Kunnossapitosuunnitteluun olemassa olevat työkalut käytetty									
0	Tools utilized		0 %	0 %		14	Tools utilized	100 %	22 %
14	Managed other way		100 %	22 %		0	Managed other way	0 %	0 %
65	matters in the assessment			100 %		65	matters in the assessment		100 %

Figure 28. Compilation of the actual status including the theoretical status of all the project maintenance data management process related tasks

Case 4									
Projektin päälikkö huomioinut kunnossapitosuunnittelun onnistumisen kannalta tärkeät asiat									
85,71 %	**tehtävistä huomioitu**								
Kunnossapitosuunnittelun valmistelu toeutunut ohjeistuksen mukaisesti									
88,89 %	**ohjeistuksen mukaisesti valmisteltu**								
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä mitä pitäisi hoitaa ei ole aloitettu									
0,00 %	**tehtävälistan tehtävisä aloittamatta**								
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä, mitä pitäisi hoitaa on vielä meneillään									
42,86 %	**tehtävälistan tehtävistä vielä meneillään, mitkä pitäisi olla jo suoritettu**								
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä, mitä pitäisi hoitaa on suoritettu/valmistunut									
50,00 %	**tehtävälistan suoritettavista tehtävistä suoritettu**								
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä, mitä pitäisi varmistaa ettei ole tarpeellisia projektin osalta on käyty läpi									
100,00 %	**tehtävälistan tehtävistä mitkä ei vaadi toimenpiteitä tarkastettu**								
Kunnossapitosuunnitteluun tarvittavat lähtötiedot saatavilla									
100,00 %	**tarvittavista lähtötiedoista saatavilla**								
Kunnossapitosuunnittelun toteutukseen käytetyt työkalut käytössä ohjeistuksen mukaan.									
0,00 %	**olemassa olevista työkaluista hyödynnetty kunnossapitosuunnittelussa**								

Table 4. Mill 2 case 4 results.

5. Case 5

	Projektipäällikön haastattelu	Kyllä	Ei
11	Kunnossapitosuunnittelu huomioitu projektisuunnitelmassa	x	
23	Projektin vastuut käyty läpi, kunnossapitosuunnittelijan kanssa	x	
24	(Aloituskokouksessa) käsitelty projektin päämitoitukset, sisältö ja rajaus (pi-kaaviot ja kytkennät laitokseen, sijoituspiirrustukset, laitteistojen alustavat tekniset selvitykset)	x	
25	Tiedot projektiorganisaatiolla (tallennettu esim m-files, mihin kaikilla pääsy)	x	
42	Aloituskokouksessa tai aloituskeskustelussa sovittu kunnossapitosuunnittelun datan toimitukse	x	
7	Projektinäkymä luotu M-filesiin	x	
71	Projektidokumenttien hallinnointi M-Filesissä	x	
72	PI-kaavio saatavilla	x	
73	Layout saatavilla	x	
74	laitedokumentit saatavilla tekniset tiedot	x	
75	laitedokumentit saatavilla käyttö ja huolto-ohjeet	x	
76	laitedokumentit saatavilla kokoonpanopiirustus osaliitteloineen	x	
77	Varaosien valmistajien tiedot saatu	x	
78	Varaosa toimitukset projektin aikana	x	
	Kunnossapitosuunnittelun kannalta tärkeät lähtötiedot huomioitu: 14	14	0

	Kyllä/ei
1. tekninen scope määritelty	K
2. kunnossapitosuunnittelija määritely	K
3 kunnossapitosuunnitelma luotu (rom checklist tarvittavat asiat ja vastuut)	K
4 dokumenttien toimitus ja valmisturninen suunniteltu	K
Oletko aiemmin toimitnut projektipäällikkönä?	KYLLÄ
Projektipäällikön rooli esisuunnittelussa:	KYLLÄ

Figure 29. Modelled theoretical status of the project manager tasks related to instructions.

	Projektipäällikön haastattelu	Kyllä	Ei
11	Kunnossapitosuunnittelu huomioitu projektisuunnitelmassa	x	
23	Projektin vastuut käyty läpi, kunnossapitosuunnittelijan kanssa	x	
24	(Aloituskokouksessa) käsitelty projektin päämitoitukset, sisältö ja rajaus (pi-kaaviot ja kytkennät laitokseen, sijoituspiirrustukset, laitteistojen alustavat tekniset selvitykset)	x	
25	Tiedot projektiorganisaatiolla (tallennettu esim m-files, mihin kaikilla pääsy)	x	
42	Aloituskokouksessa tai aloituskeskustelussa sovittu kunnossapitosuunnittelun datan toimitukse	x	
7	Projektinäkymä luotu M-filesiin	x	
71	Projektidokumenttien hallinnointi M-Filesissä		x
72	PI-kaavio saatavilla	x	
73	Layout saatavilla	x	
74	laitedokumentit saatavilla tekniset tiedot	x	
75	laitedokumentit saatavilla käyttö ja huolto-ohjeet	x	
76	laitedokumentit saatavilla kokoonpanopiirustus osaliitteloineen	x	
77	Varaosien valmistajien tiedot saatu	x	
78	Varaosa toimitukset projektin aikana	x	
	Kunnossapitosuunnittelun kannalta tärkeät lähtötiedot huomioitu: 14	13	1

	Kyllä/ei
1. tekninen scope määritelty	K
2. kunnossapitosuunnittelija määritely	K
3 kunnossapitosuunnitelma luotu (rom checklist tarvittavat asiat ja vastuut)	K
4 dokumenttien toimitus ja valmisturninen suunniteltu	K
Oletko aiemmin toimitnut projektipäällikkönä?	KYLLÄ
Projektipäällikön rooli esisuunnittelussa:	KYLLÄ

Figure 30. Recorded actual status of the project manager tasks where the deviations are highlighted.

Kysymykset 1/2 projektin kunnossapitosuunnittelijalle		
Oletko vastannut aiemmin kunnossapitosuunnittelusta projektissa?	Kyllä/Ei	Kyllä
	Ei	Kyllä
Kunnossapitosuunnittelun aikataulu tehty? (tai kunnossapitosuunnitelma tehty?)		x
Laitetiedot saatu toimittajalta (SAPiin vietävät)		x
Huoltosuunnitelmiin tarvittavat tiedot saatu toimittajalta (SAPiin vietävät)		x
Varaosatilaukset tehty		x
Kriittiset varaosat saatu		x
nimikeharmonisointi suoritettu		x
toimintopaikkojen kriittisyysluokittelu valmis		x
SAP päivitys aloitettu?		x
SAP rakennemuutokset suunniteltu?		x
	0	9

Figure 31. Modelled theoretical status of the Maintenance Engineer tasks related to instructions.

Kysymykset 1/2 projektin kunnossapitosuunnittelijalle		
Oletko vastannut aiemmin kunnossapitosuunnittelusta projektissa?	Kyllä/Ei	Kyllä
	Ei	Kyllä
Kunnossapitosuunnittelun aikataulu tehty? (tai kunnossapitosuunnitelma tehty?)	x	
Laitetiedot saatu toimittajalta (SAPiin vietävät)		x
Huoltosuunnitelmiin tarvittavat tiedot saatu toimittajalta (SAPiin vietävät)		x
Varaosatilaukset tehty		x
Kriittiset varaosat saatu		x
nimikeharmonisointi suoritettu		x
toimintopaikkojen kriittisyysluokittelu valmis	x	
SAP päivitys aloitettu?		x
SAP rakennemuutokset suunniteltu?		x
	2	7

Figure 32. Recorded actual status of the Maintenance Engineer tasks where the deviations are highlighted.

Kysymykset 2/2 projektin kunnossapitosuunnittelijalle			Current state				Tarvittava tieto saatavilla	
Ohjeistus	Aihe		Not started	In process	Completed	Not needed	Ei	Kyllä
307 Projek	**Kunnossapidon vaatimien tietojen päivitys**							
		Toimintopaikat, uuden toimintopaikan perustaminen tai nykyisen päivittäminen (IL01 & IL02)		x				x
		Kriittisyysluokittelun suorittaminen (IL02)		x				x
		Teknisen dokumentaation päivittäminen (CV02N)		x				x
		Uusien teknisten dokumenttien tallennus toimintopaikalle/laitteelle (CV01N & CV02N)		x				x
		Uuden laitteen perustaminen tai nykyisen päivittäminen (IE01 & IE02)		x				x
		Huoltosuunnitelmien luominen ja päivittäminen (IP18)		x				x
		Varaosien varastointitarpeiden läpikäynti		x				x
		Osaluettelon päivittäminen/luominen (IB11 & IB12, IB01 & IB02, CS01 & CS02)		x				x
		Takuutietojen määrittäminen toimintopaikalle/laitteelle (IL02, IE02)		x				x
		Vanhojen huoltosuunnitelmien poistaminen (IP18)				x		x
		Dokumenttien/dokumenttisidosten poistaminen poistuneiden laitteiden osalta (CV02N)				x		x
		Vanhojen osaluetteloiden poistaminen (IB12, IB02, CS02)				x		x
		Poistuvien nimikkeiden kartoitus ja romuttaminen (CS15)				x		x
		Vanhojen laitteiden ja toimintopaikkojen poistaminen (IE02 & IL02)				x		x
			0	9	0	5	0	14

Figure 33. Modelled theoretical status of the project related maintenance data management process related maintenance data check-list tasks.

Kysymykset 2/2 projektin kunnossapitosuunnittelijalle			Current state				rvittava tieto saatavi	
Ohjeistus	Aihe		Not started	In process	Completed	Not needed	Ei	Kyllä
307 Projek	**Kunnossapidon vaatimien tietojen päivitys**							
		Toimintopaikat, uuden toimintopaikan perustaminen tai nykyisen päivittäminen (IL01 & IL02)			x			x
		Kriittisyysluokittelun suorittaminen (IL02)		x				x
		Teknisen dokumentaation päivittäminen (CV02N)			x			x
		Uusien teknisten dokumenttien tallennus toimintopaikalle/laitteelle (CV01N & CV02N)			x			x
		Uuden laitteen perustaminen tai nykyisen päivittäminen (IE01 & IE02)			x			x
		Huoltosuunnitelmien luominen ja päivittäminen (IP18)	x					x
		Varaosien varastointitarpeiden läpikäynti			x			x
		Osaluettelon päivittäminen/luominen (IB11 & IB12, IB01 & IB02, CS01 & CS02)			x			x
		Takuutietojen määrittäminen toimintopaikalle/laitteelle (IL02, IE02)			x			x
		Vanhojen huoltosuunnitelmien poistaminen (IP18)				x		x
		Dokumenttien/dokumenttisidosten poistaminen poistuneiden laitteiden osalta (CV02N)				x		x
		Vanhojen osaluetteloiden poistaminen (IB12, IB02, CS02)				x		x
		Poistuvien nimikkeiden kartoitus ja romuttaminen (CS15)				x		x
		Vanhojen laitteiden ja toimintopaikkojen poistaminen (IE02 & IL02)				x		x
			1	1	7	5	0	14

Figure 34. Recorded actual status of the project related maintenance data management process related maintenance data check-list tasks.

Tilanne	Case 5					Ohjeistuksen mukainen tavoitetila			
Projekti päällikkö huomioinut ohjeistuksen mukaan kunnossapitosuunnittelun onnistumisen kannalta tärkeät asiat									
13	Considered		93 %	20 %		14	Considered	100 %	22 %
1	Not considered		7 %	2 %		0	Not considered	0 %	0 %
Kunnossapitosuunnittelun valmistelu toteutunut ohjeistuksen mukaisesti									
2	done		22 %	3 %		0	done	0 %	0 %
7	Delayed		78 %	11 %		9	Delayed	100 %	14 %
Projektin kunnossapitosuunnittelun tilanne									
1	Not started		7 %	2 %		0	Not started	0 %	0 %
1	In process		7 %	2 %		14	In process	100 %	22 %
7	Completed or Yes		50 %	11 %		0	Completed or Yes	0 %	0 %
5	Not needed		36 %	8 %		0	Not needed	0 %	0 %
Kunnossapitosuunnitteluun tarvittavat tiedot saatavilla									
14	Data available		100 %	22 %		14	Data available	100 %	22 %
0	Data missing		0 %	0 %		0	Data missing	0 %	0 %
Kunnossapitosuunnitteluun olemassa olevat työkalut käytetty									
1	Tools utilized		7 %	2 %		14	Tools utilized	100 %	22 %
13	Managed other way		93 %	20 %		0	Managed other way	0 %	0 %
65	matters in the assessment			100 %		65	matters in the assessment		100 %

Figure 35. Compilation of the actual status including the theoretical status of all the project maintenance data management process related tasks

Case 5	
Projektin päälikkö huomioinut kunnossapitosuunnittelun onnistumisen kannalta tärkeät asiat	
92,86 %	**tehtävistä huomioitu**
Kunnossapitosuunnittelun valmistelu toeutunut ohjeistuksen mukaisesti	
77,78 %	**ohjeistuksen mukaisesti valmisteltu**
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä mitä pitäisi hoitaa ei ole aloitettu	
7,14 %	**tehtävälistan tehtävisä aloittamatta**
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä, mitä pitäisi hoitaa on vielä meneillään	
0,00 %	**tehtävälistan tehtävistä vielä meneillään, mitkä pitäisi olla jo suoritettu (tehtäviäsuoritettu etukäteen)**
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä, mitä pitäisi hoitaa on suoritettu/valmistunut	
100,00 %	**tehtävälistan suoritettavista tehtävistä suoritettu ja 78% meneillään olevista tehtävistä suoritettu etukäteen**
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä, mitä pitäisi varmistaa ettei ole tarpeellisia projektin osalta on käyty läpi	
100,00 %	**tehtävälistan tehtävistä mitkä ei vaadi toimenpiteitä tarkastettu**
Kunnossapitosuunnitteluun tarvittavat lähtötiedot saatavilla	
100,00 %	**tarvittavista lähtötiedoista saatavilla**
Kunnossapitosuunnittelun toteutukseen käytetyt työkalut käytössä ohjeistuksen mukaan.	
7,14 %	**olemassa olevista työkaluista hyödynnetty kunnossapitosuunnittelussa**

Table 5. Mill 3 case 5 results.

6. Case 6

	Projektipäällikön haastattelu	Kyllä	Ei		
11	Kunnossapitosuunnittelu huomioitu projektisuunnitelmassa	x		1. tekninen scope määritelty	K
23	Projektin vastuut käyty läpi, kunnossapitosuunnittelijan kanssa	x		2. kunnossapitosuunnittelija määritely	K
24	(Aloituskokouksessa) käsitelty projektin päämitoitukset, sisältö ja rajaus (pi-kaaviot ja kytkennät laitokseen, sijoituspiirrustukset, laitteistojen alustavat tekniset selvitykset)	x		3 kunnossapitosuunnitelma luotu (rom checklist tarvittavat asiat ja vastuut)	K
25	Tiedot projektiorganisaatiolla (tallennettu esim m-files, mihin kaikilla pääsy)	x		4 dokumenttien toimitus ja valmistuminen suunniteltu	K
42	Aloituskokouksessa tai aloituskeskustelussa sovittu kunnossapitosuunnittelun datan toimitukse	x			
7	Projektinäkymä luotu M-filesiin	x			
71	Projektidokumenttien hallinnointi M-Filesissä	x			
72	PI-kaavio saatavilla	x			
73	Layout saatavilla	x			
74	laitedokumentit saatavilla tekniset tiedot	x			
75	laitedokumentit saatavilla käyttö ja huolto-ohjeet	x			
76	laitedokumentit saatavilla kokoonpanopiirustus osaliitteloineen	x			
77	Varaosien valmistajien tiedot saatu	x			
78	Varaosa toimitukset projektin aikana	x			
	Kunnossapitosuunnittelun kannalta tärkeät lähtötiedot huomioitu: 14	14	0		

Figure 36. Modelled theoretical status of the project manager tasks related to instructions.

	Projektipäällikön haastattelu	Kyllä	Ei				
11	Kunnossapitosuunnittelu huomioitu projektisuunnitelmassa	x		1. tekninen scope määritelty	K		
23	Projektin vastuut käyty läpi, kunnossapitosuunnittelijan kanssa	x		2. kunnossapitosuunnittelija määritely	K		
24	(Aloituskokouksessa) käsitelty projektin päämitoitukset, sisältö ja rajaus (pi-kaaviot ja kytkennät laitokseen, sijoituspiirrustukset, laitteistojen alustavat tekniset selvitykset)	x		3 kunnossapitosuunnitelma luotu (rom checklist tarvittavat asiat ja vastuut)	K		
25	Tiedot projektiorganisaatiolla (tallennettu esim m-files, mihin kaikilla pääsy)	x		4 dokumenttien toimitus ja valmistuminen suunniteltu	K		
42	Aloituskokouksessa tai aloituskeskustelussa sovittu kunnossapitosuunnittelun datan toimituksesta		x	Oletko aiemmin toimitnut projektipäällikkönä?	KYLLÄ		
7	Projektinäkymä luotu M-filesiin	x		Projektipäällikön rooli esisuunnittelussa:	KYLLÄ		
71	Projektidokumenttien hallinnointi M-Filesissä	x					
72	PI-kaavio saatavilla	x					
73	Layout saatavilla	x					
74	laitedokumentit saatavilla tekniset tiedot	x					
75	laitedokumentit saatavilla käyttö ja huolto-ohjeet	x					
76	laitedokumentit saatavilla kokoonpanopiirustus osaliitteloineen	x					
77	Varaosien valmistajien tiedot saatu	x					
78	Varaosa toimitukset projektin aikana	x					
	Kunnossapitosuunnittelun kannalta tärkeät lähtötiedot huomioitu: 14	13	1				

Figure 37. Recorded actual status of the project manager tasks where the deviations are highlighted.

Kysymykset 1/2 projektin kunnossapitosuunnittelijalle		
Oletko vastannut aiemmin kunnossapitosuunnittelusta projektissa?	Kyllä/Ei	Kyllä
	Ei	Kyllä
Kunnossapitosuunnittelun aikataulu tehty? (tai kunnossapitosuunnitelma tehty?)		x
Laitetiedot saatu toimittajalta (SAPiin vietävät)		x
Huoltosuunnitelmiin tarvittavat tiedot saatu toimittajalta (SAPiin vietävät)		x
Varaosatilaukset tehty		x
Kriittiset varaosat saatu		x
nimikeharmonisointi suoritettu		x
toimintopaikkojen kriittisyysluokittelu valmis		x
SAP päivitys aloitettu?		x
SAP rakennemuutokset suunniteltu?		x
	0	9

Figure 38. Modelled theoretical status of the Maintenance Engineer tasks related to instructions.

Kysymykset 1/2 projektin kunnossapitosuunnittelijalle		
Oletko vastannut aiemmin kunnossapitosuunnittelusta projektissa?	Kyllä/Ei	Kyllä
	Ei	Kyllä
Kunnossapitosuunnittelun aikataulu tehty? (tai kunnossapitosuunnitelma tehty?)	x	
Laitetiedot saatu toimittajalta (SAPiin vietävät)		x
Huoltosuunnitelmiin tarvittavat tiedot saatu toimittajalta (SAPiin vietävät)		x
Varaosatilaukset tehty		x
Kriittiset varaosat saatu		x
nimikeharmonisointi suoritettu		x
toimintopaikkojen kriittisyysluokittelu valmis	x	
SAP päivitys aloitettu?		x
SAP rakennemuutokset suunniteltu?		x
	2	7

Figure 39. Recorded actual status of the Maintenance Engineer tasks where the deviations are highlighted.

Kysymykset 2/2 projektin kunnossapitosuunnittelijalle		Current state				Tarvittava tieto saatavilla	
Ohjeistus	Aihe	Not started	In process	Completed	Not needed	Ei	Kyllä
307 Projek	**Kunnossapidon vaatimien tietojen päivitys**						
	Toimintopaikat, uuden toimintopaikan perustaminen tai nykyisen päivittäminen (IL01 & IL02)			x			x
	Kriittisyysluokittelun suorittaminen (IL02)			x			x
	Teknisen dokumentaation päivittäminen (CV02N)			x			x
	Uusien teknisten dokumenttien tallennus toimintopaikalle/laitteelle (CV01N & CV02N)			x			x
	Uuden laitteen perustaminen tai nykyisen päivittäminen (IE01 & IE02)			x			x
	Huoltosuunnitelmien luominen ja päivittäminen (IP18)			x			x
	Varaosien varastointitarpeiden läpikäynti			x			x
	Osaluettelon päivittäminen/luominen (IB11 & IB12, IB01 & IB02, CS01 & CS02)			x			x
	Takuutietojen määrittäminen toimintopaikalle/laitteelle (IL02, IE02)			x			x
	Vanhojen huoltosuunnitelmien poistaminen (IP18)			x			x
	Dokumenttien/dokumenttisidosten poistaminen poistuneiden laitteiden osalta (CV02N)			x			x
	Vanhojen osaluetteloiden poistaminen (IB12, IB02, CS02)			x			x
	Poistuvien nimikkeiden kartoitus ja romuttaminen (CS15)			x			x
	Vanhojen laitteiden ja toimintopaikkojen poistaminen (IE02 & IL02)			x			x
		0	0	14	0	0	14

Figure 40. Modelled theoretical status of the project related maintenance data management process related maintenance data check-list tasks.

Kysymykset 2/2 projektin kunnossapitosuunnittelijalle		Current state				rvittava tieto saatavi	
Ohjeistus	Aihe	Not started	In process	Completed	Not needed	Ei	Kyllä
307 Projek	**Kunnossapidon vaatimien tietojen päivitys**						
	Toimintopaikat, uuden toimintopaikan perustaminen tai nykyisen päivittäminen (IL01 & IL02)			x			x
	Kriittisyysluokittelun suorittaminen (IL02)		x				x
	Teknisen dokumentaation päivittäminen (CV02N)			x			x
	Uusien teknisten dokumenttien tallennus toimintopaikalle/laitteelle (CV01N & CV02N)			x			x
	Uuden laitteen perustaminen tai nykyisen päivittäminen (IE01 & IE02)			x			x
	Huoltosuunnitelmien luominen ja päivittäminen (IP18)			x			x
	Varaosien varastointitarpeiden läpikäynti		x				x
	Osaluettelon päivittäminen/luominen (IB11 & IB12, IB01 & IB02, CS01 & CS02)			x			x
	Takuutietojen määrittäminen toimintopaikalle/laitteelle (IL02, IE02)			x			x
	Vanhojen huoltosuunnitelmien poistaminen (IP18)			x			x
	Dokumenttien/dokumenttisidosten poistaminen poistuneiden laitteiden osalta (CV02N)			x			x
	Vanhojen osaluetteloiden poistaminen (IB12, IB02, CS02)			x			x
	Poistuvien nimikkeiden kartoitus ja romuttaminen (CS15)			x			x
	Vanhojen laitteiden ja toimintopaikkojen poistaminen (IE02 & IL02)			x			x
		0	2	12	0	0	14

Figure 41. Recorded actual status of the project related maintenance data management process related maintenance data check-list tasks.

Tilanne	Case 6					Ohjeistuksen mukainen tavoitetila			
Projekti päällikkö huomioinut ohjeistuksen mukaan kunnossapitosuunnittelun onnistumisen kannalta tärkeät asiat									
13	Considered		93 %	20 %		14	Considered	100 %	22 %
1	Not considered		7 %	2 %		0	Not considered	0 %	0 %
Kunnossapitosuunnittelun valmistelu toteutunut ohjeistuksen mukaisesti									
2	done		22 %	3 %		0	done	0 %	0 %
7	Delayed		78 %	11 %		9	Delayed	100 %	14 %
Projektin kunnossapitosuunnittelun tilanne									
0	Not started		0 %	0 %		0	Not started	0 %	0 %
2	In process		14 %	3 %		0	In process	0 %	0 %
12	Completed or Yes		86 %	18 %		13	Completed or Yes	93 %	20 %
0	Not needed		0 %	0 %		1	Not needed	7 %	2 %
Kunnossapitosuunnitteluun tarvittavat tiedot saatavilla									
14	Data available		100 %	22 %		14	Data available	100 %	22 %
0	Data missing		0 %	0 %		0	Data missing	0 %	0 %
Kunnossapitosuunnitteluun olemassa olevat työkalut käytetty									
1	Tools utilized		7 %	2 %		14	Tools utilized	100 %	22 %
13	Managed other way		93 %	20 %		0	Managed other way	0 %	0 %
65	matters in the assessment			100 %		65	matters in the assessment		100 %

Figure 42. Compilation of the actual status including the theoretical status of all the project maintenance data management process related tasks

Case 6									
Projektin päälikkö huomioinut kunnossapitosuunnittelun onnistumisen kannalta tärkeät asiat									
92,86 %	**tehtävistä huomioitu**								
Kunnossapitosuunnittelun valmistelu toeutunut ohjeistuksen mukaisesti									
77,78 %	**ohjeistuksen mukaisesti valmisteltu**								
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä mitä pitäisi hoitaa ei ole aloitettu									
0,00 %	**tehtävälistan tehtävisä aloittamatta**								
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä, mitä pitäisi hoitaa on vielä meneillään									
14,29 %	**tehtävälistan tehtävistä vielä meneillään, mitkä pitäisi olla jo suoritettu**								
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä, mitä pitäisi hoitaa on suoritettu/valmistunut									
85,71 %	**tehtävälistan suoritettavista tehtävistä suoritettu**								
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä, mitä pitäisi varmistaa ettei ole tarpeellisia projektin osalta on käyty läpi									
100,00 %	**tehtävälistan tehtävistä mitkä ei vaadi toimenpiteitä tarkastettu**								
Kunnossapitosuunnitteluun tarvittavat lähtötiedot saatavilla									
100,00 %	**tarvittavista lähtötiedoista saatavilla**								
Kunnossapitosuunnittelun toteutukseen käytetyt työkalut käytössä ohjeistuksen mukaan.									
7,14 %	**olemassa olevista työkaluista hyödynnetty kunnossapitosuunnittelussa**								

Table 6. Mill 3 case 6 results.

7. Mill 1 Cases (1 and 2) combined

Tilanne Mill 1					Ohjeistuksen mukainen tavoitetila			
Projekti päällikkö huomioinut ohjeistuksen mukaan kunnossapitosuunnittelun onnistumisen kannalta tärkeät asiat								
22	Considered	76 %	17 %		28	Considered	33 %	22 %
7	Not considered	24 %	5 %		0	Not considered	0 %	0 %
Kunnossapitosuunnittelun valmistelu toteutunut ohjeistuksen mukaisesti								
4	done	22 %	3 %		0	done	0 %	0 %
14	Delayed	78 %	11 %		18	Delayed	33 %	14 %
Projektin kunnossapitosuunnittelun tilanne								
0	Not started	0 %	0 %		0	Not started	0 %	0 %
4	In process	14 %	3 %		0	In process	0 %	0 %
14	Completed or Yes	50 %	11 %		18	Completed or Yes	21 %	14 %
10	Not needed	36 %	8 %		10	Not needed	12 %	8 %
Kunnossapitosuunnitteluun tarvittavat tiedot saatavilla								
25	Data available	89 %	19 %		28	Data available	33 %	22 %
3	Data missing	11 %	2 %		0	Data missing	0 %	0 %
Kunnossapitosuunnitteluun olemassa olevat työkalut käytetty								
2	Tools utilized	7 %	2 %		28	Tools utilized	33 %	22 %
26	Managed other way	93 %	20 %		0	Managed other way	0 %	0 %
131	matters in the assessment		100 %		130	matters in the assessment		100 %

Figure 43. Overall status of both mills 1 cases combined

Mill 1, Case 1 & 2
Projektin päällikkö huomioinut kunnossapitosuunnittelun onnistumisen kannalta tärkeät asiat
79 % tehtävistä huomioitu
Kunnossapitosuunnittelun valmistelu toeutunut ohjeistuksen mukaisesti
78 % ohjeistuksen mukaisesti valmisteltu
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä mitä pitäisi hoitaa ei ole aloitettu
0 % tehtävälistan tehtävisä aloittamatta
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä, mitä pitäisi hoitaa on vielä meneillään
14 % tehtävälistan tehtävistä vielä meneillään, mitkä pitäisi olla jo suoritettu
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä, mitä pitäisi hoitaa on suoritettu/valmistunut
78 % tehtävälistan suoritettavista tehtävistä suoritettu
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä, mitä pitäisi varmistaa ettei ole tarpeellisia projektin osalta on käyty läpi
100 % tehtävälistan tehtävistä mitkä ei vaadi toimenpiteitä tarkastettu
Kunnossapitosuunnitteluun tarvittavat lähtötiedot saatavilla
89 % tarvittavista lähtötiedoista saatavilla
Kunnossapitosuunnittelun toteutukseen käytetyt työkalut käytössä ohjeistuksen mukaan.
7 % olemassa olevista työkaluista hyödynnetty kunnossapitosuunnittelussa

Table 7. Mill 1 projects, case 1 & 2 results combined.

8. Mill 2 Cases (3 and 4) combined

Tilanne Mill 2					Ohjeistuksen mukainen tavoitetila			
Projekti päällikkö huomioinut ohjeistuksen mukaan kunnossapitosuunnittelun onnistumisen kannalta tärkeät asiat								
24	Considered	83 %	18 %		28	Considered	100 %	22 %
5	Not considered	17 %	4 %		0	Not considered	0 %	0 %
Kunnossapitosuunnittelun valmistelu toteutunut ohjeistuksen mukaisesti								
7	done	39 %	5 %		0	done	0 %	0 %
11	Delayed	61 %	8 %		18	Delayed	100 %	14 %
Projektin kunnossapitosuunnittelun tilanne								
3	Not started	11 %	2 %		0	Not started	0 %	0 %
14	In process	50 %	11 %		0	In process	0 %	0 %
8	Completed or Yes	29 %	6 %		26	Completed or Yes	93 %	20 %
3	Not needed	11 %	2 %		2	Not needed	7 %	2 %
Kunnossapitosuunnitteluun tarvittavat tiedot saatavilla								
17	Data available	61 %	13 %		28	Data available	100 %	22 %
11	Data missing	39 %	8 %		0	Data missing	0 %	0 %
Kunnossapitosuunnitteluun olemassa olevat työkalut käytetty								
0	Tools utilized	0 %	0 %		28	Tools utilized	100 %	22 %
28	Managed other way	100 %	21 %		0	Managed other way	0 %	0 %
131	matters in the assessment		100 %		130	matters in the assessment		100 %

Figure 44. Overall status of both mills 2 cases combined

Mill 2, Case 3 & 4
Projektin päällikkö huomioinut kunnossapitosuunnittelun onnistumisen kannalta tärkeät asiat
86 % tehtävistä huomioitu
Kunnossapitosuunnittelun valmistelu toeutunut ohjeistuksen mukaisesti
61 % ohjeistuksen mukaisesti valmisteltu
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä mitä pitäisi hoitaa ei ole aloitettu
11 % tehtävälistan tehtävisä aloittamatta
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä, mitä pitäisi hoitaa on vielä meneillään
50 % tehtävälistan tehtävistä vielä meneillään, mitkä pitäisi olla jo suoritettu
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä, mitä pitäisi hoitaa on suoritettu/valmistunut
33 % tehtävälistan suoritettavista tehtävistä suoritettu
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä, mitä pitäisi varmistaa ettei ole tarpeellisia projektin osalta on käyty läpi
100 % tehtävälistan tehtävistä mitkä ei vaadi toimenpiteitä tarkastettu
Kunnossapitosuunnitteluun tarvittavat lähtötiedot saatavilla
61 % tarvittavista lähtötiedoista saatavilla
Kunnossapitosuunnittelun toteutukseen käytetyt työkalut käytössä ohjeistuksen mukaan.
0 % olemassa olevista työkaluista hyödynnetty kunnossapitosuunnittelussa

Table 8. Mill 2 projects, case 3 & 4 results combined.

9. Mill 3 Cases (5 and 6) combined

Tilanne Mill 3					Ohjeistuksen mukainen tavoitetila			
Projekti päällikkö huomioinut ohjeistuksen mukaan kunnossapitosuunnittelun onnistumisen kannalta tärkeät asiat								
26	Considered	93 %	20 %		28	Considered	100 %	22 %
2	Not considered	7 %	2 %		0	Not considered	0 %	0 %
Kunnossapitosuunnittelun valmistelu toteutunut ohjeistuksen mukaisesti								
4	done	22 %	3 %		0	done	0 %	0 %
14	Delayed	78 %	11 %		18	Delayed	100 %	14 %
Projektin kunnossapitosuunnittelun tilanne								
1	Not started	4 %	1 %		0	Not started	0 %	0 %
3	In process	11 %	2 %		14	In process	50 %	11 %
19	Completed or Yes	68 %	15 %		13	Completed or Yes	46 %	10 %
5	Not needed	18 %	4 %		1	Not needed	4 %	1 %
Kunnossapitosuunnitteluun tarvittavat tiedot saatavilla								
28	Data available	100 %	22 %		28	Data available	100 %	22 %
0	Data missing	0 %	0 %		0	Data missing	0 %	0 %
Kunnossapitosuunnitteluun olemassa olevat työkalut käytetty								
2	Tools utilized	7 %	2 %		28	Tools utilized	100 %	22 %
26	Managed other way	93 %	20 %		0	Managed other way	0 %	0 %
130	matters in the assessment		100 %		130	matters in the assessment		100 %

Figure 45. Overall status of both mills 3 cases combined.

Mill 3, Case 5 & 6
Projektin päällikkö huomioinut kunnossapitosuunnittelun onnistumisen kannalta tärkeät asiat
93 % tehtävistä huomioitu
Kunnossapitosuunnittelun valmistelu toeutunut ohjeistuksen mukaisesti
78 % ohjeistuksen mukaisesti valmisteltu
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä mitä pitäisi hoitaa ei ole aloitettu
4 % tehtävälistan tehtävisä aloittamatta
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä, mitä pitäisi hoitaa on vielä meneillään
7 % tehtävälistan tehtävistä vielä meneillään, mitkä pitäisi olla jo suoritettu (tehtäviäsuoritettu etukäteen)
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä, mitä pitäisi hoitaa on suoritettu/valmistunut
93 % tehtävälistan suoritettavista tehtävistä suoritettu ja 78% meneillään olevista tehtävistä suoritettu etukäteen
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä, mitä pitäisi varmistaa ettei ole tarpeellisia projektin osalta on käyty läpi
100 % tehtävälistan tehtävistä mitkä ei vaadi toimenpiteitä tarkastettu
Kunnossapitosuunnitteluun tarvittavat lähtötiedot saatavilla
100 % tarvittavista lähtötiedoista saatavilla
Kunnossapitosuunnittelun toteutukseen käytetyt työkalut käytössä ohjeistuksen mukaan.
7 % olemassa olevista työkaluista hyödynnetty kunnossapitosuunnittelussa

Table 9. Mill 3 projects, case 5 & 6 results combined.

10. All cases combined and summarized

Tilanne Kaikki					Ohjeistuksen mukainen tavoitetila			
Projekti päällikkö huomioinut ohjeistuksen mukaan kunnossapitosuunnittelun onnistumisen kannalta tärkeät asiat								
72	Considered	84 %	18 %		84	Considered	100 %	22 %
14	Not considered	16 %	4 %		0	Not considered	0 %	0 %
Kunnossapitosuunnittelun valmistelu toteutunut ohjeistuksen mukaisesti								
15	done	28 %	4 %		0	done	0 %	0 %
39	Delayed	72 %	10 %		54	Delayed	100 %	14 %
Projektin kunnossapitosuunnittelun tilanne								
4	Not started	5 %	1 %		0	Not started	0 %	0 %
21	In process	25 %	5 %		14	In process	17 %	4 %
41	Completed or Yes	49 %	10 %		57	Completed or Yes	68 %	15 %
18	Not needed	21 %	5 %		13	Not needed	15 %	3 %
Kunnossapitosuunnitteluun tarvittavat tiedot saatavilla								
70	Data available	83 %	18 %		84	Data available	100 %	22 %
14	Data missing	17 %	4 %		0	Data missing	0 %	0 %
Kunnossapitosuunnitteluun olemassa olevat työkalut käytetty								
4	Tools utilized	5 %	1 %		84	Tools utilized	100 %	22 %
80	Managed other way	95 %	20 %		0	Managed other way	0 %	0 %
392	matters in the assessment		100 %		390	matters in the assessment		100 %

Figure 46. Overall status of all mill and cases combined.

Mill 1, Case 1 & 2
Projektin päällikkö huomioinut kunnossapitosuunnittelun onnistumisen kannalta tärkeät asiat
86 % **tehtävistä huomioitu**
Kunnossapitosuunnittelun valmistelu toeutunut ohjeistuksen mukaisesti
72 % **ohjeistuksen mukaisesti valmisteltu**
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä mitä pitäisi hoitaa ei ole aloitettu
5 % **tehtävälistan tehtävisä aloittamatta**
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä, mitä pitäisi hoitaa on vielä meneillään
24 % **tehtävälistan tehtävistä vielä meneillään, mitkä pitäisi olla jo suoritettu**
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä, mitä pitäisi hoitaa on suoritettu/valmistunut
68 % **tehtävälistan suoritettavista tehtävistä suoritettu**
Kunnossapitosuunnittelun tehtävälistan mukaisista tehtävistä, mitä pitäisi varmistaa ettei ole tarpeellisia projektin osalta on käyty läpi
100 % **tehtävälistan tehtävistä mitkä ei vaadi toimenpiteitä tarkastettu**
Kunnossapitosuunnitteluun tarvittavat lähtötiedot saatavilla
83 % **tarvittavista lähtötiedoista saatavilla**
Kunnossapitosuunnittelun toteutukseen käytetyt työkalut käytössä ohjeistuksen mukaan.
5 % **olemassa olevista työkaluista hyödynnetty kunnossapitosuunnittelussa**

Table 10. All mills' projects, case 1-6 results combined.

11. Utilization of supportive tools

Only criticality classification tool was utilized in all the Case projects. Other supportive tools such as SAP document mass uploading, Winshuttle, S9 technical documentation was not utilized and commonly seen easier way to manage all the needed data manually from the manuals when still this way of working is considered very time consuming.

			Case 1		Case 2		Case 3		Case 4		Case 5		Case 6	
Kysymykset 2/2 projektin kunnossapitosuunnittelijalle			Työkalut käytössä		Työkalut käytössä		Työkalut käytössä		Työkalut käytössä		Työkalut käytössä		Työkalut käytössä	
Ohjeistus	Aihe		Ei	Kyllä	Ei	Kyllä	Ei	Kyllä	Ei	Kyllä	Ei	Kyllä	Ei	Kyllä
307 Proje	Kunnossapidon vaatimien tietojen päivitys													
	Toimintopaikat, uuden toimintopaikan perustaminen tai nykyisen päivittäminen (IL01 & IL		x		x		x		x		x		x	
	Kriittisyysluokittelun suorittaminen (IL02)			x		x	x		x			x		x
	Teknisen dokumentaation päivittäminen (CV02N)		x		x		x		x		x		x	
	Uusien teknisten dokumenttien tallennus toimintopaikalle/laitteelle (CV01N & CV02N)		x		x		x		x		x		x	
	Uuden laitteen perustaminen tai nykyisen päivittäminen (IE01 & IE02)		x		x		x		x		x		x	
	Huoltosuunnitelmien luominen ja päivittäminen (IP18)		x		x		x		x		x		x	
	Varaosien varastointitarpeiden läpikäynti		x		x		x		x		x		x	
	Osaluettelon päivittäminen/luominen (IB11 & IB12, IB01 & IB02, CS01 & CS02)		x		x		x		x		x		x	
	Takuutietojen määrittäminen toimintopaikalle/laitteelle (IL02, IE02)		x		x		x		x		x		x	
	Vanhojen huoltosuunnitelmien poistaminen (IP18)		x		x		x		x		x		x	
	Dokumenttien/dokumenttisidosten poistaminen poistuneiden laitteiden osalta (CV02N)		x		x		x		x		x		x	
	Vanhojen osaluetteloiden poistaminen (IB12, IB02, CS02)		x		x		x		x		x		x	
	Poistuvien nimikkeiden kartoitus ja romuttaminen (CS15)		x		x		x		x		x		x	
	Vanhojen laitteiden ja toimintopaikkojen poistaminen (IE02 & IL02)		x		x		x		x		x		x	
			13	1	13	1	14	0	14	0	13	1	13	1

tom functional location criticality classification

Figure 47. maintenance data management process supportive tools utilization

Appendix 6. Interview questions form for steering the interviews

Background: The objective of the thesis is to find new information, that can be utilized to develop the data management in projects with available software, tools, and processes. Title of the thesis is "Maintenance planning process and tools development in projects: case reviews in ongoing and finished projects related to mechanical renewals". Questions are related to maintenance data management process, supportive tools (software, contract appendixes utilized for maintenance data requesting from suppliers) available in UPM.

Common questions:

1. Name, title, experience within maintenance generally and maintenance planning in projects?
2. Earlier project experience in UPM. What was the latest project you participated in and are you participating currently in any ongoing projects, where you have a role in maintenance planning?
3. How did the earlier or current ongoing project maintenance planning and implementation process succeed or how is it succeeding in common?
    a. What succeeded/succeeds well?
    b. What could have been/shall be done better?
4. How was/is the co-operation between project different stakeholders during the project (stakeholders: project management, engineering (multiple disciplines), operative organization, etc)?
    a. What succeeded/succeeds well?
    b. What could have been/shall be done better?

Questions related to management of maintenance planning tasks in a project by maintenance engineer.

1. when investment decision is made, how fast are you usually introduced to the project technical scope and the time schedule of the project? Have you made a time schedule for maintenance planning?
2. Tell me about project phase management related to maintenance planning?
    a. Were there any meetings arranged related to maintenance planning?
    b. What was handled during the meetings?
    c. Who was participating in the meetings?

    d. What was handled in the first meeting?
    e. what was handled in the last meeting?
3. How was the maintenance data receiving from suppliers arranged/managed?
    a. Was there arranged any supplier specific meetings related to maintenance planning?
    b. Was the data delivered by email or uploaded to a project document management system?
4. Have you faced any issues in projects related to maintenance engineering? If you have, what kind?
5. Are the company's project work practices uniform and clear in the project? how could be improved?
6. Are the company project maintenance planning and data management practices clear? how could be improved?
7. Are you familiar with M-Files, project document management system? Have you faced any issues using M-Files? if you have, what kind?

Questions related to UPM maintenance data management in projects.

1. How is functional location procedure going? Have you faced any issues related to creation/management of these?
    a. needed information available?
    b. related tools in use?
    c. challenges?
    d. opportunities for improvement?
2. How is the criticality classification procedure going? Have you faced any issues related to creation/management of this?
    a. needed information available?
    b. related tools in use?
    c. challenges?
    d. opportunities for improvement?
3. How is the technical documentation uploading to SAP procedure going? Have you faced any issues related to creation/management of these?
    a. needed information available?
    b. related tools in use?
    c. challenges?

    d. opportunities for improvement?
4. How is the Creation or modification of equipment positions procedure going? Have you faced any issues related to creation/management of these?
    a. needed information available?
    b. related tools in use?
    c. challenges?
    d. opportunities for improvement?
5. How is the creation or modification of maintenance planning procedure going? Have you faced any issues related to creation/management of these?
    a. needed information available?
    b. related tools in use?
    c. challenges?
    d. opportunities for improvement?
6. How is the determination of needed spare parts procedure going? Have you faced any issues related to creation/management of this?
    a. needed information available?
    b. related tools in use?
    c. challenges?
    d. opportunities for improvement?
7. How is the creation or modification of bill of material lists procedure going? Have you faced any issues related to creation/management these?
    a. needed information available?
    b. related tools in use?
    c. challenges?
    d. opportunities for improvement?
8. How is the adding of warranty period for new equipment procedure going? Have you faced any issues related to creation/management of these?
    a. needed information available?
    b. related tools in use?
    c. challenges?
    d. opportunities for improvement?
9. How is the deletion of old maintenance plans procedure going? Have you faced any issues related to management of these?

   a. needed information available?
   b. related tools in use?
   c. challenges?
   d. opportunities for improvement?

10. How is the deletion of documentation procedure going? Have you faced any issues related to management of these?
    a. needed information available?
    b. related tools in use?
    c. challenges?
    d. opportunities for improvement?
11. How is the deletion of old bill of materials procedure going? Have you faced any issues related to management of these?
    a. needed information available?
    b. related tools in use?
    c. challenges?
    d. opportunities for improvement?
12. How is the deletion of old spare parts and related master data procedure going? Have you faced any issues related to management of these?
    a. needed information available?
    b. related tools in use?
    c. challenges?
    d. opportunities for improvement?
13. How is the deletion of old equipment positions and functional locations procedure going? Have you faced any issues related to management of these?
    a. needed information available?
    b. related tools in use?
    c. challenges?
    d. opportunities for improvement