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Global Rebuild Standard Instructions and Work Sequences

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Has been interesting and educational time with my Industrial Management studies since September 2020. At first, I would like to thank my Thesis instructor Dr. Thomas Rohweder for his strong professional guidance and knowledge during my writings and studies. Also, a great thanks to M.A. Sonja Holappa for her guidance with my professional language and Dr. Juha Haimala and Dr. James Collins for excellent lectures and continuous support.

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<p>The outcome of this Thesis is to recommend the rebuild work sequence process map and the rebuild work instructions within it for the Case Company's global rebuild business. The rebuild concept provides the life extension for the underground mining equipment, which are in the end of the expected lifetime, to restore the machine's condition near to its original level in terms of performance, availability, and productivity. As the rebuild business offering is fairly new concept for the Case Company, and the implementations of the proper work instructions did not follow the same path with the global demands, it is recommended to standardize the rebuild processes globally by the standard rebuild work sequences and the rebuild work instructions at this stage already.</p> <p>The research approach of this Thesis was a design research and includes the four stages where the first stage is a current state analysis, which provides the strengths and weaknesses of the current process and the second stage, the literature review, combines the findings and insights from the selected literatures for the first stage findings and provides a conceptual framework. The third stage recommends the initial rebuild work sequence process map and the rebuild work instructions and the fourth, the validation stage includes the final recommendations for the rebuild work sequence process map and the rebuild work instructions.</p> <p>The outcome of this Thesis is the final recommendations for the rebuild work sequence process map and the rebuild work instruction examples within it. Standard way of working in the rebuild project improves the safety, quality, lead-time and the customer satisfaction.</p>	
Keywords	Standard rebuild work sequence process map and rebuild work instructions

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Acronyms

NPD	New Product Development.
OEM	Original Equipment Manufacturer.
SOP	Standard Operation Procedures.
GANTT	Project Schedule Chart.
SMPS	Standard Work Manual, Case Company.
BPH	Business Process Harmonization.
PDCA	Plan-Do-Check-Act, Case Company.
5W+1H	Who-What-When-Where-Why-How, Case Company.
WCM	World Class Manufacturing.
Pull&Pack	Modified Original Engineering Drawings, Case Company.
Toolman	Machine Manuals, case Company.
BOM	Bill of Material.
SWIP	Standard Work in Progress.

1 Introduction

Work instructions are a vital part of the manufacturing processes for better safety, quality and production efficiency. A value of the high-quality work instructions is underlined especially when the company outsources their production, or part of it, and when the ramp up processes need to be seamless in the new location with new employees.

The standardized work sequences and the work instructions provides good solutions for multiple production processes and the standard model is flexible for continuous improvements and modifications according to the production needs.

According to Pereira (2013), standard work is defined as a set of work procedures establishing the best methods and sequences for each process and each work. Like all the Lean production methods, standard work aims to minimize waste while maximizing performance in the workload and operation of each worker. It is a tool used in cellular manufacturing and pull production in order to keep the pace of production lined up with the flow of customer orders, and in such a way that the operators can easily change positions within the process (Pereira et al. 2016).

Johansson (2013) states that the standardized work contains a different way of thinking which motivates the entire organization to work more efficient and deliver a higher quality at lower cost (Johansson et al. 2013).

1.1 Business Context of the Case Company

The case company is a high-tech and global engineering group offering products and services that enhance customer productivity, profitability and sustainability. The case company holds world-leading positions in selected areas – tools and tooling systems for metal cutting; equipment and tools, service and technical solutions for the mining industry and rock excavation within the construction industry; products in advanced stainless steels and special alloys as well as products for industrial heating. In 2019, the case company had approximately 40,000 employees and revenues of about SEK 100 billion and it has operations in more than 160 countries.

The case company's organizational way of working is to be decentralized and entrepreneurial to ensure value for shareholders and customers. The case company consists of five independent business areas (machining solutions, mining and rock technology, material technology, other functions, group functions) and divisions with separate missions, targets and strategic priorities. The divisions are the highest operational units being fully responsible for their performance, i.e. profit and loss.

Parts and Service division is one of the nine divisions of the Mining and Rock Technology business area which is a global leading supplier of equipment and tools, service and technical solutions for the mining and construction industries. Application areas include rock drilling, rock cutting, crushing and screening, loading and hauling, tunneling, quarrying and breaking and demolition. In 2019, sales were approximately 45 billion SEK with about 14,000 employees within continuing operations.

The Parts and Service division has 56 workshops globally and this thesis focuses on their underground mining machine rebuild process development (Intranet, Case Company 2020).

1.2 Business Challenge, Objective and Outcome

Rebuild business is quite a new business concept in the Parts and Service division business area which the case company offers to its customers nowadays. Rebuild is a major intervention in the middle life of the equipment, in order to restore the machine near to its original condition in regards to performance, availability and productivity.

Customer demands for the mining machine rebuilds have been increasing rapidly in recent years and relevant instructions or other engineering documents are not at the level which meets the demands and many important documents are not even available.

The case company has plenty of instructions on how to build up the machine, from the beginning till the end, as it is the original machine manufacturer, but does not have any specific instructions available on how to dismantle the same machines in a proper way in separate sequences as there were not any specific needs for this kind of material earlier.

The case company has experience from the machine rebuilds in the past but basically these were conducted as a normal machine repair concept and following more the customer's requests and/or needs.

Basically, all earlier rebuild projects have been managed using limited and/or poor instructions and therefore the involvement of skilled and well experienced technicians has been more than important. Unavailability of the proper rebuild is not very professional and does not meet today's requirements and demands in areas of safety, quality, manpower and economy. Also, the unavailability of instructions generates an extra workload to the main factory resources and especially to the service operation division's technical support department.

Nowadays many customers are interested to extend the lifetime of their mining machine fleet and expectations are high as the case company provides very similar warranty period and competitive extended lifetime for the machines which are rebuilt by the skilled employees of the case company.

However, many smaller companies, like local engineering workshops, are interested to take over the rebuild businesses in many countries and support the same customers with good skills and experience of similar engineering field. It is recommended to take all necessary actions to keep the global rebuild business under the case company's offering umbrella for better rebuild business quality and continuous customer aftermarket support.

Accordingly, the objective of this study is to create a proposal for the instructions and work sequences for the rebuilds of the underground mining machines (LOHA, loading and hauling) and the outcome of this study is the final proposal for the global rebuild process and work sequence instructions for improved efficiency, productivity, quality and safety of the rebuild projects in the case company.

1.3 Thesis Outline

This Thesis includes the Case Company's loading and hauling rebuild business area only and does not include the final implementations or other related development areas as the timeframe is limited and the full scope of the rebuild work sequences and the rebuild work instruction standardization, with all necessary implementations, is vast.

However, the main outcome of this Thesis is the rebuild standard work sequence process map and the rebuild work instructions within it and recommend the same outcome with necessary implementations to the Case Company

This Thesis includes interviews from the case company's workshop managers and engineers who are especially selected as data sources due to their specific experience from the mining machine rebuild area. However, valuable data needs to be collected from the workshops also who might have lower experience from the same or not even any rebuild experience at all as it is important to collect all possible ideas and thoughts from the stakeholders who have a fairly good understanding what the final instructions of rebuilds should be and what their needs might be as the end users of the final material.

This Thesis contains 7 sections starting with the Introduction. Section 2 describes the project plan, explaining in detail the research design and methods as well as the data collection plan created in order to carry out the study and ensure the best possible outcome. Section 3 describes the analyses of the current rebuild instructions and practices with the summaries of the findings. Section 4 describes the improvement ideas collected from relevant literature and best practice and outlines the conceptual framework of the Thesis. Section 5 describes the initial proposals for the standard rebuild work sequence process map and the rebuild work instructions. Section 6 describes the pilot results from the initial rebuild material and the final proposal for the global rebuild materials. Finally, section 7 describes the final conclusions and evaluation of the Thesis.

2 Project Plan

This section describes the research approach, data collection and analysis methods used in this study. It includes a research design which shows the different stages and the logic of this study. This section includes four sub-sections.

2.1 Research Approach

The object of this Thesis is to create a proposal for the standard instructions and work sequences into the case company's real-life rebuild business environment. The selected research method in this Thesis is a Design Research and use of existing documentation, information and qualitative and quantitative data collections where all details are analyzed and described. Hence, Design Research, with both data collections methods, is the relevant research method for this Thesis.

According to Kananen (2013), With the help of design research some problem is eliminated, or something is developed for the better. Although starting something always adheres to the assumption for improvement (Kananen 2013).

Kananen (2013) states that the design research does not aim to generalize and neither do so action, case and qualitative research. The research result is a change from the past that concerns only the phenomenon that was the objective of the research. The implementation of the change process can be transferred into a corresponding context but not the result as such because the result requires a change process. the result can be utilized also elsewhere by taking into account the actions and context required by the change. As a generalization: lets us not make the same mistakes. The results of development may, for example, including the following: product - A new product concept has been developed and process - the throughput of the product/process has been improved and the job satisfaction in the workplace has been enhanced successfully (Kananen 2013).

According to Kananen (2013), written material such as minutes, memoranda, reports, biographies, articles and all documented information can be used as research material in support of theme interview material and quantitative material. This applies in qualitative research in particular where research may be based on existing written material and interpretations made on that (so-called contents analysis). For example, research of history is based entirely on written material that has been produced in the times past (Kananen 2013).

Kananen (2013) states that for research based on materials a researcher must take choices between different materials. Supplies of materials associated with design research are often lacking and researcher must be satisfied with what he/she has succeeded in finding and getting. The confidentiality of the materials will also provide its own restrictions, especially if the required materials are associated with businesses (Kananen 2013).

According to Kananen (2013), design research is very close to the concept “action research”. The differences between them are very fine. Instead of using the concept “Design Research”, we could also use “Design-Based Research”. Action research is often associated with development of teaching, training and people. Typical for all of these concepts is that there is a development cycle and a change (Kananen 2013).

The final objective of this Thesis is to present the new proposal of the rebuild work sequence process map and the work instructions within it for the Case Company’s workshops globally. One vital part of this research is to deep analyze qualitative data collections from all the selected workshops. The Collected data might vary due to cultural aspects and therefore the original questionnaires and other data collections need to be kept clear and simple.

2.2 Research Design

This section introduces the research design of Thesis with the outcome of the final proposal for the rebuild work sequence process map and the rebuild work instruction standardization. The research design is illustrated in Figure 1 below with outcomes of the four main stages with an idea to progress horizontally from one phase to the next.

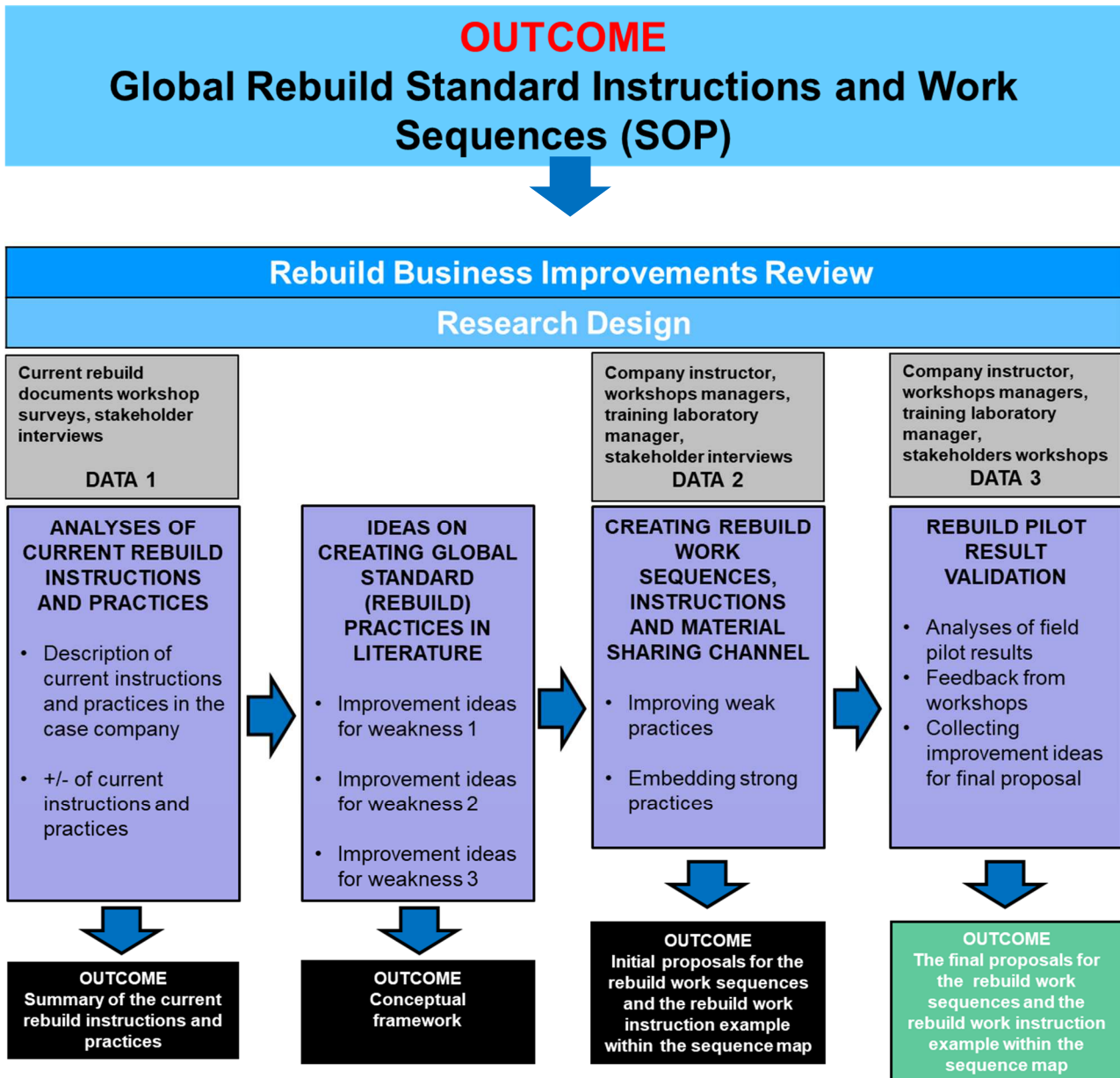


Figure 1. Research Design of the Thesis.

As described in Figure 1, the research design is designed to reach the final outcome for a proposal of the standard model of the rebuild work sequences and the rebuild work instructions for the Case Company’s global workshops and rebuild projects.

This Thesis includes four stages where the first stage is the current stage analysis (CSA), a data collection (Data 1) with the outcome of the strengths and weaknesses of the current rebuild instructions and practices. The second stage includes the collections of the insights and ideas from the relevant literature with the outcome of the conceptual framework (CFW). The third stage (Data 2) includes the initial proposal for the global rebuild instructions and work sequences. The fourth and final stage focuses on the validation of the final proposal for the global rebuild instructions and work sequences.

The first stage data collection (Data 1) was conducted with the specific field level questionnaires for qualitative and quantitative data results. Also, the first stage data collection includes the analyses of all available rebuild instructions, documentations and common knowledge of the current rebuild practices which were collected for deeper analyses. The outcome results are separated to strengths and weaknesses along with descriptions and additional comments by the researcher.

The target stakeholders (workshops) were selected for the first data collection (Data 1) by earlier rebuild projects and technical experiences, planned rebuild projects and capabilities for the future's field pilots with the new rebuild instructions and work sequences. Also, the selected workshops were capable to make valuable proposals and feedback for all possible improvements of the pilot documentations during the whole pilot projects.

The first data were collected from the selected stakeholders via emails, phone conversations and Teams meeting.

The second stage is focused on collecting all necessary information, improvement ideas and best practices from the industrial and related literatures and outcome is the conceptual framework for dealing with the selected weaknesses in the case company's rebuild projects.

The third stage (Data 2) includes the next level interviews and feedback collections from the selected stakeholders, rebuild pilot project/-s and improvements to the weak practices and embedding the strong practices. The questionnaires for the next level interviews have been collected along with the results of the first and second stages. Outcome of the third stage is the initial proposals for the rebuild work sequences and the rebuild instructions.

Fourth and the final stage includes the final data collecting (Data 3) and analyses from the rebuild field pilot project/-s and workshop feedback with all improvement ideas for the final proposal of the standard instructions and work sequences for the global rebuilds.

2.3 Data Collection and Analysis

This Thesis includes three separate data collection rounds in three different workshop and with wide group of the stakeholders.

It is important to collect all necessary data from the same selected workshops and stakeholders for the qualitative data and the best end results at this stage when the preliminary proposal of the rebuild instructions and work sequences is under development process. Also, the selected workshops have flexibilities and capabilities to provide a vital developmental feedback and proposals for possible further improvements in the rebuild standardization project.

Another important and practical reason behind the selected workshops is the current rebuild business plan for the upcoming customer rebuild projects from where the necessary improvement data will be generated in the real-life actions.

As seen in Figure 1, the Data was collected in three rounds for this Thesis project. The first round (Data 1) was conducted for the current state analysis of the rebuild instructions and practices with the selected case company's global workshops. The first data collection was conducted in Teams meetings and emails. The outcome of the first data collection is the summary of the current rebuild instructions, and relative materials, and practices how the rebuild projects have been managed earlier. The summary is divided into positive and negative outcomes.

Table 1. Details of interviews in Data 1 collection.

	Participants / role	Data type	Topic, description	Date, length	Documented as
Data 1 - ANALYSES OF CURRENT REBUILD INSTRUCTIONS AND PRACTICES					
1	Respondent 1: Australia (Perth) Workshop Manager	Workshop Survey Excel file	Description of current rebuild instructions and practices +/- of current instructions and practices	January 2021	Rebuild data 1 collecting.xlsx
2	Respondent 2: Chile Workshop Supervisor	Workshop Survey Excel file	Description of current rebuild instructions and practices +/- of current instructions and practices	January 2021	Rebuild data 1 collecting.xlsx
3	Respondent 3: South Africa Sales Support Man- ager Rebuild workshop Manager SKR Champion Cluster Manager Process Lead Engi- neer	Workshop Survey Excel file Online Teams Meeting	Description of current rebuild instructions and practices +/- of current instructions and practices	January 2021 70min	Rebuild data 1 collecting.xlsx
4	Respondent 4: Finland Training Laboratory Manager	Workshop Survey Excel file	Description of current rebuild instructions and practices +/- of current instructions and practices	January 2021	Rebuild data 1 collecting.xlsx
5	Respondent 5: Mexico Workshop Manag- ers and Process Engineer	Online Teams Meeting	Description of current rebuild instructions and practices +/- of current instructions and practices	January 2021 90min	Rebuild data 1 collecting.xlsx
6	Respondent 6: Canada Rebuild workshop Manager	Online Teams Meeting	Description of current rebuild instructions and practices +/- of current instructions and practices	January 2021	Rebuild data 1 collecting.xlsx
7	Respondent 7: Australia, Finland Portfolio Managers	Online Teams Meeting	Clarifications for the SOP re- quirements of the rebuild pro- jects	January 2021 30 min	Meeting minutes
8	Respondent 8: Mongolia Workshop Project Planner	Workshop Survey Excel File	Description of current rebuild instructions and practices +/- of current instructions and practices	February 2021	Rebuild data 1 collecting.xlsx

As seen in Table 1, the first data collection (Data 1) includes the key stakeholder's surveys, interviews, and review of existing rebuild material and practices for better understanding what does the current status of the Case Company's rebuild operations globally.

The second data collecting round (Data 2) includes the results of the Current State Analyses (CSA) of the first data collection round (Data 1), stakeholders' inputs and the outcome of the Conceptual Framework (CFW) from the relevant literatures.

An original plan was to arrange the rebuild pilot project with initial rebuild work instructions and the rebuild work sequence map in one of the case company's global workshop and participate closely with a purpose of an immediate data collections and corrections as well as a possible pilot project modifications and overall pilot project management from the beginning till the end. However, due to the global Covid-19 pandemic situation, valid rebuild project availability and the travel restrictions it was impossible coordinate any international travels or rebuild pilot project in the Case Company's workshop surroundings. Thus, the original pilot plan was re-planned, it was decided to pilot the initial rebuild material via online systems.

Table 2. Details of Data 2 collections.

	Participants / role	Data type	Topic, description	Date, length	Documented as
Data 2 - CREATING STANDARD INSTRUCTIONS AND WORK SEQUENCES					
1	Training Laboratory Manager Finland	Teams meetings Emails, Phone conversations	Rebuild work sequence and rebuild instruction (SOP) requirements	Weekly meetings From September 2020 till March 2021	Meeting minutes
2	Global Workshop Operations Stakeholders inputs	Teams meetings Emails, Phone conversations	Rebuild work sequence and rebuild instruction (SOP) requirements	Monthly meetings February, March 2021	Recordings Meeting minutes
3	Current State Analyses (Data 1) Outcome	Teams Meetings Questionnaires	Description of current rebuild instructions and practices +/- of current instructions and practices	January 2021	Rebuild data 1 collecting.xlsx Meeting minutes
4	CFW Outcomes	Literature Review	Literature review for the rebuild operation development	January, February, March 2021	Section 4

The third data collecting round (Data 3) was conducted by the same way as the data collecting round two (Data 2). The main purpose of the third data collecting round was to collect all valuable feedback results from the pilot rebuild project, with necessary evaluations and validations, for the final proposal of the global standard rebuild instructions and work sequences.

Table 3. Details of Data 3 collections.

	Participants / role	Data type	Topic, description	Date, length	Documented as
Data 3 - REBUILD PILOT RESULT VALIDATION					
1	Pilot project outcome	Teams meetings Emails, Phone conversations	Rebuild work sequence and rebuild instruction (SOP) requirements	Monthly meetings	Meeting minutes
2	Global Workshop Operations Stakeholders inputs	Teams meetings Emails, Phone conversations	Rebuild work sequence and rebuild instruction (SOP) requirements	Monthly meetings	Meeting minutes
3	Training Laboratory Manager Finland	Teams meetings Emails, Phone conversations	Rebuild work sequence and rebuild instruction (SOP) requirements	Weekly meetings, from April till May 2021	Meeting minutes
4	VP, parts and service department	Emails, Phone conversations	Rebuild work sequence and rebuild instruction (SOP) requirements	Monthly meetings	Meeting minutes,

2.4 Data Collection Materials

A list of the Case Company's relevant internal documents are listed in table 5 below that are used in the data collection rounds (Data1, 2 and 3) for the best possible outcome of the final proposal for the global rebuild standard instructions and work sequences.

Table 4. Internal documents used in the current state analysis (CSA).

	Name of the document	Number of pages/other content	Description
1	Modified Original Equipment Manufacturer (OEM) drawings	20 – 60 Pages/ Machine	Pull&Pack drawings, PDF format
2	GANTT chart	1 Diagram/ Machine	Machine specific GANTT project chart, MPP format
3	Original machine type manuals	4210 Pages/ Machine	Machine specific Toolman manual, PDF format, hard copy
4	Original machine type manuals with updated rebuild information	4210 Pages/ Machine	Machine specific Toolman manuals with updated sections, PDF format, hard copy

5	Current rebuild standard operation procedures (SOP)	17 Pages/ Machine	Machine specific rebuild SOPs, xls format
6	Original Equipment Manufacturer (OEM) assembly drawing	450 Pages/ Machine	Original OEM's assembly drawings, PDF format, engineering format
7	Original Equipment Manufacturer (OEM) standard operation procedures instructions (SOP)	900 Pages/ Machine	Machine specific assembly instructions, PPT format
8	Original Equipment Manufacturer (OEM) 3D models	300-500MB	Machine specific assembly instructions, JT 3D format
9	The Case Company's Standard Work Manual (SMPS 2016)	24 Pages	Manual for internal instructions and standardization

The listed material (Table 5) above includes the current rebuild instructions as well as other similar relevant materials which are implemented for the Case Company's manufacturing purposes in the past. It was important to take the manufacturing material under investigation to get wider view and understanding for the depth of available manufacturing materials and opportunities to use these materials for the rebuild business purposes.

Descriptions for the listed rebuild documents, from 1 to 5, are available in section 3.3 (Description of Current Rebuild Material) and the documents of 6, 7 and 8, Original Equipment Manufacturer's assembly drawings, Original Manufacturer's Assembly instructions (SOPs) and Original Equipment Manufacturer's 3D models, are described in further, section 2.4.

The original equipment manufacturer's assembly drawings (Document 6) include all necessary detailed drawings for the machine assembly processes that are used in the Case Company's assembly factories. Basically, these are the main documents to build up the new machine in the assembly lines. However, these documents rarely include any actual assembly instructions as the purpose is to illustrate the components/parts and provide necessary part list with the part numbers only. Some component manufacturing drawings might be included into these Blueprint documents also which protect this particular material as for internal factory use only.

The original manufacturer's standard operation procedures (Document 7) are created and implemented as the supporting assembly instructions for the Case Company's production assembly lines. These documents include the well-illustrated assembly instructions with the assembly work sequences from the beginning till the end. An original purpose of these assembly instructions was to provide detailed assembly instructions and work sequences which are not available in the original equipment assembly drawings (Blueprint). However, this material is available in the Finnish language only and has not been updated at times as the material is not actively used in the case company's product lines.

The original equipment manufacturer 3D models (Document 8) are the high-level design materials of the products which are produced by the Case Company's design engineering department with their design software. This particular material is highly protected along with the material 6 as the Case Company's Blueprint category materials. Thus, these two materials (Document 6 and 8) are for Case Company's internal manufacturing use only.

The Case Company has created a work manual for its internal instructions and standardization. The Case Company's Standard Work Manual (SMPS 2016) provides valuable information for the final outcome of this Thesis and particularly, how to create the final proposal of standard instructions and work sequences for the Case Company's internal usage.

3 Analyses of Current Rebuild Instructions and Practices in the Case Company

This section includes the current state analysis (CSA) of the rebuild instructions and practices and describes the strengths and weaknesses from both. This section includes fifteen sub-sections.

3.1 Overview of the Current State Analysis Stage

The first data collection was implemented by investigating the existing material of the rebuilds which were created by the case company in the past. Basically, available material is limited as an informational point of view and some of the materials have not been updated or even never completed.

The second data collection was implemented by Excel questionnaires sheet via email which was sent to all selected stakeholders. The main idea of the questionnaires was to keep the questions as simple and clear as possible for better outcome of the data collection, which also provides an easier way of the final data combining and analyzing, and also, keeps the stakeholder's focus in the area of the main topic.

The third data collection was based on the initial proposal of the rebuild material and it was conducted by online meetings with the selected stakeholders for clarifying the importance of their valuable feedback. However, some of the stakeholders were not able to provide their written feedback by emailing a completed Excel questionnaire sheets and necessary feedback was collected during the online meetings.

However, the timing of the data collection was correct with some stakeholders as they had completed their recent rebuild project or were planning to start another one within a few weeks. These are suitable stages for the qualitative feedback from the real-life actions.

During the data collection project was decided to start the Global Workshop Process Improvement meetings monthly which improves the case company's internal communication and provides the global platform for the workshop stakeholders where they are able to share their experiences, observations and other vital information regarding the issues of rebuild businesses and workshops.

The case company's monthly meetings with the global stakeholders provide valuable and the latest information particularly from the workshop managers' perspective as the similar information might be difficult to share in other sessions due to limited meeting time schedule or lack of support in the same areas. Presentations and meeting topics for these particular meetings had been created by nominated workshop or other related stakeholders.

3.2 Data 1 collection questionnaires

The first data collection (Data 1) questionnaires were selected with an idea to keep it as simple as possible but also, to collect as much important feedback from the stakeholders as possible for better understanding of the current situation. The questionnaires consisted of four questions as follows in the subsections below.

3.2.1 Description of current rebuild instruction

The first question gathered information of existing rebuild instructions which have been used in the stakeholder's rebuild projects earlier. Due to a knowledge of the limited rebuild documents another related question was highlighted, as a part of the first one, as a request to describe other instructions and documents that have been created and implemented locally if any.

3.2.2 Description of current rebuild practices

The second question gathered information of the current rebuild practices that have been used and developed locally. Many workshops have created their own methods and tactics of working for long time, due to different working cultures and workshops layouts, and this was another important topic to collect as many excellent improvements and implementations of the work practices as possible for further analysis.

3.2.3 Recommendations for the rebuild instruction standardization

The third question, as a brainstorming request, was created to collect all possible ideas and thoughts for the model of the future rebuild instructions and documents.

3.2.4 Additional comments for rebuild projects

The fourth question gathered other valuable feedback for the further actions in the rebuild standard instruction standardization project as what kind of work-related information should be included and illustrated in the initial version of the rebuild instruction. By purpose, this question was wide and leaves space for all kind of ideas that can be useful and important ones in the project of the rebuild instruction standardization.

3.3 Description of current rebuild instructions

A list of available instructions for the machine rebuilds is quite short as mentioned earlier, as shown in Table 5.

Table 5. Current available rebuild documents.

Current Rebuild Instruction	Details/Name
Modified OEM's assembly drawings	Pull&Pack drawings
GANTT chart	GANTT project chart
Original machine type manuals	Toolman manuals
Original machine type manuals with updated rebuild information	Toolman manuals with updated rebuild information sections (spare parts)
Rebuild standard operation procedures	Rebuild SOPs

The current instructions include Pull&Pack drawings which are created from an original machine type manufacturing drawing with an idea to provide a modified and simplified instructions with the parts which need to be replaced during the rebuild project. Also, another idea was to include all the same parts as the rebuild sales kit includes as well as the sections where these parts locate.

Another document is a project GANTT chart which provides a timetable for rebuild work sequences in the higher level and supports the project planner and manager to keep the monitoring for the time schedule during the project.

The case company's original machine manual (related with machine serial number), a Toolman manual is available and the same type of "serial number based" manuals have been delivered to the end users within every machine delivery since the beginning. This manual book includes several sections such as operator, maintenance, spare parts and service manuals.

The Case company provides an updated version of the Toolman manual as a part of rebuild kit offering. Basically, all information is updated that is related with the rebuild parts. The updated rebuild Toolman does not provide any work instruction for the rebuild processes, it is working as an updated spare part catalog only.

Some of "rebuild standard operation procedures" (SOP) have been created in the past but these existing SOPs are very similar as the rebuild GANTT charts as both of documentations include the work sequences and estimated labor hours which makes these documents more the rebuild project

planning tools. However, these particular SOPs are not useful due to unavailable work instructions, illustrations or other relevant explanations of the rebuild working methods. Therefore, it would be wrong to use the name of the standard operation procedures from this material.

3.4 Description of current practices

According to all interviewees, the current practices of the rebuilds are very similar as a normal machine repair processes in the case company's global workshops. The rebuild projects, as well as other machine repair projects had been carried out without any specific or common work instructions or dismantle/reassembly sequences or any other instructions which might have been created for this kind of work only.

Many workshops have their own excellent experience and the way of working with the machines which they have created and developed during the numerous machine maintenances, repairs and similar projects over the time. Also, a global support over the Case Company's different departments has been one of the key factors in the successful rebuild projects earlier. In some cases, the amount of requested support creates an extra workload to the Case Company's other departments as the rebuild business sector might not have been as their main focus business areas as well as unavailability of the proper rebuild instructions which can provide necessary guidelines and support in the decisions.

The current rebuild practices follow closely the same working sequences (high level) as illustrated in Figure 1 below.

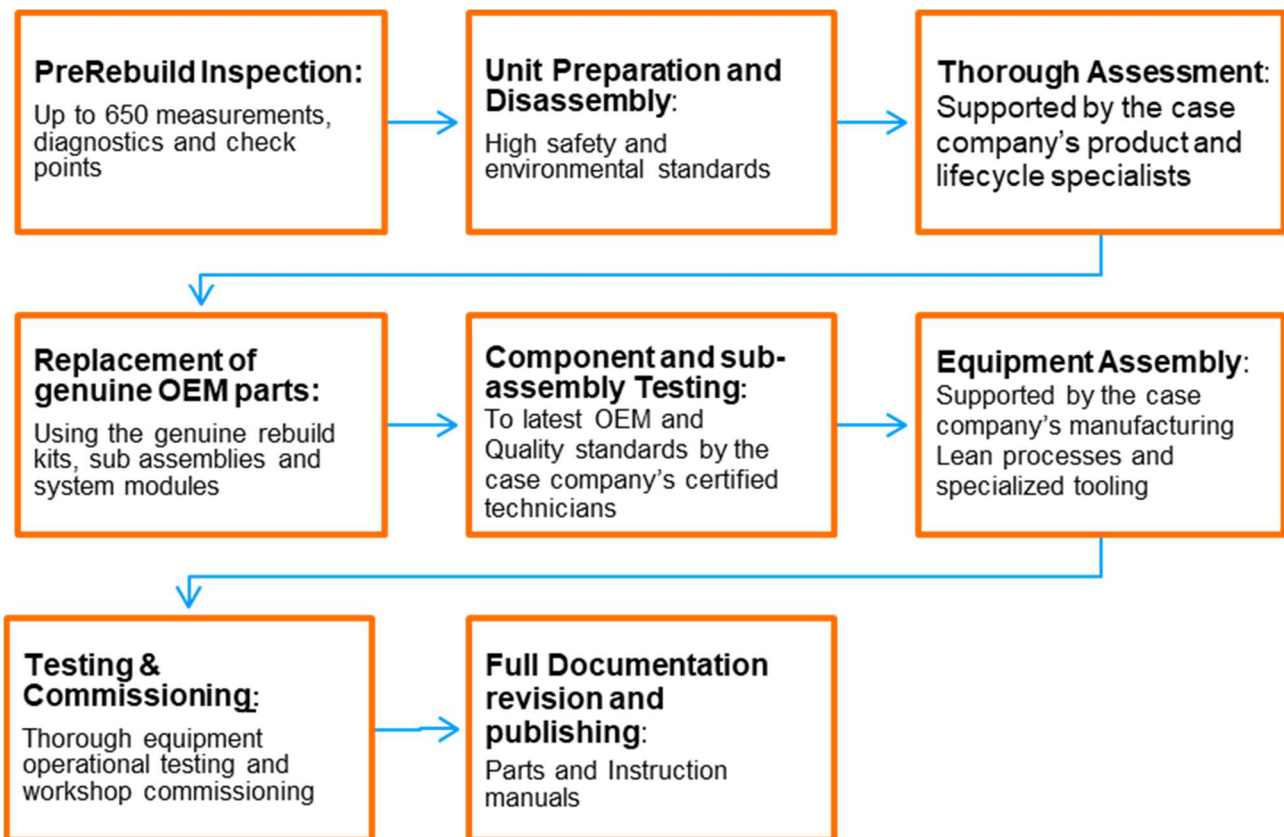


Figure 1. Rebuild Higher Level process map (Case Company's library 2020).

The Case Company's Rebuild Process map includes 8 high-level steps with separate work tasks. The first step describes the pre-inspection task on the customer site which provides important information from the machine and its current condition. This particular machine audit includes numerous of functional and visual inspections which are useful to create the machine specific rebuild scope for the necessary repairs and spare parts.

The second step contains the machine preparation and disassembly tasks. Basically, these activities take place in the Case Company's workshop area but in some cases might be conducted in the customer's facilities as well. The machine preparation task includes a proper washing/cleaning and disassembly.

The third step contains the final assessments for the necessary frame/component repairs and the right selection of the spare parts/rebuild kit for the final rebuild scope with a support of the Case Company's technical and spare part departments.

The fourth step describes the replaced genuine rebuild spare parts, sub-assembled rebuild components and/or semi-assembled component modules that the Case Company provides as an Original Equipment Manufacturer (OEM).

The fifth step includes the quality inspections and tests for the replaced and/or repaired components that have been conducted by the Case Company's certified employees. The necessary quality tests and inspections follow the OEM's latest rebuild quality guidelines.

The sixth step includes the assemblies where all the new and repaired components and parts have been re-assembled back to the machine frames.

The seventh rebuild step includes all the functional and visual tests that have been conducted after the machine is completely rebuilt and in working condition. This particular step includes deep electrical and technical tests where all the safety and functional aspects will be inspected, tested and approved by the Case Company's certified representatives. In this stage the rebuilt machine is fully commissioned before the delivery back to the customer.

The eighth and the final step includes all necessary rebuild documentation collections and preparations for the customer and the Case Company's internal documentation purposes. The rebuilt machine is ready for its delivery along with the warranty documents, updated machine specific manuals and commissioning documents.

3.5 The case company's rebuild portfolio offer

Mainly, there are five different types of rebuild methods available for the customers where the first and conventional way to perform the rebuild project is a Strip and Quote model where all the main components will be inspected and repaired or replaced, as agreed with the customer. In other words, this is very customer tailormade rebuild model where the main scope is to follow the customer instructions for repairing and replacing a component by another component.

The second and third rebuild methods are named by the Life Extension models (Partial Scope Rebuilds) where the amount of replacing and repairing components is larger than with the first rebuild option.

The fourth and fifth rebuild methods, a Reborn and a Reborn + (Full Scope Rebuild) are full rebuild scope options where all necessary components will be replaced and repaired including the latest

product upgrades. In other words, both options provide a new life for the old machine that is comparable to brand-new equipment.

Figure 2 illustrates the Case Company's four main rebuild kit offers and component differences between each kit.

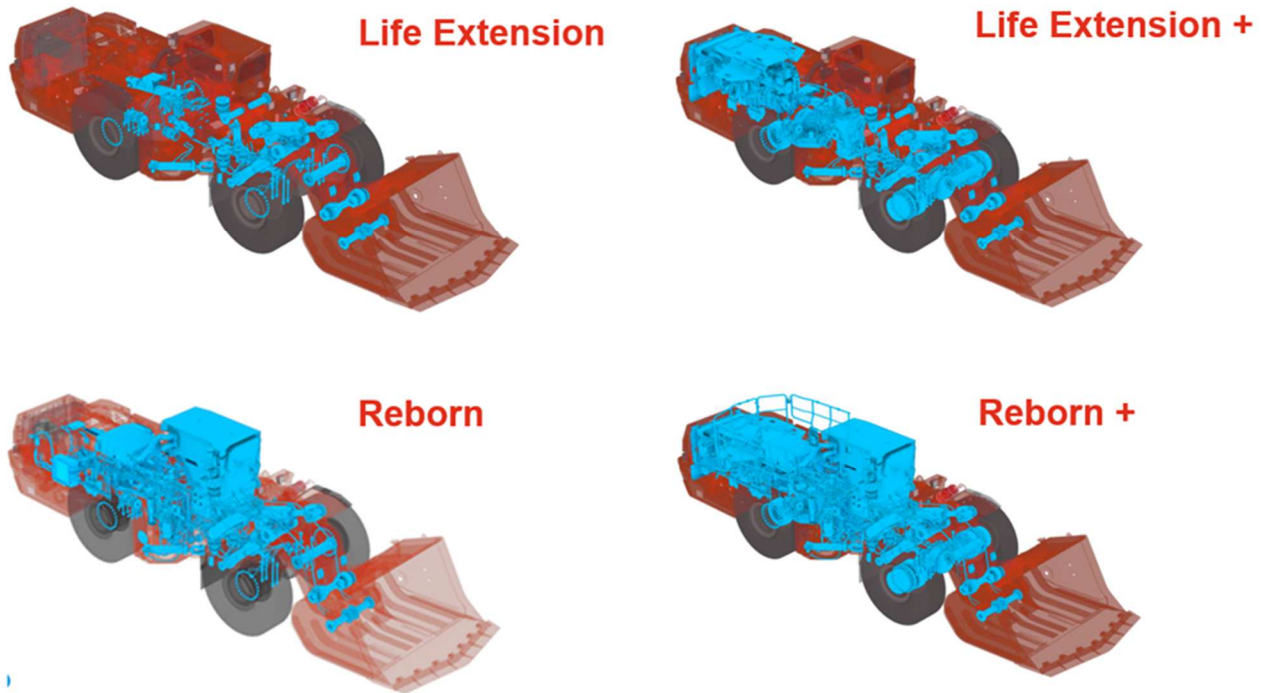


Figure 2. The Case Company's Rebuild Offer Portfolio (Case Company library 2020).

Figure 2 above illustrates the four different component exchange levels where the replaceable and/or repairable components and parts are highlighted on the machine frames in blue. The rebuild kits include all necessary parts and components according to the level of the planned rebuild.

3.6 Strengths and Weaknesses of the current rebuild instructions and practices

Analyzing and combining the results of the Data collections are critical part of this Thesis to achieve the best possible outcome of the Thesis. The data collection includes the conceptual framework also which is the outcome of the literature review (Stage 2).

3.6.1 Strengths of the current rebuild instructions

Table 6 below indicates the collected strengths of the current rebuild instructions.

Table 6. Strengths of Current Available Rebuild Instructions.

+ Original machine specific manuals (Toolman) are available.
+ Original machine specific manuals (Toolman) with updated information sections (specific section according to rebuild spare parts) is/are a part of the rebuild sales.
+ GANTT rebuild project charts are available.
+ Modified factory assembly drawings are available (Pull&Pack drawings).
+ Rebuild SOPs have been created in the past.

The case company has released the Pull&Pack drawings to support the machine rebuild projects. These particular drawings are modified and simplified from the original OEM's assembly drawings to describe and highlight the actual components, locations and part numbers for the rebuild project purpose only. Also, the Pull&Pack drawings include illustrations and/or other details of the spare parts which are planned to be replaced during the rebuild project. Basically, these drawings also support an original bill of material (BOM) of the rebuild spare part kits.

The GANTT project chart provides the full project scope with estimated time schedules of each action. This material is important especially for the responsible rebuild project manager to monitor the progress of the project and for further action planning.

The case company provides an excellent machine model and serial number-based manuals (Toolman) which include a wide range of information for the end user. The Toolman manuals are original information package and supporting the end user with proper guidelines and information of the operating models, periodical maintenance practice, service instructions and necessary spare parts. Also, this vital and wide information package includes numerous important technical drawings and schematic which are usable during the whole lifetime of the machine.

The second version of the Toolman, the Rebuild Toolman provides useful updated machine model-based information of the parts and components that are replaced or repaired used in the rebuild project. Also, an updated spare part list is included.

However, these manuals do not provide specific information for the machine rebuild project, as it is not the original purpose of this material either, but the Toolman manuals will be a crucial supporting material in the rebuild projects with the deep machine type based technical information and specification.

Current rebuild standard operational procedures (SOP) have been created in the past with an idea to provide better instructional support for the operational stakeholders. However, these documents are not finished and piloted in the real-life rebuild projects and the contents of the material does not meet the expectations of the rebuild stakeholders.

3.6.2 Weaknesses of the current rebuild instructions

Table 7 below indicates the collected weaknesses of the current rebuild instructions.

Table 7. Weaknesses of Current Available Rebuild Instructions.

- Unavailable dismantle and reassembly instructions with illustrated work tasks.
- Unavailable rebuild work sequences and labour hours.
- Current rebuild SOPs are disorganized.
- Existing material in not properly piloted (theoretical material only).
- GANTT project charts are not piloted and updated.
- Global workshops have limited access into existing material.

The current documents do not include illustrated instructions for the machine dismantling and reassembly work tasks or any other operational guidelines for the machine rebuilds. The machine specific rebuild instructions are not available and basically, the previous rebuild projects have technically been managed with the use of the Toolman manuals and Pull&Pack drawings (modified OEM's assembly drawings).

The Toolman manual (machine model specific manuals) is not created for the machine rebuild purpose originally but provides valid specification details and technical information from the machine's design for the end users from the rebuild perspective also. The Toolman is the most important manual during the whole lifetime of the machine, and it has another updated version also (Rebuild Toolman) which has created for the rebuild purposes only.

Use of the Toolman manuals in the rebuild project is not practical either due to its massive size and as this particular manual is not designed for this type of projects where the speed is one key element. The Pull&Pack drawings provide illustrated information of the locations of the components on the machine's frame but not any instructions how to dismantle or reassemble and neither the work sequences.

The second version of the Toolman, the Rebuild Toolman does not include any rebuild instructions either, only necessary information are updated that is related with the rebuild spare parts and components.

As mentioned earlier (section 3.6.1), the rebuild project GANTT chart or available rebuild SOPs are not designed to support the technical work actions as these are more suitable for the project management.

3.6.3 Strengths of the current rebuild practices

Table 8 below indicates the collected strengths of the current rebuild practices.

Table 8. Strengths of Current Rebuild Practices.

+ The case company's employee high technical skill level.
+ Existing experience of the mining machines.
+ High employee engagement level and excellent communication.
+ Positive customer satisfaction in earlier rebuild projects.

The Case Company has a long and successful history from its own and specific business area, and it is reflecting from the skillful and capable employees all over the Globe. These unique employees have a long experience from the Case Company's products, and this has been the key factor of the successful rebuild projects in the past.

The Case Company has improved the global workshop facilities, tooling and working methods rapidly that offers high quality workmanship and good performance as well.

3.6.4 Weaknesses of the current rebuild practices

Table 9 below indicates the collected weaknesses of the current rebuild practices.

Table 9. Weaknesses of Current Rebuild Practices.

- Unavailable guidelines for the rebuild projects.
- Unavailable standard rebuild work practices.
- Rebuild project planning difficulties due to GANTT project charts (not updated).
- Some final test and quality inspections are currently performed in the customer site even though it would be better to perform them in the Case Company's site.

Earlier rebuild projects, or other machine service projects, have been excellent learning improving curves to the workshops. However, this kind of working methods that is based on the earlier experience might cause high costs and unexpected delays in the projects.

3.7 Summary of the Strengths and Weaknesses of the current rebuild instructions and practices

The Summary of the Strengths and Weaknesses of the current rebuild instructions and practices indicates that the current rebuild documents have not been introduced and/or published widely to the necessary stakeholders earlier. To avoid the same, it is important to take under consideration the best possible process model for the way of the rebuild document internal publication globally in this Thesis.

The first (Data1) collection provides valuable information from the Case Company's global workshops for the current state analysis of the available rebuild instructions and practices. The data was collected with the list of questionnaires that was emailed to the selected workshop stakeholders. Also, Teams online meetings were held with interviewees 3, 5 and 6 for the same data collecting purposes.

The results of data (Data1) indicates that proper rebuild instructions are not available and earlier machine rebuilds are managed with the case company's highly skilled employees and their experiences from the similar mining machine repair projects.

Another explanation for the earlier successful rebuild projects is the rebuild project frequency in the same workshop facilities when necessary, experiences and skills are accumulated and then utilized for the next projects. Also, continuous support from the Case Company's other global departments have been markable in the earlier rebuild projects. However, the continuous rebuild projects is a valuable benefit for some of the Case Company's workshops and business areas only where the customer's focus is stronger for the life extension of the current mining machine fleet.

Basically, all rebuild projects are different due to the technical condition of the target machine and this important factor needs to be taken into consideration during the rebuild project mapping. Thus, conducting a proper machine audit in advance is a vital part of the successful rebuild project providing the important information for the project scoping and advance preparations.

The case company has a limited amount of materials for the rebuilds (Table 6, Current available rebuild documents) that are collected into an internal Share Point cloud system. However, the Case Company's Share Point does not include the machine model specific Toolman manual as this particular document has been delivered to the customer and the Case Company sales area's technical support department along with the machine delivery. Neither the updated sections of the Rebuild Toolman manuals are available in the Share Point as these documents are a part of the rebuild project and provided at the same time as a whole rebuild kit.

The Case Company's Rebuild Share Point is useful platform for all related materials but surprisingly some of the global workshops and/or stakeholders have not the access into this particular material which indicates that the existing rebuild material is not well presented and published internally in the past.

According to Interviewee 1, *"there is no access into Share Point where the existing rebuild material is uploaded"*

Based on the outcome of the first data collection (Data1), the Case Company does not have proper work instructions and documents for the rebuild projects and existing limited support material is outdated and some of material is not completed. Another important comment from an Interviewee 7 regarding the type of requested rebuild material.

According to Interviewee 7, *“Dismantling instructions for the rebuilds are not so important at this stage but the instructions for the reassembly are needed as soonest”*.

The Case Company has a long experience, as an Original Equipment Manufacturer (OEM), the World Class Manufacturing (WCM) as well as a Lean-Manufacturer, which states clearly that the suitable instructions and other valuable documents are made in the past and might be applicable for the rebuild purposes directly or after possible re-engineering.

Table 10 below indicates the selected weakness areas for further rebuild global standardization improvements.

Table 10. Selected weaknesses for the global rebuild standardization improvements.

<ul style="list-style-type: none"> • Unavailable rebuild work sequences.
<ul style="list-style-type: none"> • Current rebuild SOPs are impractical.
<ul style="list-style-type: none"> • Existing rebuild material is not properly piloted earlier (theoretical material only).
<ul style="list-style-type: none"> • Global workshops have limited access into the existing material.

The main focus area of this Thesis is to develop the standard rebuild operation procedures (SOP) and work sequences and the next section (Section 4) introduces the relevant literature reviews, related ideas and insights for the best possible outcome of the conceptual framework.

4 Literature Review for the Rebuild Operation Development

This section includes the collection of the related insights and ideas from available literature for developing the preliminary proposal of the global rebuild standard instructions, rebuild process improvements and harmonization to the Case Company. The focused areas are the selected weaknesses from the outcome of the current state analyses that clarified in the Section 3.7.

This section includes seven sub-sections, and each section starts with the relevant citations from the selected literature and ends with the summary of the possible ideas, methods or concepts for building the best possible outcome of the initial proposal for the rebuild standard instructions and work sequences in section 5.

Finally, the last part of section 4 (Section 4.4) summarizes all the relevant ideas from the selected literature for building the Conceptual Framework of this thesis.

4.1 Importance of Standard Procedures

According to Olofsson (2016) the advice for standardized work might be many, but the most common are improved safety, reduced process variation and increased productivity. The business areas where the human work and manual assembly is existing, a car manufacturing plant, for instance, the methodology for standardized work is important. It is as much about making each step equally as fast so as not to disturb the flow as it is performing every procedure, in the same way, every time, to stabilize the quality of the product. Also, when the industrial work is as a manual in the wider scope, there is greater competition and price pressure, it is no coincidence that the automotive industry is a business leader in the methodology (Olofsson, 2016).

Olofsson (2016) states that the objective of introducing standardized work is not primarily that industries work quicker but increasing the possibility of doing it correctly the first time. In this way there is better possibilities to avoid extra work due to deviations, production problems, complaints, reworking or accidents. Introducing a system for the continuous improvements without the standard for the work, it would be difficult to improve something in the work methods. Standardizing the work procedure allows to improve it effectively. The indirect effects of documentation and following standardized work can sometimes be greater than the direct effects, like improved process stability or increased productivity. Work instruction standardization allows the system where all employees' creativeness can be used efficiently for continuous improvement. Another benefit of the standardized work is that it enables the managers in the organization do a good job by giving them the tools to help in everyday

leadership. To implement, manage and improve a standardized work requires a very present leadership. The key to success is that leaders can devote enough time to familiarize themselves with how the work within their area of responsibility is carried out and to ensure that the work procedures are continuously improved. The standardized work needs to follow up in a structured manner and should have the ability to coach their employees on how to develop the work processes (Olofsson, 2016).

4.2 Approach to Standardized Work and Instruction Design

This section provides insights and ideas for the development of the standard instructions and work sequences for the Case Company's global mining machine rebuilds.

Development of the new documentations, and especially all related real-life implementations might cause confusing and negative impact by the end users when the well-planned implementation methods are crucial for the best possible end results.

Hammer (2004) states that when the companies need to adopt a new approach to implementing operational innovations that would be wise not to try to implement an innovation all at once. Breaking a large-scale implementation into a series of limited releases creates momentum, dispels skepticism and anxiety, and delivers a powerful rejoinder to carping critics. This alternative idea is popular in software product development and variously known as iterative, evolutionary, or spiral development. One begins with one's best estimate of the innovation, builds a first version of it, and then tries it out with customers or users. Knowledge gained from these tests is then fed back into a fast-cycle iteration of the next version. (Hammer, 2004: 84-93).

4.2.1 Work Instructions Standardization

Olofsson (2016) states that to achieve the best possible level of the standardized work, the work instructions should be on the level that employees bother to read and keep updated. Also, overly detailed instructions are not good solution neither. It is also unsustainable to create "IKEA-instructions" that every employee might understand without any specific training. Even if self-explaining work instructions would be a good thing to create, it is laborious to achieve the target that the personnel would be able to work according to the work instructions without any training. The rate of alterations in the most industries are wide, and the operations are complex. Instead, the work instructions should include as little text as possible and exclude the details that everyone already knows how to do or the things that are not so critical. The work instructions are steering documents

for how the work should be completed but are mostly used in real-life as a support material during the training and follow-ups (Olofsson, 2016).

Olofsson (2016) also describes that when creating the brief work instructions, must be ensured that all the staff employees have the necessary fundamental competencies by specifying what courses employees should have participated in and what formal exams are required or other demands on the skills that take on place to adapt the work instructions to the correct level. It works similarly in the most workplaces; the more can be sure that employees already know then easier the work instructions will be (Olofsson, 2016).

An example by Olofsson (2016): “For an electrician, it may be sufficient with a wiring diagram to understand how to do a particular installation because we know that the electrician has basic competence because of the certification he or she has” (Olofsson, 2016).

The Standard Work Manual (SMPS, 2016) states that the standardization is the starting point for continues improvement, and the basis for identifying waste and variance in the process. The establishment of standardized work is key to creating reliable performance. Ideally, The Standardized Work enables work to be performed without any variance in the wanted output. Standardized Work is a detailed definition of the most efficient method to produce a product or perform a service at a balanced flow to achieve a desired output rate. It breaks down the work into elements which are sequenced, organized, and repeatedly followed. It typically describes how a process should consistently be executed and documents current best practices. Each step in the process is defined and must be performed repeatedly in the same manner. Any variations in the process would increase the cycle time and might cause quality issues (SMPS, 2016).

The SPMS's four key elements and explanations for the Standardized Work are given in table 11 below:

Table 11. The four key elements for the Standardized Work (SPMS 2016).

ELEMENT	DESCRIPTION
Takt Time	The rate at which products must be made in a process to meet customer demand
Cycle Time the precise work sequence	Which an operator performs tasks within takt time
Standard Work-in-Progress (SWIP)	The standard inventory, including units in machines, required to keep the process operating smoothly
Standard Sequence	The routing of operations to be completed with the cycle time to meet the customer demand (volume). It describes the sequence from the first to last operations. It defines the throughput time which need to be designed to meet the customer expectations

Standardized work requires collecting and recording data using standard forms. These forms are used by engineers and frontline managers to design the process and by selected stakeholders to make improvements in their own jobs (SMPS, 2016).

The SPMS (2016) Standardized Work Answers the 5W+1H of A Process: Who, what, when, where, why, and how:

- Who operates the process?
- How many people does it take?
- What does the final product look like?
- What are the quality check points?
- What are the possible tools to complete the job?
- When is a part completed and ready for the next step (how long the cycle and takt time should be)?
- Where is this process completed?
- Why is this step necessary or value-adding?
- Why this a quality check point is necessary?

- What are the time and resource limitations?

Overall, the process should not be unclear.

The SPMS (2016) states that the standard work provides a baseline from which a better approach can be developed. This supports continuous improvement methods to leverage learning from previous work issues. It is expected that all facilities will use the standard formats and content for products and models. Standard work documents are required to be in English and in the local language. Governance systems will be established which allow the control of change so that the latest and highest quality version of standard work is available to all who require access (SMPS, 2016).

The SPMS (2016) provides the basic requirements for implementing Standardized Work:

- Some of tasks are manually performed in the process (not fully automated).
- Acceptable level of quality and equipment functionality exists.
- Employees understand the importance of standardized operations.
- A process owner who will sustain the improvements.
- Management and supervisors are committed to sustaining the improvement efforts.

The SPMS (2016) lines that when a need for a standard process is identified it should be documented and follow the Plan- Do-Check-Act (PDCA) cycle to be implemented. This is described below:

- Plan (Create the Standard) – Use a cross-functional team to document the work elements in sequence with cycle times.
- Do (Implement the Standard) – This includes educating all those involved on what the standard process is.
- Check (Verify adherence and monitor output) –The audit process is designed to determine how well the standard is followed and document and track improvement opportunities. Whenever there is a discrepancy between the expected and actual output of the standard process, an opportunity exists to improve.
- Act (Determine what is incorrect and improve) – Depending on the type of issue, there are already processes in place to do root cause analysis and determine how to fix the process and ensure the issue does not return.

According to the standardization project collaboration, SPMS (2016) states that it is important to communicate with all selected stakeholders about the plans for their area, getting a basic understanding of the flow of the area and helping them identify the best representative for the task and by

explaining that everyone will have an opportunity to provide feedback. The process must be monitored and documented (SMPS, 2016).

Select Target Operation and Establish a Team (SPMS, 2016):

- Define the scope of the process or task to be standardized.
- Define success, define defects, and review customer requirements for the output of the process.
- Establish a cross functional team who are familiar with the operation being improved.

4.2.2 Standardized Operating Procedures (SOP)

According to Olofsson (2016), Many industries have been creating detailed Standard Operating Procedures (SOP) for internal use due to requirements of the quality systems. Basically, the SOPs describes all the work steps in the process and might include other relevant information also as the required tooling and/or safety procedures. The SOPs might cause a problem as these documents are often thick and difficult to read if the target is to include as much relevant information as possible. Many employees might feel that they do not have the time or energy to read the material. In the industries where the detailed SOPs are necessary it should be observed on as “the user-manual”, the manual what the employees use if unsure or have problems (Olofsson, 2016).

4.2.3 Introduction and Implementation of the Standard Work Instructions

Olofsson (2016) states that during the implementation, support organizations like quality or technical departments have significant roles especially when setting the boundaries for the work team to relate to. Also, should avoid that engineering or management departments are only resources who develop the details in the standard work instructions as this model might cause low motivation and standards without a local ownership. The skilled labor is the key for the successful work instruction standardization as they have the valuable knowledge. The standardized work is a standard for how the employees perform each step and to agree on standardized work means to proceed from the general standards or policies, make an interpretation and create local work instruction. In large organizations need to develop many work instructions, the implementations will become a thorough job. Since many people will be involved in the work, proper planning and coordination are needed. A good way to follow the process is to visualize the progress made with each work instruction on a whiteboard and regularly meet to synchronize the work (Olofsson, 2016).

Hammer (1999), the role of process owner may not act as a temporary project manager only who is active only during the development and implementation of the new process design. Ownership of the process must play a permanent role for two reasons. First, the process plans must be involved as business conditions change, and the process owners must guide this development. Second, in the absence of strong process owners, the old organizational structures will soon strengthen themselves (Hammer et. al, 1999).

“In a process enterprise, the key structural issue is no longer centralization versus decentralization; it’s process standardization versus process diversity.”, (Hammer et. al, 1999).

Olofsson (2016) provides an example for the introduction process which is given in table 12 below:

Table 12. An example of the introduction process (Olofsson, 2016).

WORKSHOP	PURPOSE
Training	Give an understanding of the methodology and the planning
Map the present state	A shared picture of how it works today
Analyze incoming steps	A critical review of current work procedure
Agree on What, How and Why	The development of the new/updated work instructions
Test the work instructions	Validate and improve
Competence, inventory and training	Ensure that all can follow the new work procedure

Olofsson (2016) has created the six steps workshop as seen in Table 12. These steps are explained in more detail below.

Workshop 1 – Train Everyone.

Purpose: Give an understanding of the methodology and the planning.

The first step is to arrange a proper training for the stakeholders regarding what is standardized work is and how it should be implemented. Training materials might be needed.

Workshop 2 – Mapping the Current Situation

Purpose: A common picture of how it works today.

The second step is to map out the current state with existing Standard Operating Procedures.

Workshop 3 – Analyze the Work

Purpose: A critical review of today's work procedure.

The third step, the stakeholders go through all steps and assesses each one of them. An example is shown below in Table 13.

Table 13. Analyze the current work procedures (Olofsson, 2016).

CURRENT WORK PROCEDURES	ANSWER
Is this work necessary?	YES/NO
Should it be done at a different location?	YES/NO
Should this be done sooner or later than today?	YES/NO
Is this the right person to do this?	YES/NO
Is it possible to improve or simplify?	YES/NO

Analyzing the current work procedures and sequences provides valuable information for further developing and updating. Additionally, the collected suggestions and insights are valuable information during the whole improvement process.

Workshop 4 – Agree on What, How and Why

Purpose: Development of new/updated work instructions.

The fourth step carry out each step-in selected order once all the Key Points are agreed for the best possible quality of the work. It is important to gather all valuable information and smart solutions from the experienced stakeholders to minimize the risk of accidents or quality defects.

Workshop 5 – Test the Work Instructions

Purpose: Check and improve

The fifth step, the first version of the new work instructions is completed along with the stakeholders it should test them in real work-life. It is important to measure times between each work steps and compare. Wide differences indicate in various performing methods. Changes would be necessary for the next possible test round.

Workshop 6 – Competence, Inventory and Training

The sixth and final step, selection for the person/-s who produce the standard work procedure materials. It is common to get help from the workshop supervisor/-s who can create a draft version of standardized work procedures based on the collected results from the stakeholders. The standard work instructions should be available easily and visible for all key employees for the ease follow-up and compare how the actual work is performed (Olofsson, 2016).

According to Olofsson (2016), recommended training method for the new standardized work procedures is the Four-Step method to ensure that all stakeholders are well trained and capable for independent work.

Olofsson, 2016 provides the Four-Step Training method is given in table 14 below:

Table 14. The Four-Step Training Method (Olofsson, 2016).

Steps
1. Plan the Training
2. Show How to Do the Task
3. Let the Student Do the Work by Themselves
4. Follow-Up

Olofsson (2016) has created the Four-Step training method as seen in Table 14. These steps are explained in more detail below:

Four-Step Method

Step 1. Plan the Training:

The first step includes a proper training material preparation for the latest Standard Work procedures, work sequences and/or SOPs.

Step 2. Show How to Do the Task:

The second step describes the actual work steps in the latest Standard Work procedures, work sequences and/or SOPs.

Step 3. Let the Employee Do the Work:

The third step is hands-on work in the real work environment.

Step 4. Follow-Up:

The fourth step includes the frequent follow-up for further updates and improvements.

4.3 Process Modelling

According to Martinsuo (2010), the key characteristics of process management are systems thinking, customer focus, goal orientation, focus on value-adding activities, effective use of feedback in modifying operations, and systematic and deliberate process development for performance improvement. Understanding and developing activities as processes is an effective way to implement strategy, achieve customer satisfaction, promote efficiency, and enhance cross-functional and cross-organizational cooperation. Process management is often associated with productivity improvement and elimination of non-value-adding activities. In addition, process management emphasizes the systematic use of tools, documentation and information systems that are integral to sharing good practices and standardizing and automatizing activities. Process modeling often involves the adoption of new information systems, too (Martinsuo et. al, 2010).

Martinsuo (2010) states that enhancing the performance of organizations through processes can imply a shift to a process-oriented approach, implementation of a new single process, radical re-engineering of existing processes, or implementing improvements of varying scale into current processes. Different process improvement needs have different characteristics. For example, when creating an entirely new process in an environment where other processes are already in place, the development need may be triggered by a new product, or a new way to deliver the product using subcontractors. In this type of a situation, there may be new players involved and the introduction of the process may generate significant risks and uncertainties, and piloting is likely to be necessary (Martinsuo et. al, 2010).

Martinsuo (2010) states for an old process developing that in the spirit of continuous improvement, the employees working in the process may trigger process improvement through their practical and stepwise development proposals. Improvement can take place in small steps or it may already have occurred spontaneously, which simply implies the need to update the process descriptions to take the improvements into account. In practice, different kinds of development projects can be connected with each other: for example, in a merger, it is necessary to create completely new processes, as well as radically re-engineer and improve old processes gradually (Martinsuo et. al, 2010).

4.3.1 Mapping the Process – Detailed Description

According to Martinsuo (2010), Mainly processes critical to survival or efficiency need to be observed on a more detailed level where resources are planned to each task. Detailed flowcharts and practical guidelines would be needed for proper process implementation. The following are separated in the detailed process description: the work tasks being monitored and controlled, interdependences between the tasks (material and information flow), and roles and responsibilities. Would be beneficial to describe the tools and information required in each task. It would be necessary to make a clear distinction between two types of situations in the detailed process description (Martinsuo et. al, 2010):

- If the process will be carried out always in the same way, a detailed work task description is important that all involved persons have the same information.
- If the process includes hesitations and it is not necessary to perform it in the same way, then the detailed description does not need, step by step task lists would be adequate.

Martinsuo (2010) states that many different versions of detailed process charts are created and no standard practice in the process description area. The four common methods are flowchart, process flow diagram, task matrix and textual instructions. Each illustration might provide different process description. When charting the target process, it is typical to map the process from the end to the start. In this way, it is possible to define what needs to be complete before the customer need is fulfilled (final output), what tasks to be done for the final output (activity) and what tasks to be complete for the initial output. Also, it is valuable to investigate what tools and systems would be needed for each work tasks for the best possible outcome of the planned work tasks (Martinsuo et. al, 2010).

According Martinsuo (2010), when charting the current process, it is important take account that the current activities and outputs may not meet the ideals and that the process description may be confusing, unclear and difficult to follow. Systematic process charting thorough simply documenting can help to clarify the agreed ways of working. Also, a vital target behind the process modeling is to search possible improvement areas. Thus, it is important during the current process charting that the current and target process models are separate. The work process review with the key stakeholders is a good way to recognize and prioritize the development needs in the process chart and to engage employees working in the process in the development work. However, when describing the target work process, in turn, it is important to ensure the simplicity and practicability of the work process model. The main reason for the process review is ensure that the planned work processes are in harmony with good practices and meets its planned objectives (Martinsuo et. al, 2010).

4.3.2 Process Piloting, Improvement, and Implementation

Martinsuo (2010) underlines the importance of the pilot test for the target process. It should be piloted with good support and conditions before its general implementation. The piloting of complicated processes may not always be possible, but even in these cases, the planned process model should be piloted by asking the work process personnel and other stakeholders' opinions regarding the feasibility, defects, and areas for development in the work process. Possible improvement areas of the entire work process should be easily recognized by the piloting and testing activities and these should be taken before the wide process launching. Planned process implementation also involves developing the competences of the employee involved in carrying out the process and familiarizing the necessary systems to the process. This may require a separate campaign, a training program for different employee groups, process guidelines targeted at different stakeholders, changes to IT systems, and even changes to the Company's presentation materials and web pages. The process implementation might cause modifications to other planned processes which are under development and this possible impact should be planned and scheduled already in the early stages of the development project (Martinsuo et. al, 2010).

4.3.3 Process Objectives

Martinsuo (2010) states that a process is not an end in itself, but a tool. The objectives of processes – as well as sub- processes – are to be in line with the company strategy and promote its fulfillment. Practically this requires that the objectives of the process take under consideration the customer, and customer value creation, and the company's target goals. Also, the objectives of sub-processes should be aligned with the higher-level processes. Process monitoring is supported by solid, measurable objectives with the target levels that can be modified until the performance finally improves (Martinsuo et. al, 2010).

Martinsuo (2010) provides determining process objectives:

- What direction the current strategy offers to the process.
- Customer expectations and requirements regarding the process.
- Compare with the similar processes to recognize the practicable performance objectives and possibilities for renewal.
- Set performance targets for the process.
- The performance targets should be developed with achievable way.

4.3.4 Identifying Areas for Development

Martinsuo (2010) states that the performance indicators can be useful in identifying potential areas of process development, by providing information about the process and its current state. However, the identification of specific development areas requires that the process and its components be examined with insight and in relation to objectives. Attention should be paid particularly to value-creating activities and their detection among any operation, and in this, process modeling plays an important role. Directing attention to value-creating activities also reveals potential problem areas in value creation (Martinsuo et. al, 2010).

4.4 Process Harmonization Systems

This section provides insights and ideas for the development of the Case Company's rebuild documentation harmonization globally. The section 3.7, Summary of the Strengths and Weaknesses of the current rebuild instructions and practices indicates that the current rebuild documents have not been introduced and/or published widely to the necessary stakeholders globally earlier. To avoiding the same, it is important to take under consideration the best possible process model for the way of the rebuild document internal publication globally in this Thesis.

Melissen (2012) states that the Business Process Harmonization (BPH) concerns the standardization of an organization's business processes while leaving room for desired variations. These variations can be wanted because of differences in legislation and market needs globally. The merger of processes based on the best possible model adapted from a reference model or other best-practice model from within or beyond the organization, and that Business Process Standardization (BPS) is performed to increase the performance of an organization in terms of time, costs and quality. Resolving the differences between process models where possible, designing a reference model with an optimal number of process variations based on the remaining process models, and reconfiguring actual processes according to the harmonized reference model (Melissen R, 2012).

Zellner (2015) states that the process harmonization is strongly related to the process standardization and process complexity. It is expected that process complexity decreases with increasing measures of process harmonization and hence increasing process standardization (Zellner et. al, 2015).

Irene (2017) provides an example of an industrial company-wide standardization project as a three-step process standardization model including a pre-step and the final step with following steps: set a standard process owner, a standard process development with comparing the best practice, combining the standard process definitions (implementation plan development) and the standard process implementation (launch standard operation process). In addition, the standardization has a positive impact on accuracy and the absence of errors, as well as on the process time and process cost reduction (Irene Maria Schönreiter, 2017).

Heidi (2011) describes that when designing the business processes, it is often necessary to address multiple processes with the same goal. For example, the most companies maintain different processes for a sourcing of services, the sourcing of product-related items and the sourcing of non-product-related items. Also, many companies maintain multiple different processes due to geograph-

ically separate locations. In this model, re-designing would be necessary for the processes as standard or as specific as possible. Standardization provides several benefits as an improvement in efficiency, reduction of complexity and lower operating costs. However, the full standardization would be difficult in some cases due to different legislations or cultural aspects (Heidi Romero et. al, 2011).

Heidi (2011) provides three metrics for the measuring of the Level of Harmonization (Heidi Romero et. al, 2011):

Understandability – A metric must be understandable.

Meaningfulness. A metric must be meaningful. The less variance means a higher level of standardization.

Uniformity. For improving understandability of the metrics, they should be applied widely to measure the level of harmonization for the different features.

4.5 The Global Process Improvement

Johansson (2013) states for the standardized assembly instruction design, the production engineer should be aware of a value adding and not a value adding actions, and both need to be measured by time. Also, a certain quality level should be existing in the production and with the product that the employees can see the real benefits of using the standardization work. One of the most important parts of the standardized work concept is the continuous improvements for the system (Johansson et. all, 2013).

Johansson (2013) provides eight steps to develop the standardized work:

- Create improvement teams.
- Define a Takt Time (explained in section 4.2.1, table 11).
- Define a cycle time (explained in section 4.2.1, table 11).
- Define work sequence.
- Define a standard quantity of the work in progress.
- Create a standard workflow diagram.
- Create a standard operation instruction.
- Continuous monitoring for the possible improvement.

According to SMPS (2016), the standard build sequence (workflow diagram) is the high-level standard work documentation, and it describes the assembly process and standard workload in a visual chart. The process is separated into multiple process steps which should be aligned with the standard operating procedures (SMPS, 2016).

4.6 Conceptual Framework of This Thesis

The necessary insights and ideas to develop the standard rebuild operation procedures and work sequences, as well as for the improvement ideas for the rebuild process and harmonization have been found and described in the next sections.

Table 15 describes the key themes of the selected improvement areas along with the relevant literature.

Table 15. The Conceptual Framework of this Thesis.

Selected Improvement Areas	Area	Literature
Develop preliminary proposal for the rebuild standard instructions	Approach of the Standardized Work and Instruction Design	The Standard Work Manual (2016, SMPS) Succeeding with Standardized Work, Oskar Olofsson, 2016
Develop preliminary proposal for the rebuild standard instructions global sharing	Process Harmonization Systems	Harmonization of Business Process Models, Heidi Romero et. al, 2011 Methodologies for process Harmonization in the Post-Merger Integration Phase, Irene Maria Schönreiter et. al, 2017 A Business process Harmonization Approach Using Process Mining technique, Melissen R, 2012
Process model improvement for the preliminary rebuild standard instructions and work sequences	Process Modelling	Process Modeling for Improved Performance, M.Martinsuo and Marja Blomqvist, 2010
Develop preliminary proposal for the rebuild work sequence process map	The Process Improvement Globally	Industrial Engineering and Production Management, Courtney Hoover, 2017 Toyota by Toyota, Samuel Obara et. al, 2012 The Standard Work Manual (2016, SMPS)

As clarified in Table 15, the conceptual framework includes the five main categories which includes the selected weaknesses of the current state analysis from the Section 3.7. The first, the development of the preliminary proposal for the rebuild standard instructions category includes the best possible insights and ideas from the selected literature. The second category, the development for the preliminary proposal of the rebuild standard instructions global sharing relates to the ideas for the secured rebuild material sharing globally. The third topic, the research of the valuable material for the preliminary rebuild standard instructions and work sequences focuses to other relevant material from in the Case Company's manufacturing departments. The fourth, the development of the preliminary proposal for the rebuild work sequence process map describes the creation of the rebuild build sequence/work diagram map. The fifth and the final category includes the pilot project plan for the preliminary rebuild standard instructions and work sequences.

The preliminary proposals for the Case Company's global rebuild standard instructions and work sequences, that are based on the conceptual framework above, are presented in the next section (Section 5). The main purpose of the conceptual framework is to develop the selected weaknesses which are the main outcome of the current state analysis as described in section 3.7.

5 Creating the Initial Proposal

The main objective of this thesis study is to create an initial proposal of the global rebuild work sequences and the rebuild instructions for the Case Company's underground mining machines. The final outcome of this study is the final proposal for the global rebuild work sequences and the work instructions for improved efficiency, productivity, quality and safety of the rebuild projects.

This section combines the findings from the current state analysis and the conceptual framework for the creation of the initial proposal for the standard rebuild work instructions and rebuild work sequences. This section includes six sub-sections.

5.1 Overview of the Initial Proposal

Important data collections (Data1 and 2) for the initial proposal of the case company's standard rebuild work sequence and work instruction (SOP) were collected from the current rebuild documentations and the selected stakeholders. Important data collections were conducted via online Teams sessions along with separate questionnaires.

The first data (Data1) collection, the current state analysis of the rebuild instructions and practices was conducted from the review of the case company's current rebuild material and practices as well as the feedback from the selected stakeholders, in other words, from the case company's nine global workshops who have various levels of experience from the earlier rebuild projects.

The second data collections (Data 2) include all important feedback from the selected stakeholders from the first pilot project of the initial proposal of the rebuild work sequences and the work instructions. The initial pilot rebuild materials have been created by following the outcome of the first data collection round (Data1). The second data collection method was modified from the original plan due to global pandemic situation as it has been influenced widely to the Case Company's safety policy regarding the travel restrictions.

Also, extremely tight time schedule of the rebuild improvement process has been forced to make necessary modifications into the rebuild pilot project plan. The original plan for the second data collection was to arrange the real-life rebuild pilot project in the selected Case Company's front line workshop where the initial machine type of rebuild materials were planned to use in the actual rebuild project and where the possible modifications and corrections can be done immediately to the initial materials and the rebuild project.

The updated second data collection round (Data2) has been decided to arrange as a pilot project with the examples of the rebuild documents which includes the initial proposals for the rebuild work sequence map and the rebuild work instructions which are created for the three separate work steps of the initial work sequence map. As Martinsuo (2010) states that for an old process developing that in the spirit of continuous improvement, the employees working in the process may trigger process improvement through their practical and stepwise development proposals. Improvement can take place in small steps, or it may already have occurred spontaneously, which simply implies the need to update the process descriptions to take the improvements into account. In practice, different kinds of development projects can be connected with each other: for example, in a merger, it is necessary to create completely new processes, as well as radically re-engineer and improve old processes gradually (Martinsuo et. al, 2010).

Also, a proposal for the rebuild document sharing has been taken under consideration due to the outcome of the current state analyses. Surprisingly, the accesses into the case company's current rebuild materials have not been shared widely between the global workshops and stakeholders as essential.

5.2 Initial Proposals for The Rebuild Standard Work Instructions and Sequences

The initial proposals are the results from the current stage analyses, conceptual framework and collected inputs from the case company's selected stakeholders. The results from the current state analyses indicates that some of the case company's current rebuild materials are unusable for the real-life rebuild projects and vital rebuild reassembly instructions are not created in the past. However, one of a positive finding from the current rebuild material was the rebuild project GANTT-chart which is valuable material for further rebuild projects after necessary updates.

The four selected and numbered initial proposal areas are illustrated in Figure 3 below (grey squares) and each area are described in the text after the Figure.

The initial proposals are illustrated in Figure 3 below.

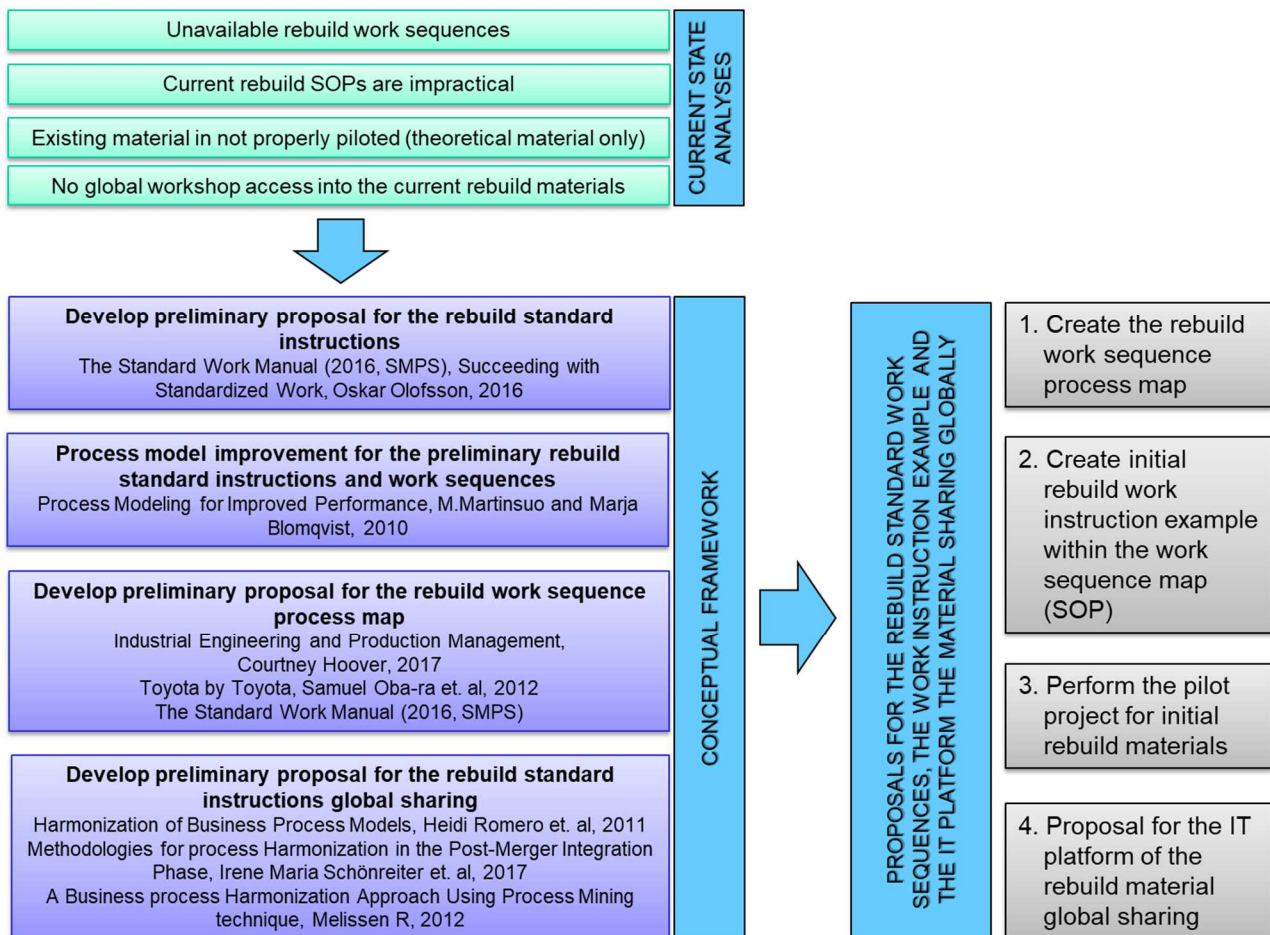


Figure 3. Summary of initial proposals for the standard rebuild instructions and work sequences.

As shown in figure 3 above, the initial proposals are illustrated in four numbered grey squares. The first proposal square describes the rebuild work sequence process map which includes the higher-level assembly steps (workflow). The proposed rebuild process map is illustrated and described in section 5.3.1 below.

The second square includes a proposal for an initial rebuild instruction (SOP) example within the rebuild work sequence process map. The rebuild work instructions are the main materials along with the rebuild sequence process map in the rebuild projects with valuable information of the assemblies, sub-assemblies, work sequences, necessary preparations of any particular work steps. Also, the standard work instructions should include necessary safety instructions for all work steps if possible. The proposed rebuild standard instruction model is illustrated and described in section 5.4.1 below.

The third square includes a proposal for the pilot project of the initial rebuild material which includes the initial rebuild work sequence process map and the one example of the rebuild work instruction. Also, the proposal for the IT platform which should be used for the rebuild material sharing globally. The proposed rebuild pilot project is described in section 5.5 below.

The fourth and final square includes a proposal for the IT platform which is necessary for safe secure global material sharing. The proposed IT platform is described in section 5.6 below.

5.3 Proposal for the Rebuild Work Sequence Process Map

The rebuild work sequence process map is mandatory document separately for the Case Company's each machine models. Mainly, the rebuild work sequence map includes the planned workflow with each separate work tasks and targeted labor hours for the same. The sequence map guides the project managers, supervisors, and technicians regarding the main rebuild work tasks and correct work sequences which are valuable information for the rebuild project planning and mapping in advance and during the project.

Martinsuo (2010) states that many different versions of detailed process charts are created and no standard practice in the process description area. The four common methods are flowchart, process flow diagram, task matrix and textual instructions. Each illustration might provide different process description. When charting the target process, it is typical to map the process from the end to the start. In this way, it is possible to define what needs to be complete before the customer need is fulfilled (final output), what tasks to be done for the final output (activity) and what tasks to be complete for the initial output. Also, it is valuable to investigate what tools and systems would be needed for each work tasks for the best possible outcome of the planned work tasks. However, when describing the target work process, in turn, it is important to ensure the simplicity and practicability of the work process model. The main reason for the process review is ensure that the planned work processes are in harmony with good practices and meets its planned objectives (Martinsuo et. al, 2010).

The detailed machine model based rebuild works sequence maps are recommended to use for the case company's rebuild projects with the similar visual detailed workflow sequence map which includes estimated labor hours, quality inspection and functional testing gates. Work tasks can be separated to the lower-level work sequences as many steps are required for clarifying purposes.

According to SMPS (2016), the standard build sequence (workflow diagram) is the high-level standard work documentation, and it describes the assembly process and standard workload in a visual chart. The process is separated into multiple process steps which should be aligned with the standard operating procedures (SMPS, 2016).

According to Martinsuo (2010), Mainly processes critical to survival or efficiency need to be observed on a more detailed level where resources are planned to each task. Detailed flowcharts and practical guidelines would be needed for proper process implementation. The following are separated in the detailed process description: the work tasks being monitored and controlled, interdependences between the tasks (material and information flow), and roles and responsibilities. Would be beneficial to describe the tools and information required in each task. It would be necessary to make a clear distinction between two types of situations in the detailed process description: if the process will be carried out always in the same way, a detailed work task description is important that all involved persons have the same information and, if the process includes hesitations and it is not necessary to perform it in the same way, then the detailed description does not need, step by step task lists would be adequate (Martinsuo et. al, 2010).

5.3.1 The Initial Proposal for the Rebuild Sequence Process Map

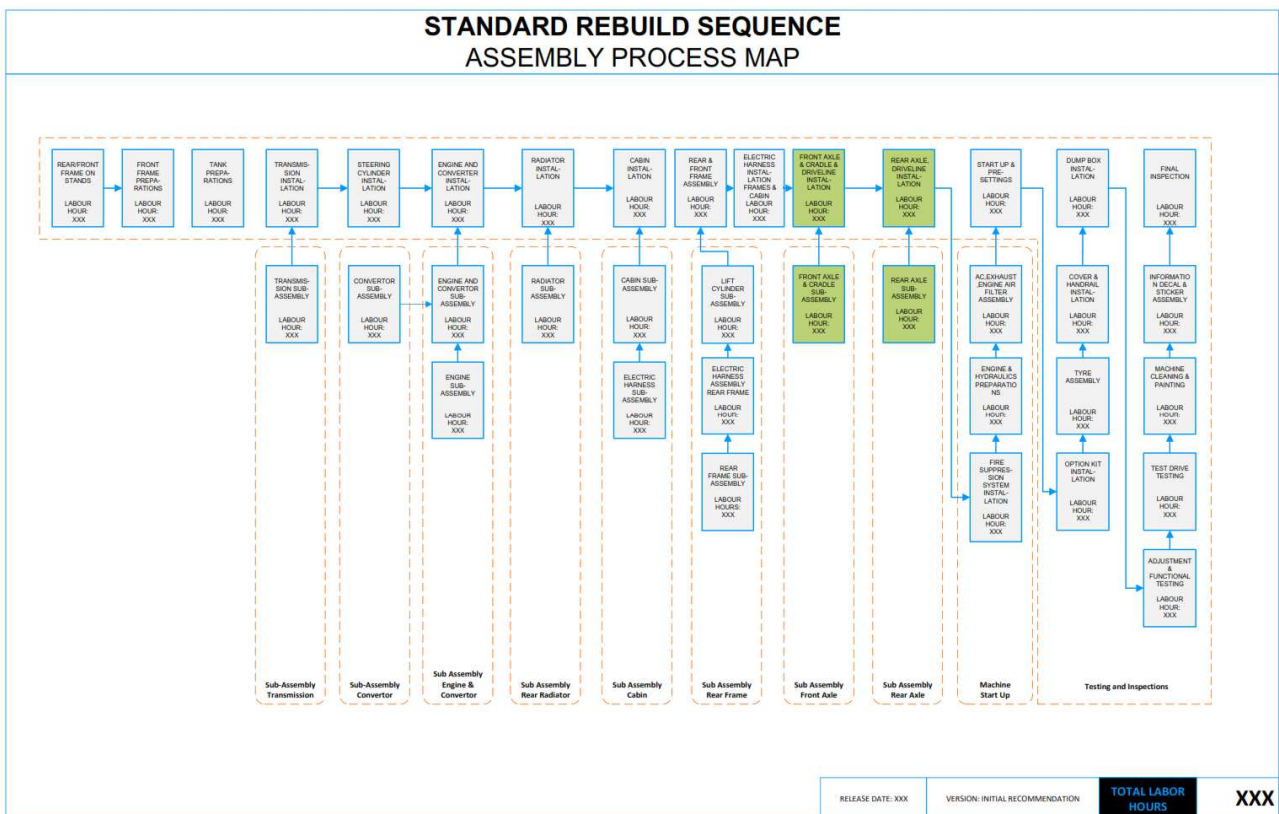


Figure 4. The initial rebuild standard work sequence process map.

The upper horizontal work sequence row describes the main rebuild assembly work activities and the vertical rows describe the sub-assembly activities. Also, the work sequences (squares) are colour coded for better understanding and information of the proposed rebuild work tasks. The green colour coded work tasks indicate that the rebuild work instruction material have been created initially for pilot project purposes of this Thesis and for these particular rebuild work steps only.

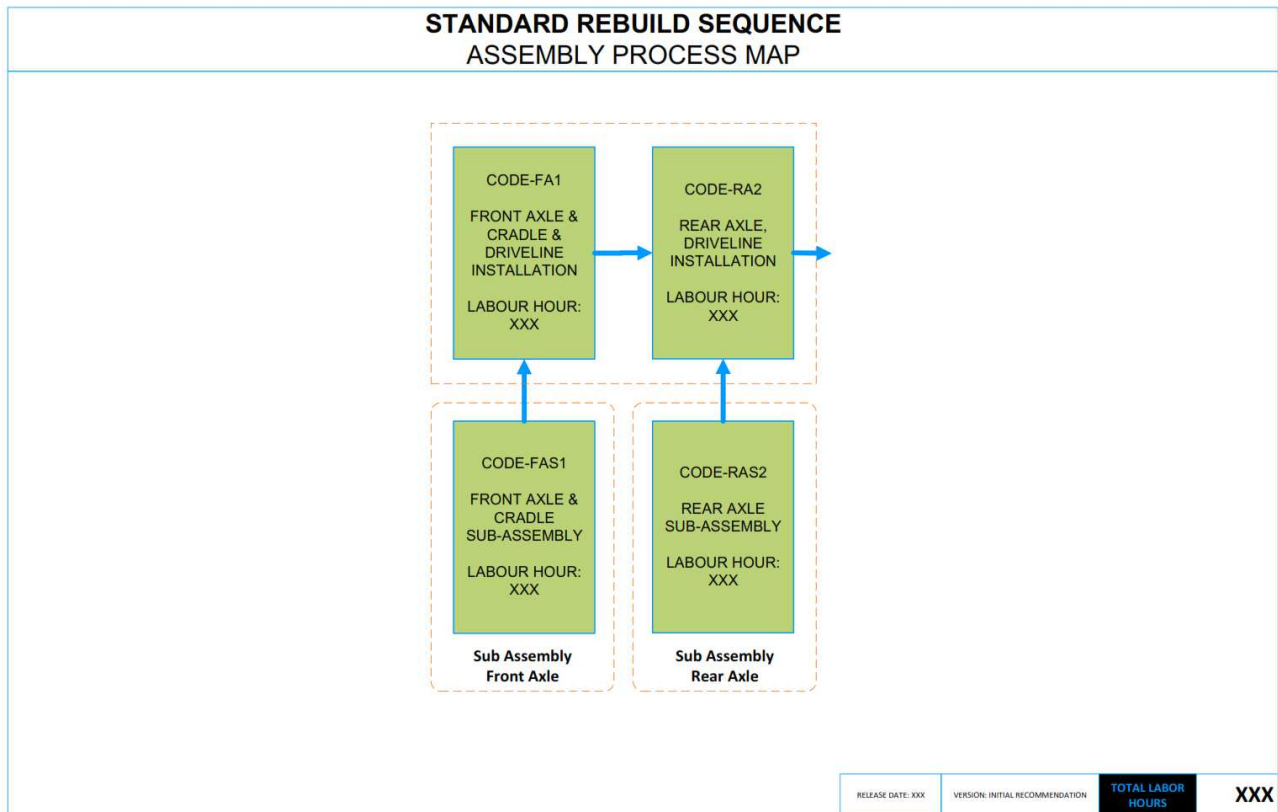


Figure 5. The selected initial rebuild work sequences for the material piloting.

As illustrated in figure 5 above, four rebuild work sequences are selected for the piloting of the re-engineered rebuild work instruction material. Each work sequence task is coded by the work process code individually and the main work functions are described as well as estimated labor hours are included into each work tasks. Two higher rebuild work task squares describes the main work sequences (upper main row) and the lower rebuild work tasks includes the sub-assemblies.

5.4 Initial Proposal for the Rebuild Work Instructions (SOPs)

The proper rebuild work instructions are another mandatory document along with the rebuild work sequence map. As mentioned earlier in Section 3.7, the Case Company has a long and markable experience as an original equipment manufacturer of the underground mining machines and this clearly indicates that the work instructions have been created for its internal production purposes earlier. However, the similar or any other assembly work instructions (SOP type of instructions) have not been created and introduced for the machine rebuild purposes which might vary from the original assembly processes.

According to Olofsson (2016), Many industries have been creating detailed Standard Operating Procedures (SOP) for internal use due to requirements of the quality systems. Basically, the SOPs describes all the work steps in the process and might include other relevant information also as the required tooling and/or safety procedures (Olofsson, 2016).

The Case Company's available rebuild documents were researched during the data collection rounds and the outcome was that the current rebuild instructions are not suitable for possible modification or other re-engineering work for the initial proposal of the rebuild instructions. However, the Case Company's internal assembly work instructions (in Section 2.4, table 5, document no.7) were researched during the data collection rounds as well and these might provide a suitable work instruction format level for the necessary modifications and re-engineering which are necessary for the rebuild work instruction purposes. Basically, the Case Company does not use this particular work instruction materials anymore as the production department has decided to replace the old assembly instructions by the new model of the production instructions.

These OEM's internal standard operation procedures (SOPs) includes a large amount of the machine model specific material (nearly 900 pages per machine model) and it is impossible to modify all necessary materials for the one machine model's pilot project purposes of this Thesis due to limited time schedule.

Martinsuo (2010) states that enhancing the performance of organizations through processes can imply a shift to a process-oriented approach, implementation of a new single process, radical re-engineering of existing processes, or implementing improvements of varying scale into current processes. Developing old processes that in the spirit of continuous improvement, the employees working in the process may trigger process improvement through their practical and stepwise development proposals. Improvement can take place in small steps, or it may already have occurred spon-

taneously, which simply implies the need to update the process descriptions to take the improvements into account. In practice, different kinds of development projects can be connected with each other: for example, in a merger, it is necessary to create completely new processes, as well as radically re-engineer and improve old processes gradually (Martinsuo et. al, 2010).

The proposed material for the rebuild work instruction have been modified and re-engineered from the original Case Company's assembly instructions which had originally been internally introduced in the Finnish language only and in different format. Also, the content might extensively vary as the final purpose of the modified work instructions is widely different than the original purpose was.

Thus, the limited time schedule of the Thesis, three separate assembly instructions were modified for the rebuild work instruction and sequence pilot project only and these are identified with the green colour in the rebuild work sequence map.

5.4.1 The Initial Standard Rebuild Work Instruction Example.

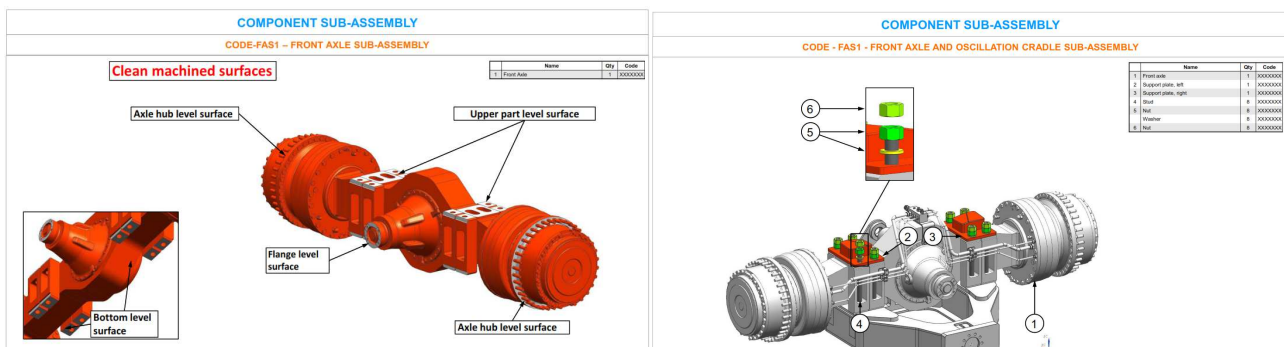


Figure 6. The Initial Standard Rebuild Work Instruction examples.

Two examples of the initial standard rebuild work instruction are illustrated in figure 6 above. These particular initial rebuild work instructions are examples from the 70 different rebuild work instruction pages which are re-engineered for the rebuild document piloting project only.

5.5 The Pilot Project for the Initial Rebuild Documents

An original plan was to arrange the field pilot project for the initial rebuild documents which were included the full set of the rebuild work instructions for the one machine model and its components. Also, the rebuild work sequence project chart for the same machine model was planned to pilot along with the full machine model wise rebuild instruction materials at the same time in the real-life rebuild project/-s at one or in many the case company's selected workshops simultaneously. However, due

to the current situations with the global rebuild projects, global travel restrictions (Covid-19) and limited time schedule in this thesis, it was decided to manage the pilot project differently.

Martinsuo (2010) underlines the importance of the pilot test for the target process. It should be piloted with good support and conditions before its general implementation. The piloting of complicated processes may not always be possible, but even in these cases, the planned process model should be piloted by asking the work process personnel and other stakeholders' opinions regarding the feasibility, defects, and areas for development in the work process. Possible improvement areas of the entire work process should be easily recognized by the piloting and testing activities, and these should be taken before the wide process launching. Planned process implementation also involves developing the competences of the employee involved in carrying out the process and familiarizing the necessary systems to the process. This may require a separate campaign, a training program for different employee groups, process guidelines targeted at different stakeholders, changes to IT systems, and even changes to the Company's presentation materials and web pages. The process implementation might cause modifications to other planned processes which are under development and this possible impact should be planned and scheduled already in the early stages of the development project (Martinsuo et. al, 2010).

The pilot project has been decided to conduct for the rebuild work sequence map and three detached rebuild work instructions within it. All selected stakeholders have been received the material for their survey and feedback purposes within the separate questionnaires. Basically, the pilot project is the feedback collection project for the recommended rebuild work sequence and instructions which are created for the Case Company's global rebuild operations as the main outcome of this Thesis.

5.6 Recommendations for the Rebuild Material Sharing and Updating

The Case Company has the operations in more than 160 countries, and it is important to develop the best possible outcome for the document sharing and flexibility for possible further modifications and/or adjustments and updates due to a local or global requests and demands. However, suspicious behaviors in the industrial business sector regarding the industrial spying is very common nowadays, internally, and externally, and many companies takes seriously this harmful activity or the threat of it. Competition between the companies is in high level and thus, this might cause some suspicious phenomenon especially in some industrial cultures where the barriers are lower for the industrial spying.

The Case Company has many global competitors in the mining machine rebuild business sector which are actively searching the vital information for their own rebuild operation business offerings to the same customers and the target to penetrate the same business area without any relevant experience. Thus, it is highly recommended to share the Case Company's rebuild material via secured IT platform and nominate one administration person to update and coordinate the whole rebuild material database.

SPMS (2016) states that the governance systems will be established which allow the control of change so that the latest and highest quality version of standard work is available to all who require access (SPMS, 2016).

According to Olofsson (2016), the final step is a selection for the person/-s who produce the standard work procedure materials. It is common to get help from the workshop supervisor/-s who can create a draft version of standardized work procedures based on the collected results from the stakeholders. The standard work instructions should be available easily and visible for all key employees for the ease follow-up and compare how the actual work is performed (Olofsson, 2016).

According to Martinsuo (2010), the key characteristics of process management are systems thinking, customer focus, goal orientation, focus on value-adding activities, effective use of feedback in modifying operations, and systematic and deliberate process development for performance improvement. Understanding and developing activities as processes is an effective way to implement strategy, achieve customer satisfaction, promote efficiency, and enhance cross-functional and cross-organizational cooperation. In addition, process management emphasizes the systematic use of tools, documentation and information systems that are integral to sharing good practices and standardizing and automatizing activities. Process modeling often involves the adoption of new information systems, too (Martinsuo et. al, 2010).

During this Thesis project, it was decided to start the important monthly meetings, as mentioned in section 3.1 earlier, along with the selected global workshop stakeholders where information sharing is convenient and safe. The global workshop improvement monthly meetings along with a wide group of the selected workshop stakeholders is very first kind of global communication channel between the workshop managers and other key persons in the Case Company's operational rebuild history.

Internal communication channel was created for the global workshop monthly meetings and basically, this provides safe and practical platform for information and documentation sharing. The documentation protection system as well as access level options are available which allows practical

monitoring activities to the system's administration department. It is recommended to keep and improve the existing global workshop improvement communication forum at this stage when the rebuild materials are under improvement process.

The next section (section 6) combines the results of the current state analyses, the conceptual framework and the outcome from the Data 3 collection round for the final proposal of the standard rebuild work sequences and the standard rebuild work instructions.

6 Validation of the Proposal

This section reports on the results of the validation stage and points to further developments to the initial proposals of the Case Company's Standard Rebuild Work Sequences and Rebuild Work Instructions. At the end of this section, the final proposals and recommendations are presented as well as the final modifications that have been made for the initial proposals. This section includes nine sub-sections.

6.1 Overview of the Validation Stage

The main outcome of the validation stage is to develop the final proposals and recommendations for the initial proposals of the rebuild work sequences and rebuild work instructions. The validation round (Data 3) was conducted by the re-designed pilot project between the selected stakeholders. The main reason for the re-designed pilot project to the global pandemic situation (Covid-19) and travel restrictions. Also, due to a large amount of required material for the complete machine model rebuild work instructions was decided to perform the pilot for the rebuild work instructions with the reduced amount of the instructions.

The initial rebuild material was introduced to the Case Company's selected stakeholders, including a senior managerial level stakeholder, for their valuable inputs for the validation purposes. The global meetings were arranged via Teams in two separate sessions due to different time zones and large number of attendees. The initial rebuild material was shared via the Teams' share point securely as an encrypted draft version where the printing, sharing, and editing were limited. An idea of the secure rebuild material sharing was a part of the piloting for better understanding of further safe material sharing globally. All the selected stakeholders have received invitations for an individual access into the Case Company's share point where the new rebuild materials were uploaded and from where the stakeholder can self-study the material for better understanding of the new rebuild material concept.

Both global Teams meetings were structured by the same way, including the new rebuild material introducing within explanations and fundamentals of the rebuild work sequence map and the rebuild work instructions. The feedback collection (Data 3) questionnaires sheet was sent to each stakeholder after the meeting for their valuable insights and critiques. The questionnaires were created for the new rebuild material only as the decision of the material's global sharing and encrypting methods does not belong to the Case Company's global workshop managers. Due to importance of the encrypted material sharing, it was decided to continue the original way of material sharing (Teams) until the further information from the Case Company's senior management.

Overall feedback from the global stakeholders were positive and developing. However, it was expected that the total amount of feedback would be larger. The new rebuild materials, as the rebuild work sequence map and rebuild work instructions received a good reception from all the stakeholders and basically, the piloted rebuild materials were the long-awaited material globally.

6.2 Developments to the Proposal Based on Findings of Data Collection 3

The collected final recommendations for the rebuild work sequences and rebuild work instructions are presented in table 16 below. Also, recommendations for the rebuild material global sharing and encrypting are listed in the same table below.

Table 16. Summary of the final collected recommendations (Data 3).

Category	Summary of the Collected Recommendations
<p>The Rebuild Materials: The initial rebuild work sequence process map and the initial rebuild work instruction (SOP) within it.</p>	<ul style="list-style-type: none"> (1) Similar material needed for other machine models. (2) Component weight information can be included as well as safety reminders, tightening torques, lifting instructions, consumables information, adjusting procedures, relevant tooling guidelines, simplicity (no confusion), instruction should illustrate the component location, instruction should be easy to read, and all relevant instructions should be available for each work step. (3) The main big components (frames) should be connected in early stages to avoid heavy lifting due to limited overhead crane lifting capacity. Also, avoid repetitive work sequences and sentences. (4) Component repair instructions and labor hours should be added into the work instructions. (5) Safety reminder as the PPE (Personal Protective Equipment) should be included into the rebuild work instructions. (6) Several separate components are illustrated in the same instructions and would be good if the different components are separated into own instruction sheet. (7) Final test procedures should be included into the rebuild work instructions. (8) Labor hours should not be visible in the rebuild work sequences or instructions at this stage.
<p>The IT platform and secure material sharing: The global access into the in-rebuild material (IT platform), encrypting and further piloting.</p>	<ul style="list-style-type: none"> (1) The rebuild material should be protected for the downloading, print outs, editing and sharing. (2) The complete machine model based rebuild material should be piloted as soonest.

As shown in table 16 above, the final recommendations are divided into two categories where the first category includes the recommendations for the piloted rebuild materials and the second category includes the recommendations for the IT platform and secure material sharing that should be performed for the further internal material sharing channel as well as the second piloting round. The initial recommendations are described in section 5 and the final recommendations are described in section 6.3 below.

6.3 The Final Recommendations for the Rebuild Materials

As mentioned earlier, the initial rebuild materials received positive feedback in a general level and the overall outcome of the data collection round (Data 3) was slightly expected. However, a few new insights were collected also, and these recommendations are described in detailed level in the text below.

Table 17. The final recommendations for the rebuild material.

Category	Summary of the Final Recommendations for the Rebuild Material
The rebuild work sequence process map and the rebuild work instructions.	<ul style="list-style-type: none"> (1) Create the same rebuild material for other selected machine models. (2) Include the selected component weight information. (3) Include the selected safety information. (4) Include necessary tightening torques. (5) Include the component lifting instructions. (6) Include necessary quality inspections with specific instructions. (7) Include necessary technical adjusting procedures (e.g. hydraulic settings). (8) Include relevant tooling information (required special tool information). (9) Keep the material as simple as possible – instruction should be easy to read, and all relevant instructions should be available for each work step and avoid repetitive work sequences and sentences. (10) Re-organize the rebuild work sequence process map - the main big components should be connected in early stages to avoid heavy lifting due to limitations with the overhead crane lifting capacity. (11) Include the final test and inspection procedures. (12) Labor hours should not be visible in the rebuild work sequences or instructions.

As shown in table 17 above, the final recommendations include a several topics which should be added into the final version of the rebuild material. The first stage is to make necessary updates to the initial rebuild work sequence process map by the selected recommendations. The rebuild work sequence map is the higher level rebuild process flow map which describes the necessary work steps from the beginning till the end of the machine's dismantle and reassembly processes.

6.3.1 The Rebuild Work Sequence Process Map

The feedback was clear for the need of the rebuild work sequence maps (1) of all the machine models and thus, it is recommended to create the rebuild work sequence process map for all the selected machine models and pilot separately along with the other rebuild materials.

The selected recommendations for the rebuild work sequence process map are 6, 7, 9, 10 and 12 from table 17 above. Firstly, (6) necessary quality inspections should be mentioned by the name and

a specific quality gate symbol after the selected work task. Secondly, (7) it is recommended to use similarly the specific symbols for all necessary adjusting tasks which can be included in the process map before or/and after the work task/-s which require any possible mechanical, electrical, or hydraulic adjustments or pre-settings (e.g. hydraulic settings).

According to Martinsuo (2010), Systematic process charting through simply documenting can help to clarify the agreed ways of working. Also, a vital target behind the process modeling is to search possible improvement areas (Martinsuo et. al, 2010).

Thirdly, (9) all the rebuild material should be as easy to read as possible and avoid repetitive work sequences as well as sentences.

According to Martinsuo (2010), when describing the target work process, it is important to ensure the simplicity and practicability of the work process model (Martinsuo et. al, 2010).

However, Anders Haug (2015) states that sometimes it is necessary to mention important aspects several times to ensure that recipient notes this information. The dimension would look closely related to unnecessary instructions in the sense that some of the repetitions are unneeded. But, if the instructional information in focus is needed, then the problem is not that the information is given but that it is repeated too often by the instruction provider (Anders Haug, 2015).

Fourthly, (10) the work tasks should be re-organized the way where all possible heavy liftings would be avoided due to limited lifting capacities in the Case Company's global workshops as well as improve the safety factor of the lighting processes.

Olofsson (2016) states that basically, the SOPs describes all the work steps in the process and might include other relevant information also as the required tooling and/or safety procedures (Olofsson, 2016).

Fifth and the final recommendation (12) for the rebuild work sequence process map includes the modification which limits the shareable rebuild process information in the wider scope of the rebuild projects. During the rebuild material pilot project, it was decided to remove all labor hours from the rebuild work sequence process map, as well as from other rebuild material, as it is sensitive operational information for the Case Company, and it should be available for limited and selected stakeholders only.

6.3.2 The Rebuild Work Instructions

The second stage is to make necessary updates to the initial rebuild work instructions by the selected recommendations. The selected recommendations for the rebuild work instructions are 2, 3, 4, 5, 6, 7, 8, 9, 11 and 12 from table 17 above. Some of selected recommendations have been selected earlier for the rebuild work sequence process map as well as both documents should be updated by the same recommendations or a part of it.

The first comment, before other described recommendations below, is the feedback for the need of the rebuild work instructions of all the machine models (1). It is recommended to create the rebuild work instructions for all the selected machine models and pilot separately along with the other rebuild materials.

Firstly, the selected group of recommendations (2, 3, 4, 5, 6, 7 and 8) includes all important information for the disassembly and re-assembly activities which should be included into the correct pages of the rebuild work instructions. The component weight (2) and tightening torque (4) are relevant information which should be available directly in the instruction's pages along with other related work instructions. Available information of the component weight might improve the safety aspects as well as the weight guides into the right selection of the lifting equipment or lifting methods. Recommended safety information (3) and component lifting instructions (5) includes the specific work step related information which should be included into the work instruction pages as needed. Also, the lifting instructions for the heavier components, as the complete machine frames, should be available in the instructions. However, avoiding the repetitions and the massive workload, the safety and lifting instructions and information would be collected into the separate page, or pages, which is/are included in the larger rebuild work instructions.

It is recommended to directly follow the Case Company's safety policy if any safety instructions or other related safety guidelines are used in the rebuild material.

The quality inspections instructions (6) are relevant and important technical support material for all necessary quality gate inspections and all the quality gates should be visible with the separate symbols in the rebuild work sequence process map. The specific quality inspection procedures should be included into the basic rebuild instructions along with necessary technical instructions (7) for the mechanical, electrical and hydraulic settings and adjustments.

Anders Haug (2015) states that for the informative and understandable instructions, the consistent terminology, symbols, logic and so on should be used to avoid possible confusing of end user (Anders Haug, 2015).

Request for the necessary special tools (8) has been highlighted several times during the data collection rounds. The Case Company's global workshops are interested to use the same special tools as available in the Case Company's manufacturing factories. Basically, most of these tools are designed for the Case Company's underground machines only and thus, it is recommended to add all necessary information of the special tools into the rebuild work instructions as required by the particular work sequence.

Secondly, as mentioned in 6.3.1, the rebuild work instructions should keep as simple as possible as well and avoid repetitive work instruction guides and sentences. However, would be challenging to balance with all necessary information and simplicity of the instructions in the end.

Olofsson (2016) states that the SOPs (standard operational procedure) type of instructions might cause a problem as these documents are often thick and difficult to read if the target is to include as much relevant information as possible (Olofsson, 2016).

Thirdly, the final test and inspection procedures is recommended to keep as a separate document from the rebuild instruction due to its large size. However, this material also should have its own dedicated code which is available in the rebuild work sequence process map. This important material includes all necessary work procedures for the complete machine's final testing and quality inspections before the delivery to the customer. This material, as well as other quality inspection procedures, have a great status as it is indicating the high-quality level of the Case Company's workmanship and it should be well saved for possible further warranty claims.

Fourth and the last recommendation for the rebuild work instructions is the same as it was for the rebuild work sequence process map. All possible labor hours (12) should not be added into the work instructions at this stage.

6.3.3 The Final Recommendations for the Secure Rebuild Material Sharing and Further Piloting

The final outcome of this Thesis was to provide the final recommendation for the rebuild work sequence process map and the rebuild work instruction example within it. Possible recommendations for the secure rebuild material global sharing or recommendations for the further rebuild material piloting were not a part of the final outcome of this Thesis. Nevertheless, increasing awareness of

the secure material and information sharing globally has been concerned during the data collection rounds (Data 1 and 2) and the rebuild material piloting (Data 3). This Thesis does not include any deeper investigations of the secure material sharing globally but provides valuable recommendations, which are observed during this Thesis project, for possible further rebuild material piloting which is recommended after all larger modifications of the material.

Table 18. The final recommendations for the rebuild material secure sharing and next piloting.

Category	Summary of the Collected Recommendations
The rebuild material secure sharing and further material piloting.	(1) The rebuild material should be protected for the downloading, print outs, editing and sharing. (2) The complete machine model based rebuild material should be piloted as soonest.

As shown in table 18 above, importance of the protected rebuild material was highlighted during the pilot project (Data 3) and it is recommended that this critical topic will be taken under deeper investigation for the secure and well protected material sharing. It is recommended that the solution for the secure rebuild material sharing is available before the launching of the complete rebuild standard work sequence process map or the complete rebuild standard work instructions if possible.

However, the Case Company's internal Teams based Share Point would be a practical solution for the rebuild material sharing at this stage as the software provides the solutions for protecting and encrypting the uploaded material for sharing, printing, editing and downloads. This solution for the material sharing would be a suitable when piloting the new material and when the practical hands-on work is not necessary (with the material) in the larger projects. According to the rebuild material pilot (Data 3), the material sharing via the Teams Share Point would not be recommended as the final solution due to its unpracticality in the real-life working environments.

6.4 The Final Modifications for the Rebuild Materials

The final outcome of this Thesis was to provide the final recommendation for the rebuild work sequence process map and the rebuild work instruction example within it and this section describes the final recommendations for the rebuild work sequence process map and the rebuild work instructions which are modified by the results of the initial rebuild material pilot project (Data 3). Modifications are illustrated and described in two sub-sections below.

6.4.1 The Modified Rebuild Work Sequence Process Map

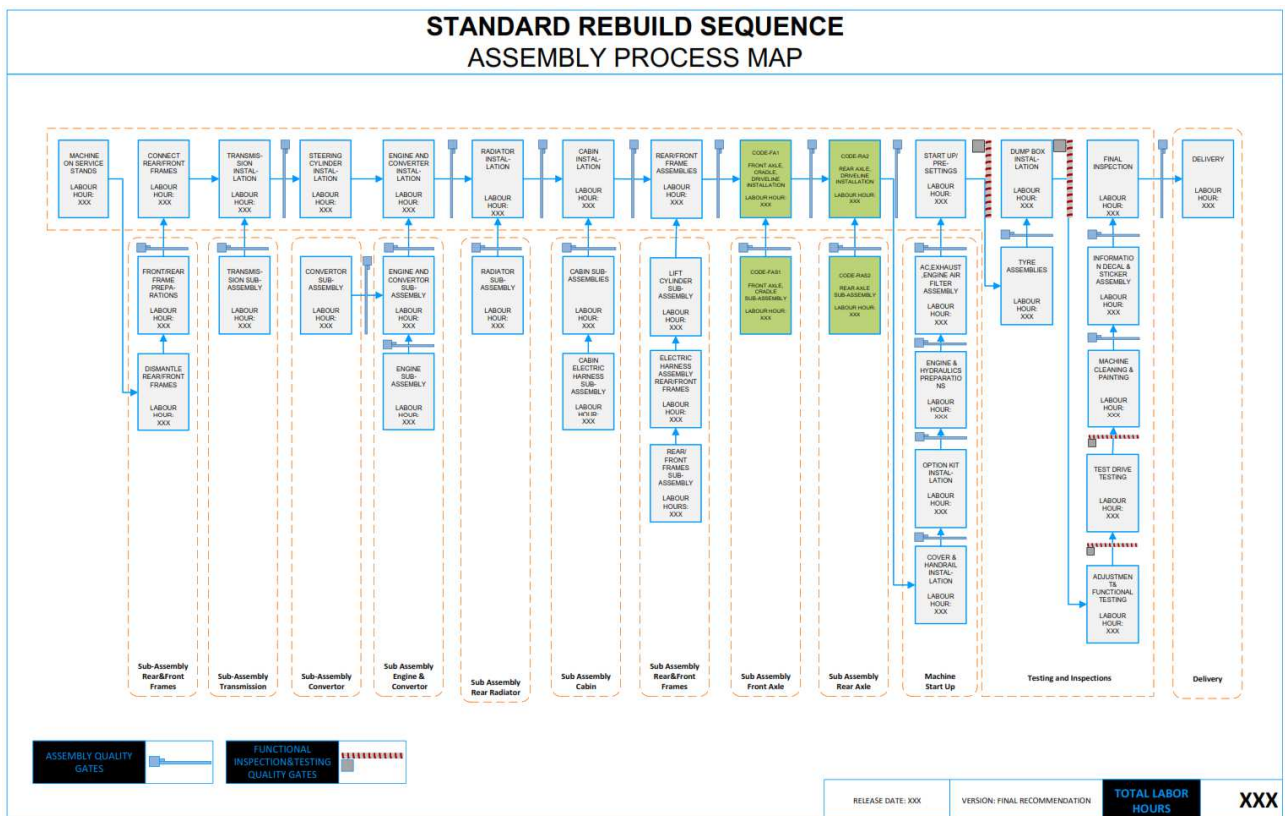


Figure 7. The Final Modified Standard Rebuild Work Sequence Process Map.

Work sequences are simplified and re-organized for better workflow in the real-life rebuild project as well as reduce the repetition of the work steps. Also, the work steps are re-organized with way where the heavy liftings are minimized as the lifting capacity might be limited in some cases due to small lifting cranes. It is recommended to design all the rebuild work sequence process maps with the similar idea where the heavy liftings are minimized for better safety and reduce a possible cost of the larger mobile crane rent or purchase.

Two different quality gates are included into the process map for improving the workmanship quality and the end product quality levels. Also, these quality gates indicate the separate inspection instructions which should be created for each quality gates. These quality gate inspection instructions are not presented in this Thesis project.

The first, the assembly quality gate (blue colour) indicates the quality inspection what is recommended to perform before or after the selected work task. This particular assembly quality gate should include the component condition inspection and assembly inspection.

The second, the functional inspection and testing quality gate (grey/red colour) includes all necessary inspections which occur when the machine is operating and when the particular functions and/or tests are possible to implement. The functional tests are important part to improve the rebuilt machine's quality, safety and lifetime. The vital final test drive work sequence includes the heavy operational as well as the lighter functional tests and loads for the rebuilt machine for the final quality report which confirm that the end product is as safety, robust and fulfill the quality expectations as the similar new product and confirmation that the rebuilt machine is the same what it is designed for originally.

It was decided by the senior management that the labor hours should not be visible in the rebuild materials at this stage. However, the labor hours will be simply included into each work sequences if the Case Company will decide to use indicative working hours in the rebuild materials.

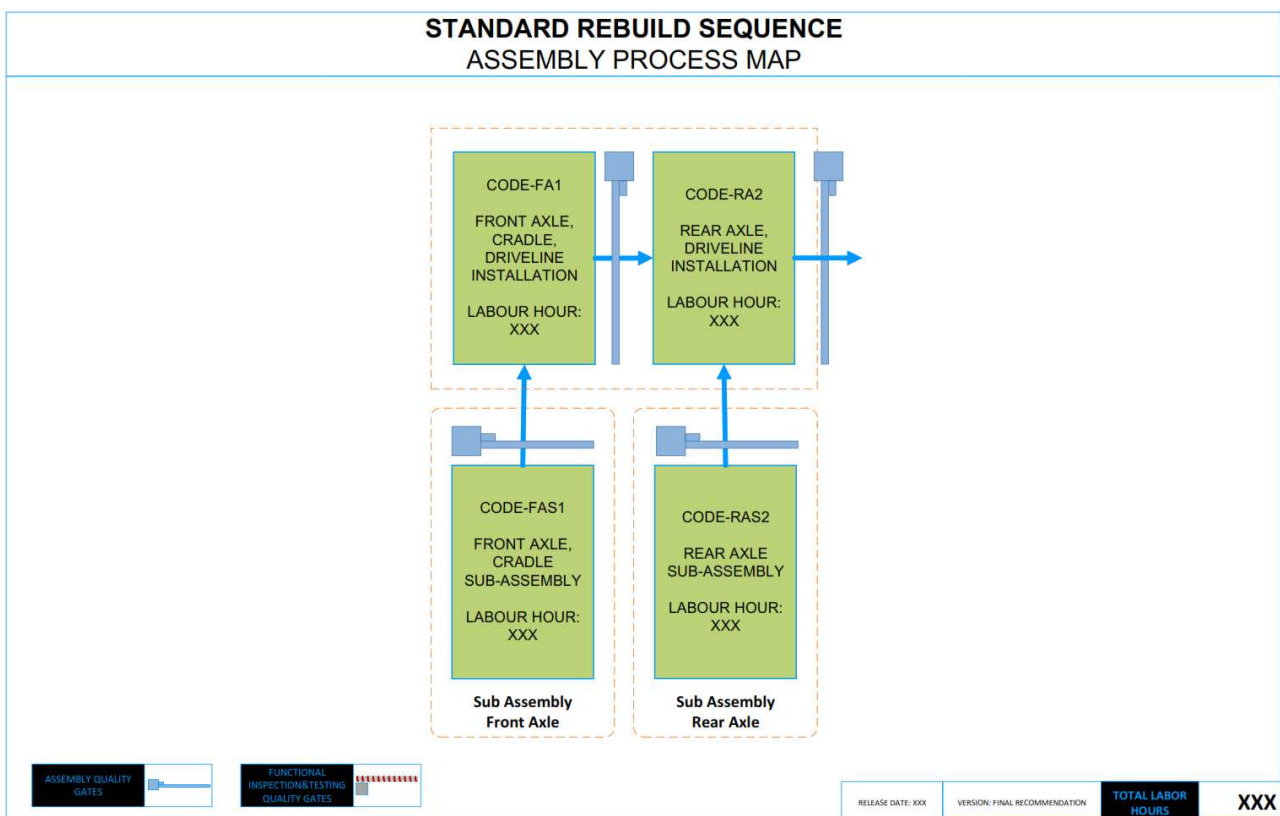


Figure 8. The selected and piloted rebuild work sequences with the final modifications.

The four work sequences in figure 8 above are selected for the rebuild work instruction piloting and these work steps are highlighted by the green colour in the rebuild work sequence process map (as mentioned earlier in section 5.3.1). Basically, the new rebuild work sequence process map was piloted along the limited amount of the rebuild work instructions due to a large need of the instructions and thus, limited time schedule of the Thesis project. Nevertheless, the pilot project with a limited

rebuild material provided important feedback, insights, and improvements for the next version of the rebuild materials.

The selected work sequences include the assembly quality inspection gates as well as all four work sequences are coded which indicates the identification code for the particular rebuild work instructions. By the specific code of the rebuild instruction, the specific rebuild instruction should be identified from the rebuild material library if the Case Company will decide to create any in the future.

The next sub-section describes the modifications which have been done for the piloted rebuild work instructions. However, due to a large amount of the rebuild material, only two separate work instructions are illustrated within necessary modifications below.

6.4.2 The Modified Rebuild Work Instruction

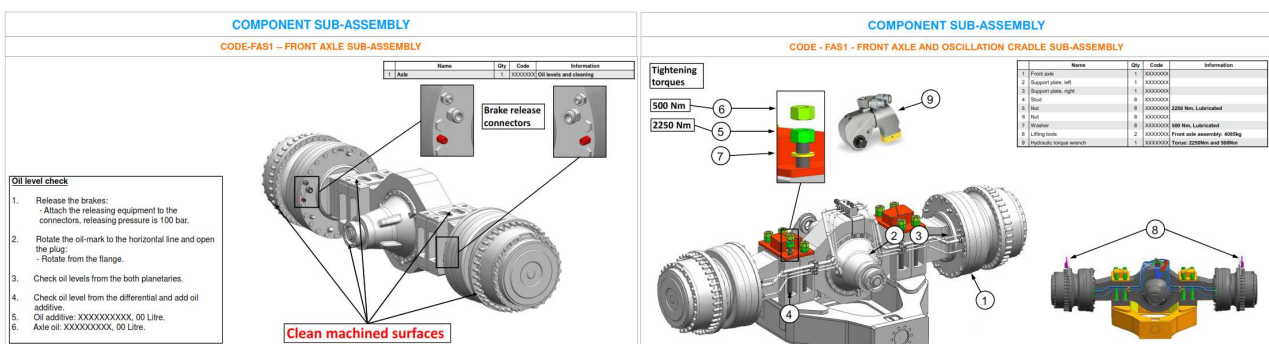


Figure 9. The final standard rebuild work instruction examples.

Two examples of the final standard rebuild work instruction are illustrated in figure 9 above. These modified rebuild work instructions are examples from the 70 different rebuild work instruction pages which are re-engineered for the new rebuild instruction purpose only. These recommended rebuild work instruction example pages are modified by adding the relevant information which are collected from the initial rebuild material piloting (Data 3).

The first rebuild work instruction example page (left side) illustrates the mining machine's front axle's sub-assembly work sequence which includes the surface cleanings and the oil fillings. The rebuilt axle is re-painted, and the machined surfaces need to be cleaned from the before final re-assembly work sequence and these machined surfaces are guided by the arrows in the instruction as seen in figure 9 above. Also, the oil filling capacities and instruction are mentioned in the same instruction. All necessary components are available with the specific serial number which are created by the Case Company and this serial number is included into the same instruction page as well.

The second rebuild work instruction example page (right side) illustrates the mining machine's complete front axle assembly with its oscillation cradle. This example instruction page includes the tightening torques of the stud bolts which are the main mounting bolts between the axle and the oscillation cradle (axle's mounting bracket). This instruction page includes a picture of the special tool (torque wrench) as well as the specific tightening torques for the tightening of the main axle's mounting stud bolts. However, it is not recommended to add all necessary standard tools into the rebuild work instruction pages due to limited space and as is not important to mention repeatedly the same standard tools. If the Case Company will add the specific information and illustration of the standard tools in future, then it is recommended to add an extra page for this purpose where all necessary tools basic tools are collected.

The instruction example for the lifting of the complete front axle assembly is illustrated in the same instruction and the complete assembly weight is informed in the information table. In this particular example instruction page the necessary lifting information are included into the same page and it is recommended to use a similar informing method with other selected rebuild work instruction pages as well where the similar lifting instructions are illustrated for the main and heavier components only. The space of the instruction page is limited and due to this, it is recommended to create a separate lifting instruction for the minor components where the component's weight and specific lifting instructions are illustrated and explained.

All rebuild work instructions follow the same type of format where the information table is in the right upper side of the page as seen in both rebuild work instruction examples in figure 9 above. The information table includes necessary instructions and information which are collected for the need of that specific work sequence which is illustrated in each rebuild work instruction pages. The serial numbers, as well as the oil capacities are marked by the X in the example rebuild work instructions for this Thesis purposes only.

Validation of the initial rebuild work sequence process map and rebuild work instruction proposals were performed differently as planned originally. The original plan for the initial rebuild material validation was to create a complete rebuild material for the one machine model and arrange a real-life pilot project in one of the Case Company's global workshop and make a possible modifications and corrections at the selected workshop along with the local stakeholder during the project. However, due to tight time schedule, large amount of the material and global Covid19 situation, the validation of the initial rebuild material proposals were arranged via phone calls, emails, Teams meeting, and shared initial rebuild materials.

The seventh and the final section summarizes the Thesis work and includes recommendations for the next implementations and provides a self-evaluation of the study.

7 Conclusions

This final section includes an executive summary, recommendations for the next possible implementations with the rebuild material and rebuild standardization project as well as a Thesis evaluation and the closing words.

7.1 Executive Summary

The objective of this Thesis was to create the global rebuild standard work sequence process map and the work instructions for the Case Company and the outcome was to recommend improvements and implementations for the created rebuild instruction materials of the Case Company's global rebuild operations. Mainly, the recommendation and implementation ideas consider to the rebuild work sequence process map and rebuild work instructions which were not available earlier. Also, the recommended rebuild materials are created with an idea to standardize the Case Company's global rebuild operations.

The research approach of this Thesis was a design research with qualitative and quantitative data collection methods where all possible and available information were analyzed. The research design includes the four stages where the first stage was a current state analysis, which provides the strengths and weaknesses of the current process and the second stage, the literature review, combines the findings and insights from the selected literatures for the first stage findings and provides a conceptual framework. The outcome of the third stage was the initial recommendations for the rebuild work sequence process map and the rebuild work instructions which were created according to the pilot project with the selected stakeholders. The fourth and the final stage includes final analyzing of the pilot project and the final recommendations for the rebuild materials as the rebuild work sequence process map and the rebuild work instructions.

The current state analyses were conducted by interviews of the selected stakeholders, workshop surveys and investigating the Case Company's existing limited rebuild material. The findings were separated into six categories where the first four categories consider the outcome of the interviews and surveys from the selected stakeholders and the second two categories consider the review of the existing rebuild material and the current rebuild practices. The findings were described and separated into the weakness and strengths categories. The literature review considers on the conceptual framework build up based on the selected weaknesses from the current state analyses stage.

The initial proposals of the rebuild work sequence process map and the rebuild work instructions examples within it were created based on the Case Company's existing and re-engineered material, the new type of the rebuild work sequence process map and the vital data collection rounds from the selected stakeholders. The initial recommendations were evaluated and commented by all the selected stakeholders via online Teams sessions and emails along with separate questionnaires.

The final recommendations for the rebuild material were divided into two separate categories where the first category includes twelve important improvement recommendations for the rebuild work sequence process map and the rebuild work instructions. The second category includes two main recommendations for the secure rebuild material sharing globally by the growing understanding of the secure critical information sharing and awareness of the competitors in the same business area. However, the outcome of this Thesis does not provide the final solution for the secure rebuild material global sharing but provides valuable recommendations, which were noticed during the pilot project, for the next possible rebuild pilot which is recommended for all the further rebuild documentations.

The Case Company has a strong reputation in the areas of the customer service and aftermarket and the recommended actions with the rebuild materials and standardized work methods may further strengthen these areas as by improved safety, quality, and lead time of the global rebuild operations. Also, the standardized quality inspections and the final tests, which include a proper documentation may improve possible warranty cases in future.

7.2 Recommendations toward Implementation

This section includes the recommendations for possible further implementations of the rebuild work sequence process map and the rebuild work instruction materials. The research of this Thesis study along with increasing rebuild business sector indicates strongly that the need of the proper rebuild instructions is valid in the Case Company's global workshops. The current Covid-19 situation has been showed also that the rebuild instructions should include all possible instructions and information that the stakeholders can operate the projects independently without continuous support from the Case Company's designated support departments.

The first recommendation considers the complete rebuild material which is based on the one selected machine type. Due to large amount of required material and short time schedule, the piloted rebuild material was limited for the pilot project of this Thesis. However, the same piloted rebuild material of the selected machine model may be completed till all necessary rebuild instruction pages as well as the final test instructions are completed along with the necessary quality gate inspection

instructions. The rebuild work instructions, and other related rebuild support documents, should follow the high-level rebuild work sequence process map which provides the rebuild process flow steps along with the guidelines of the necessary rebuild documents.

The second recommendation is focused on the rebuild material piloting. All new or modified material should be piloted with the selected stakeholders for the best possible outcome of the rebuild material. The Case Company would be able to collect necessary feedback from the separate and different machine model rebuild projects simultaneously which may speed up the possible material design process.

The third recommendation considers the rebuild material design as a normal engineering process in the new product development project. Would be beneficial to investigate if the necessary rebuild instructions and documents are possible to design and create along with other standard production documents which are mandatory for the production assembly lines. Collaboration between the different departments is recommended if the Case Company may start to research the possibilities to design the rebuild materials along with the normal production assembly instruction documents.

The fourth and the final recommendation reminds the importance of the secure material sharing and using globally. Competition in the rebuild business area is increasing rapidly in many countries and it might cause negative impact for the Case Company's rebuild business if its own valuable rebuild documents are easily available. Relevant research project for this particular topic only would provide the best solution for the secure rebuild material sharing in future.

7.3 Thesis Evaluation

The business objective was fairly clear since the beginning as the Case Company had not a solid solution for this specific area earlier. The objective of this Thesis was to provide the recommendations for this business process area and these recommendations are described in section 6. The selected stakeholders as well as the key stakeholder have been involved in this Thesis project and all data collection rounds as required for the best possible result of this Thesis study.

Basically, the outcome of this Thesis is based on the weaknesses which were collected during the data collection rounds. However, even when the original business objective was fairly clear in the beginning then the new insights and ideas were reported from the selected stakeholders and senior management. Some questions may rise still if all the necessary feedback is reported from the stakeholders and converted for the best possible outcome of the study? In the end, the tight time schedule

sets the limits for the data collection and research must be managed between available timeframes and in this perspective, the outcome of this Thesis fulfills the original objective.

Kananen (2013) states that the evaluation of effectiveness also depends on the scope of the development project. Simple improvements and methods of influencing are easier to evaluate, especially if the target is very well defined. The wider the development object is involved and the more different stakeholders it contains, the more difficult it is to evaluate and even implement the project. Opportunities for influence seem to correlate negatively with the extent of the development target (Kananen 2013).

The author of this Thesis is a part of the management team which is responsible for the operational side of the same business area for where the Thesis objective was targeted. This model also provides valuable benefits for the deep analyze and research of the observed weaknesses as well as a wide overview for the whole Case Company's business processes and a direct communication channel between the senior management, the operational team and other stakeholders. A large number of the similar strengths and weaknesses were verified from the wide group of the Case Company's professionals which support the best possible outcome of this Thesis.

The global Covid-19 pandemic situation has created challenging situation during the Thesis project. Thus, many original Thesis related project plans were replanned and readjusted for the best possible results. The global pandemic situation has caused extremely challenging situation for the Case Company's workshops also which reflected directly into the Thesis project in many ways.

The next four sub-sections evaluate validity, reliability, logic and relevance. The final section 7.4 includes the final words of this Thesis.

7.3.1 Validity

According to Kananen (2013), the basic pillars of scientific research are scientific methods and their correct use, including the credibility of available information. Data are the raw material for science, and it is processed by the right methods to obtain a creditable outcome. The credibility of the data is an important factor for the information as it is the raw material for research. If the raw material is defective, even proper data collection and analysis methods would not help. The data must meet reliability criteria in order for the research to be of a credible with high quality. Because the most important factors in design research is a change (for the better), the outcome is as important as the scientific features. But without scientific characteristics, would be difficult to get good end results even in design research or the result would not be realized. Scientific characteristics mean, or must

be understood, that they consist of a set of methods that have been found to be good and reliable for producing new credible information (Kananen 2013).

In this Thesis, creditability and validity were confirmed by the current state analysis (Data 1) which includes multiple reviews for available documents and process methods in the Case Company. Also, the current state analyses include the separate data collection rounds from the wide group of the selected stakeholders which have the best possible knowledge of the current strengths and weaknesses of the target business area. The conceptual framework provides a wide literature review from the relevant area which was beneficial and strongly linked into the best possible outcome of this Thesis Project. The data collections were arranged via Teams meetings, phone conversations, emails and the monthly global workshop meetings which was established during this Thesis project. The global workshop monthly meeting provides an excellent direct communication channel for the stakeholders where all possible issues, insights and questions were shared and regarding the Thesis project. The initial recommendation stage (Data 2) was piloted with the selected stakeholders and presented in the monthly meetings. Also, the initial documents were available to the stakeholders' further inspection and familiarizing for the best possible feedback collections.

The outcome of this Thesis may be useful for other similar studies where the poor or unavailability of the necessary instructions, documentations or other related lack of information takes the place. Section 5 and 6 may provide a valuable recommendations and information for the further projects in the Case Company.

The related background information of the business challenge and the Case Company is described in sections 1, 2 and 3.

7.3.2 Reliability

According to Kananen (2013), reliability means the consistency of the research results. Reliability may not guarantee validity because the wrong measure may also generate the same result if replicated or reliability is in order. Stability measures how the measure keeps up with the time, and consistency how the same issue is measured by the different parts of the measure. Repetition of the measuring would ensure the reliability but in practice that may be difficult and expensive, because is quantitative research and there would be hundreds or thousands of observation units. Repeating the measuring does not always guarantee reliability either as the phenomenon may change over time. Design research has the same problems with reliability as quantitative research. Additional problems might arise from the fact that design research aims for a change whereas for quantitative research to be good, the consistency of results is required (Kananen 2013).

The project plan along with the research design is described in section 2 and its implementation is presented with relevant aspects through the whole Thesis report which includes the current state analyses in section 3 and the literature review in section 4. The sections 5 and 6 includes the initial proposal and the validation of the proposal. Section 7 includes the complete self-evaluation of the Thesis project. The collected data, including the pilot outcome data, is detailed with the topics, separate questionnaires, stakeholder's details, and times.

7.3.3 Logic

The selected research method is a design research with use of existing documentation, information and qualitative and quantitative data collections where all possible details are analyzed and described. Hence, the design research, with both data collections methods, is the relevant research method for this Thesis project.

The research design includes the four separate stages where the first stage investigates the existing business challenge and the second stage studies the relevant literature for the best possible practices and ideas for the conceptual framework which was mandatory for the design of the initial proposal for the Case Company. The fourth and last stage focuses on the validation of the final proposal within all the necessary information which was supporting the final validation process.

In other words, the logic is clear, and it clarifies the business challenge, describes the best possible recommendations, and validates it as planned in the beginning. The logic of this Thesis follows the research design in the best possible way.

7.3.4 Relevance

The relevance of this Thesis has been clarified and confirmed in advance when the business challenge was selected, and the same challenge was discussed and confirmed by the senior management since the beginning as well. The selected business challenge issue has been raised in the past also and it is based on the urgent development and implementation needs in the Case Company's business area. The selected business challenge area was finally crystalized in the data collection rounds where the direct feedback were collected from the stakeholders. Thus, the selected improvement area of this Thesis report is relevant.

The literature review was supporting the relevance of this Thesis as well as the relevant insights and ideas were collected for the selected weaknesses which were identified in the current state analyses

stage. The initial proposals were validated by the selected stakeholders which includes a member of the Case Company's senior management.

Basically, all the collected data was relevant for the use of the final proposal stage, but the twelve most important feedback were selected for the improvement of the Case Company's rebuild material as the original and selected Thesis outcome was. Section 7.2 provides four other recommendations towards to the possible further implementations.

7.4 Closing Words

May be beneficial and cost effective for the Case Company if all the necessary product designs and related engineering activities are initiated in the same new product development project (NPD). In this particular case, this means that the NPD project should include the engineering activities for the machine's life extension project as well. Basically, necessary amount of the engineering drawings might be decreased when all the possible machine type related designs and modifications are engineered for its a normal estimated lifetime and beyond that, for the life extension (rebuild) in advance.

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DATA 1	REBUILD INSTRUCTION DATA COLLECTION
DESCRIPTION OF CURRENT REBUILD INSTRUCTIONS	
DESCRIPTION OF CURRENT REBUILD PRACTICES	
WHAT KIND OF REBUILD INSTRUCTIONS SHOULD BE AVAILABLE?	
OTHER COMMENTS OR NEEDS FOR REBUILD PROJECTS	

DATA 2	REBUILD PILOT FEEDBACK DATA COLLECTION
REBUILD WORK SEQUENCE MAP	
REBUILD SOP WORK INSTRUCTIONS	
OTHER FEEDBACK FOR DRAFT REBUILD SOPs AND WORK SEQUENCES	
OTHER COMMENTS OR/AND NEEDS FOR REBUILD PROJECTS	