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PLM ACCESS MODEL

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ABSTRACT

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The amount of computer systems and usage of these system has increased a lot over the years in modern industrial companies. While these systems increase productivity and give new opportunities and practices to company, there are some challenges to face with these systems. The amount of data, companies produce and handle, has increased tremendously and has become harder to manage properly.

The need for controlling the dataflow properly and storing the data to be accessed easily has increased. It is important for companies to notice this need and take action to solve the issues before they become too complex to handle. At Metso Outotec, the need for system and dataflow analysis was already recognized and the company wants to improve its policies for handling data.

This thesis is about product lifecycle system and data management in Metso Outotec Tampere site. The goal is to make it clearer, how the systems and data work over the product lifecycle and how the data flows through the systems. The idea is to visualize the systems and data with an access model and to use interview survey to get all the data. Next to analyse the interviews and access model and find the places where the company could improve its systems and data usage and prioritize these challenges to get most out of them.

The scope of this research was mobile crusher's lifecycle, and the research was done by interviewing key personnel from that products project. The interviews produced data from systems the personnel used and the data they manage in the systems. Interviews also gave open data about ongoing challenges at Metso Outotec and that data proved to be important also. The ongoing challenges are type of issues that the personnel face in their everyday work and are great points to improve in the work environment.

Based on the interview data, the PLM access model was formed, and it gave insight from the issues in the largest systems in Metso Outotec environment. Teamcenter, SAP and Aton are the largest and the most important systems in Metso Outotec environment and the model gave the understanding that those systems require attention regarding the user groups. The data usage in those systems is really decentralized and there for needs more restrict data grouping for the users to access data properly and restriction open more possibilities for restricted data in those systems.

The improvement suggestions for Metso Outotec are based on the PLM access model and the ongoing challenges collected from the interviews. These suggestions are also prioritized for impact to the company. The main take is that the company must take action to get the new policies in use and confirm that the policies for system usage and data managing is taken seriously across the company. The situation where part of the company uses modern systems and part of the company uses old systems must be dismantled as quickly as possible. It is also important to gather information from the users more frequently to understand the needs and requirement much sooner and not to wait for issues to happen. By listening to users and improving modern system usage and solving the recognized issues, Metso Outotec has great years ahead as industry leading company.

Keywords: Access model, Flow model, data management, Product lifecycle management, PLM

TIIVISTELMÄ

Kristo Lammi: PLM Pääsymalli
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Tietokonejärjestelmien määrä ja käyttö on lisääntynyt vuosien varrella nykyaikaisissa teollisuusyrityksissä. Vaikka nämä järjestelmät lisäävät tuottavuutta ja antavat yritykselle uusia mahdollisuuksia ja käytäntöjä, näiden järjestelmien käytössä kohdataan usein haasteita. Yritysten tuottaman ja käsittelemän datan määrä on kasvanut valtavasti ja sitä on vaikea hallita oikein.

Tarve hallita tietovirtaa oikein ja tallentaa helposti käytettävä data on lisääntynyt. Yritysten on tärkeää huomata tämä tarve ja ryhtyä toimiin ongelmien ratkaisemiseksi ennen kuin asioista tulee liian monimutkaisia käsitellä. Metso Outotecissa oli jo tunnistettu järjestelmä- ja tietovirta-analyysin tarve, ja yhtiö haluaa parantaa tiedonkäsittelypolitiikkaansa.

Opinnäytetyö koskee tuotteen elinkaarijärjestelmää ja tiedonhallintaa Metso Outotec Tampereen yksikössä. Tavoitteena on tehdä selvemmäksi, miten yrityksessä käytetyt järjestelmät ja data toimivat tuotteen elinkaaren aikana ja miten data kulkee järjestelmien läpi. Tavoitteena on visualisoida järjestelmät ja data pääsymallilla ja käyttää haastattelututkimusta kaiken tiedon saamiseksi. Seuraavaksi analysoida haastatteluja ja pääsymallia ja löytää kohtia, joissa yritys voisi parantaa järjestelmiensä ja datan käyttöään ja priorisoida nämä haasteet.

Tutkimuksen rajauksena oli murskaimen elinkaari, ja tutkimus tehtiin haastattelemalla kyseisen tuoteprojektin avainhenkilöitä. Haastattelut tuottivat tietoja henkilöstön käyttämistä järjestelmistä ja henkilöstön hallitsemasta datasta näissä järjestelmissä. Haastattelut antoivat myös avointa tietoa Metso Outotecin tämänhetkisistä haasteista ja että nämä haasteet osoittautuivat myös tärkeäksi. Tämänhetkiset haasteet ovat sellaisia asioita, joita henkilöstö kohtaa jokapäiväisessä työssään ja ne ovat tärkeitä parannuspaikkoja työympäristössä.

Haastattelutietojen perusteella muodostettiin PLM pääsymalli, joka antoi tietoa Metso Outotecin käyttöympäristön suurimpien järjestelmien ongelmista. Teamcenter, SAP ja Aton ovat suurimpia ja tärkeimpiä järjestelmiä Metso Outotec -ympäristössä, ja malli antoi ymmärryksen siitä, että nämä järjestelmät vaativat huomiota käyttäjäryhmissä. Datan käyttö näissä järjestelmissä on todella hajautettua, ja siksi käyttäjien tiedonsiirtoa on rajoitettava enemmän. Rajoitukset mahdollistavat suojatulle datalle parempaa käytettävyyttä näissä järjestelmissä.

Parannusehdotukset Metso Outotecille perustuvat PLM pääsymalliin ja haastatteluista kerättyihin tämänhetkisiin haasteisiin. Nämä ehdotukset on myös priorisoitu niiden vaikutuksen laajuuden mukaan. Tärkein asia on, että yrityksen on ryhdyttävä toimiin uusien käytäntöjen saamiseksi käyttöön ja vahvistettava, että järjestelmän käyttöä ja tiedonhallintaa koskevat käytännöt otetaan vakavasti koko yrityksessä. Tilanne, jossa osa yrityksestä käyttää moderneja järjestelmiä ja osa yrityksestä käyttää vanhoja järjestelmiä, on korjattava mahdollisimman nopeasti. On myös tärkeää kerätä useammin tietoja käyttäjiltä ymmärtääkseen tarpeet ja vaatimukset paljon nopeammin eikä odottaa ongelmien tapahtumista. Kuuntelemalla käyttäjiä, parantamalla nykyisten järjestelmien käyttöä ja ratkaisemalla tunnetut ongelmat, Metso Outotecilla on hyvät tulevaisuuden näkymät alan johtavana yrityksenä.

PREFACE

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Tampere, 23.12.2020

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ABBREVIATIONS AND MARKINGS

Attribute	Information about information
CAD	Computer-Aided Design
CMR	Customer Relationship Management
EDM	Engineering Data Management
ERP	Enterprise Resource Planning
MO	Metso Outotec, case company
PDM	Product Data Management
PLM	Product Lifecycle Management

1. INTRODUCTION

The amount of computer systems and usage of these system has increased a lot over the years in modern industrial companies. While these systems increase productivity and give new opportunities and practices to company, there are some challenges to face with these systems.

The amount of data, companies produce and handle, has increased tremendously and has become harder to manage properly. Some systems use duplicate data, one system is replacing older systems, some data is not maintained digitally and so on. It is important to tackle the challenges to improve as a company. Some challenges can be solved relatively quickly but some might take years before becoming solved.

This thesis is about product lifecycle system and data management in Metso Outotec Tampere site and the goal is to make it clearer, how the systems and data work over the product lifecycle and how the data flows through the systems. The goal is to visualize the systems and data with an access model and to use interview survey to get all the needed data. Next to analyse the interviews and access model and find the places where Metso Outotec could improve its systems and data usage and prioritize these challenges to get most out of them.

1.1 Metso Minerals and Metso Outotec

Metso Outotec is a forerunner in sustainable technologies, end-to-end solutions and services for the aggregates, minerals processing, metals refining and recycling industries globally.

MO’s products are designed, manufactured, sold, and supported globally. Lifecycle of MO’s products is very long and that is one reason for MO to have great global presence. This global presence also means, the company has ability to function globally with co-operations. One product can be designed and manufactured simultaneously by many MO’s locations.[1]

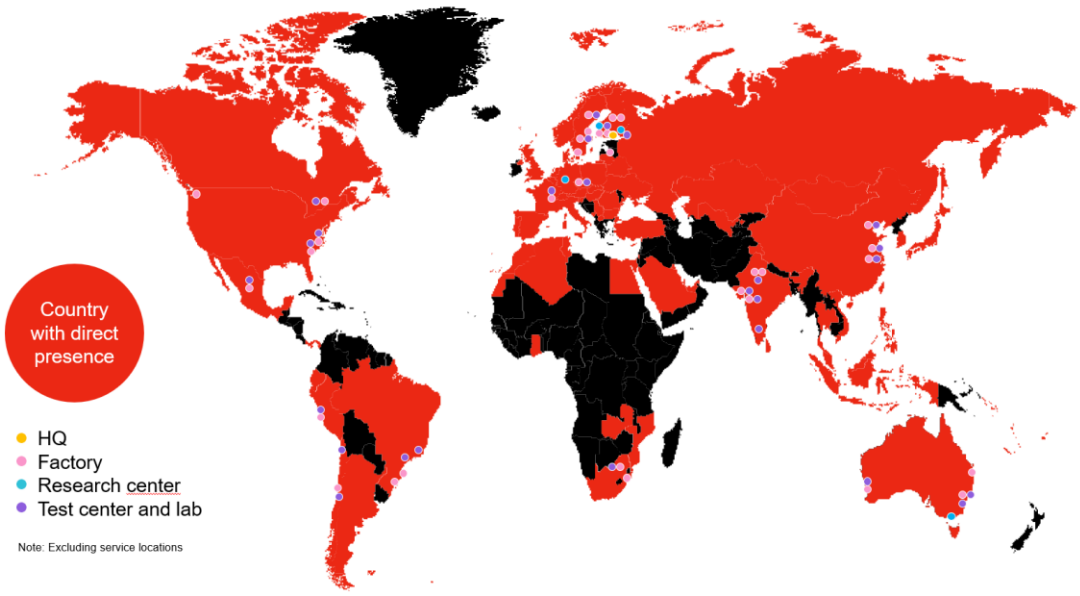

Figure 1. Metso Outotec presence globally. [2]

The company is present in over 50 countries and has over 15 000 employees with over 80 nationalities and 150 years of expertise in mining and metal industry. [2]

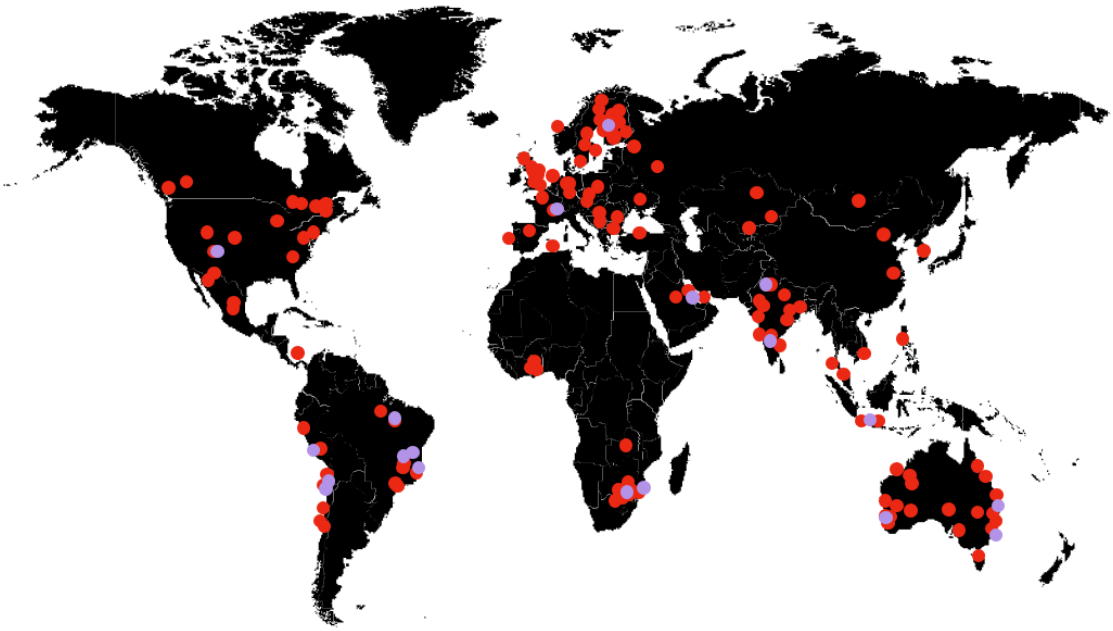

Figure 2. Metso Outotec service locations (red dots) and repair centres (purple dots) in a world map. [2]

The research began when the company was still just Metso Minerals but on July 1st 2020 the company combined with Outotec. Forming a new company under the name of Metso Outotec. These two companies complement each other exceptionally, as they have little overlapping functions, but their operations are in succession in the industry's value chain. Their customers are also around the world. Metso Minerals is concentrated in North and

South America, while Outotec's customers are located in Europe, the Middle East and Africa. [3&4]

The need for understanding the data flow became even more important than it was when the project started. However, the combination of these two companies did not affect this research because the target project was defined by Metso Minerals personnel in Tampere.

2. WORK BACKGROUND

The initial need for this research project was to better understand the systems and dataflow, and with that information to understand, how the data could be handled better within the systems. The situation now is that MO knows its systems and data practices have become harder to manage and needs changes to work better. The idea is to find the top priority issues within the systems and suggest actions to solve them.

2.1 Data control

Data management and control of the data flow is more and more crucial the bigger the workflow is. At MO, the projects are usually very large and time consuming so the importance to control data is very high. It has been recognized by the company that the data management has become more and more difficult over the years. The amount of software systems has grown, and some systems are replacing old ones. When new system is introduced it always shakes the workflow structure some way and even more if it is replacing another system.

2.2 Transition from older systems

In MO's case many core systems have stayed in place for many years like Teamcenter and SAP but there are also some systems like Aton and Lotus Notes that the company wants to get rid of in the future. The reason for the system removal and replace in this case is that the systems like Aton are old for today's use cases and MO's other systems can contain the same data and the data use cases as the old system. In MO's case the data that is maintained in Aton would be maintained in Teamcenter and SAP.

The challenge has been with the old data and the data use cases mostly. These older systems just cannot be replaced as fast as it would be ideal because of the data and practices that the older system has. It is more challenging to find the same practices in the new system that match the older system than it is to just push the data to new system from older system. The old system just has its benefits for the workflow and the practices have grown to the lifecycle so deep that it may take years to replace the older system with another system.

In MO's case, Aton PDM has been in use from early 2000 but over the years Teamcenter PLM system has grown to be the backbone of the CAD data management and the plan is to use Teamcenter for most of the product related data. This has made Aton PDM less

needed and to the point that the Teamcenter could handle all use cases included in Aton. The reason for Aton to still exist in MO's environment is that it still has use cases that some users cannot do in Teamcenter yet. The reasons are talked through better on the later sections, but the most obvious ones are that users do not have proper knowledge about Teamcenter usage for their job and therefore operate with Aton.

2.3 Network drives

While MO has many software databases to control data, the usage of network drives is still there. Network drives are the old way of controlling, storing, and sharing data but it still has its uses over other systems because of the ease of access and simple to use.

The problem with network drives lies within its limitations. The structure for data is always just folders and files and nothing else. Network drives work fine with simple data like meeting notes and presentations and such, but when it comes to more complex data, things become harder to maintain and manage. One of the biggest limitations is the lack of comprehensive metadata in the regular folder and file system. All the PDM and PLM systems benefit from the file metadata such as file creator, date of approval, different material, and size information and so on. And most importantly this metadata is used for searching the wanted data within the system and lack of it in network drives makes searching the correct data difficult.

The ease of misuse is also a big problem with network drives. Without proper instructions to users, the folder and file structure becomes hard to use. File and folder naming need to be managed manually by users and this often becomes an issue in the long run. If the network drive is not maintained, the issues can escalate to the point, where it is hard to reverse the harm, that has been done in the drive structures. There is no simple answer where the files should be if the drive maintenance is neglected.

Network drives have good security control when it comes to controlling users inside the company. Most of the companies today, including MO, have user accounts that are used to control file and folder security in network drives. Users can belong in different user groups to make it easier to give certain groups access. This is one of the top reasons why MO users prefer network drives over some systems.

PDM and PLM systems practically work without folders and the data is maintained differently. These systems have many sets of rules to overcome the struggles that network drives have. The direction at MO is clear and correct when it comes to network drive usage. They have been steadily changing file management to systems like Teamcenter over from network drives. The older data is still mostly stored in network

drives in many cases, but new data is mostly created and stored to Teamcenter. The idea for the future is to completely remove the network drives for new data usage and only keep them as legacy storage and migrate the important data to new systems.

2.4 Physical data

Physical data in this thesis refers to data that is managed only on paper and binders. This type of data was common before digital systems came to replace it. Physical data still have some use cases, but it is not beneficial for a company to use it over digital data. Storing and searching physical data has always been problematic. Also, physical data back-ups create even more storing problems.

MO still has few small use cases of physical data for new data, but the direction is to remove any new use cases on physical data and to only use physical data as extra back-ups and temporary files. MO has lots of older data that is stored in physical format and it is understandable but the use cases for that data is so rare that it is not an issue at all. Only worry is that physical data is vulnerable for time and accidents, but MO stores its older physical data properly and safely. Also, most important physical data has been stored digitally.

2.5 Data access management

One need for a data management system is an ability to control which group or person has access to modify or view certain data. Ideal way to control that is to recognize the use cases for different types of data in the system and divide use cases to different groups and then manage the data with the group access. This type of access management is controllable because it makes it possible to add and remove users within the groups, and to know what data the users have access to.

The hardest part is to understand which data belongs to which access group. When the system has many users and users have different rights to multiple groups, there will be mistakes on the data rights eventually. The way these cases are recognized and fixed comes to the administration and possibilities within the system. Also, it is very important to have proper training for every one that uses the system to minimize the chance of incorrect use.

2.6 User groups

In MO’s case the user groups in different systems have been made the product lines in mind and it is understandable why they chose that when they started using the systems.

The problem with that is the groups are too large for today's needs. The issue with large user groups is that the data access management is too loose to control properly. To solve the issue, MO needs to recognize the use cases for the data and for new groups by the use cases to replace the old user groups. The recognition of the use cases is one of the goals of the research.

2.7 Data security

When the user groups for data are working it has the instant benefit for data security within the company. This is one of the needed changes within the data systems. Right now, the secure data cannot be stored in some systems like Teamcenter because the visibility is not restrictive enough, but when the number of groups rise and are restricted properly, the data can be controlled to exact user group with ease.

Now the secure data is stored in systems like network drives where one can give rights to exact users even when the data should belong to other systems. Therefore, it is important to recognize use cases to get to this point where data can be stored in correct systems knowing the data is secured the right way.

2.8 User experience

The data security is not only a problem when it comes to too large data visibility to groups. It also has an impact to user experience within the systems. Now users have too large access to the data within some systems like Teamcenter and this causes confusion when trying to access and find the needed data. Users have access to data they never need for their work.

One example would be that the service team users have access to the CAD model data produced by designers when they only would need the spare part lists and problem reports from that product. This issue becomes even bigger when MO increases the amount of data stored in these systems.

3. ACQUISITION OF INFORMATION

To get the required information for this research there were some options to consider. These options were to get information from people and to get information by observing the system usage. After discussions, the decision was that the information had to be collected from people to gain understanding, how the data is managed. Completely other way would have been to dive deep into the systems and observe them. That would have been too time consuming and the number of systems was known to be high and there was a need to get data from project that was already made. Some of the systems were already known before the interviews and for others were demonstrated by the interviewees. So, the systems were observed in that way.

Qualitative research studies rely on interviews with participants. The data collection method is and effective way to get information from the participants in their own words. The research topic, purpose, and questions from the basis for the subjects and the types of questions for the interview. The improvised conversation may also generate unexpected areas and insights for future inquiry. [5]

Most of the information to be collected was about the systems and data usage. This information would be explained in open words and visual aids. The chosen method was to collect information with personal interviews to make the interviews more interactive and this way it was possible to probe and ask follow-up questions. [6]

Interviews are the most challenging but rewarding forms of measurement. They require adaptability and situational understanding. The preparation for interviews has following tasks: enlist cooperative interviewees, motivate them to do a good job, clarify any confusions, observe quality of responses, conduct a good interview. [6] These preparations were made and are explained more in depth on chapter five.

Interview formats can range from precisely constructed set of questions to a more open and unstructured questionnaire that has just general a list of topics. [5] It is important to use questionnaire and ask questions as planned to avoid differentiating the interviews. The order of the questions and to ask every question is also important – assumptions should be avoided. [6] The questionnaire did not contain many questions, but they were extensive on the subject. It was easy to follow the order and not make any assumptions.

Generally recording the interview is not a great idea according to most interview methodologists. Interviewees are often uncomfortable when they know their answers are being recorded. [6] For one person interviews, it is sufficient to record voice for qualitative

data collection purposes without affecting the results. [5] Due to the pandemic situation however, most of the interviews were arranged on Microsoft Teams as meetings and interviewees were used to that platform. This made it easy to record the interviews audio and video. This was important because the amount of information gained from the interviews was too much to just write into words, so it was important to be able to re-listen the conversations to get all out of the interviews.

3.1 Qualitative survey research

The definition for survey as a research strategy is that the premise is to determine the frequency, occurrence, interaction or distribution of certain phenomena, characteristics, or events. The aim is to generalize the results of the study from the sample to the whole group. Survey research includes a wide range of problem-solving possibilities as a research strategy, and the research can be carried out using different methods of analysis. The starting points of the survey are in quantitative research. However, depending on the survey and interview methods used, the survey data can be analysed either qualitatively or quantitatively. [7]

The type of information the interviews gave in the end made this project a qualitative survey research because the focus was more on the quality of the information and not the quantity. The research also had the idea to use the information for analysis through the access model that is formed from the interview information. More about the specifics of the research and how it was executed in chapter five.

Figure 3. Parts of quantitative data collection. Original image edited. [8]

The data collection in this research consisted all five parts shown in figure 3. The probability sampling means that the participants are chosen correctly to make results accurate. For this research, the participants were key personnel at the company with great knowledge of their subordinates to the information they gave should represent the company personnel accurately.

Interviews, surveys, questionnaires, and observations are packed into the whole interview survey process as explained earlier. The document review means that the data collection includes documents that have information related to the data collection. In this research this data was the system information and policies given during the interviews.

3.2 Analytic choices

Analytic choices are often based on what methods will harmonize with the survey genre and framework. The questions being, what will generate the most sufficient answers to the research questions and what will represent and present the findings. [5]

The expected data from the surveys was the list of systems and data events, along with the open conversations about the data management. The amount of the listed data was extensive and the need for this research was to clarify dataflow on the product lifecycle. The idea was to visualize the listed data and compress all the conversation notes to a clear set of cases.

4. DATA MANAGEMENT

Traditionally, corporate big data was simply seen as one side of a technology project or as one of the many externalities of a business or process. Today, business information is one of the most valuable assets companies need to manage. The big data is shared across several different systems and grouped together to enable relevant, profitable insights. [9]

Creating a comprehensive, flexible big data strategy enables company decision-makers to address all kinds of issues and provide a decisive competitive advantage. However, companies are working to develop a business information strategy that suits their needs. Most companies have not upgraded the way they collect, share, and manage business information assets. They still view it as a by-product of their activities. And as business information continues to grow, IT costs continue to rise. [9]

For most organizations, it is still not clear how business information is managed. Often, different projects end up managing their data independently because there is no structure or protocol that allows separate systems to share data, communicate, and collaborate. This in turn increases costs and the handling of duplications is due to the data being copied. The lack of a comprehensive information strategy is therefore still risky and costly. [9]

4.1 Engineering data management

EDM supports engineers in storing and managing engineering data in a structured way. This makes it easy to recognize the data structures and identify and collect data that is related to the correct item. There is still a huge amount of data generated which is not gathered by the engineering department but has an important role. This data is for example table calculations, schedules, presentation designs, and many kinds of documentation. If these are saved to individual directories in local machines or a decentralized data storage unit like network drives, product development is not influenced directly. The lack of organization and a proper overview can lead to data inconsistencies. This issue was the original reason for development of EDM systems so the requirement to use the system correctly is to use the system as a centralized data point. [10]

PDM systems is an improved EDM system where the relationships in CAD data is increased. Items, Bill-of-materials, and data revisions are in proper relationship with each

other. PLM system takes step even further by giving functions like workflow and program management and project control. The PLM system is often integrated with other company functions and system in different ways and plays central part in the IT infrastructure. PLM systems usually do not have ERP system functionality and those two usually complement each other with an integration. [11] Teamcenter works as a PLM system and SAP as an ERP system and with an integration in MO.

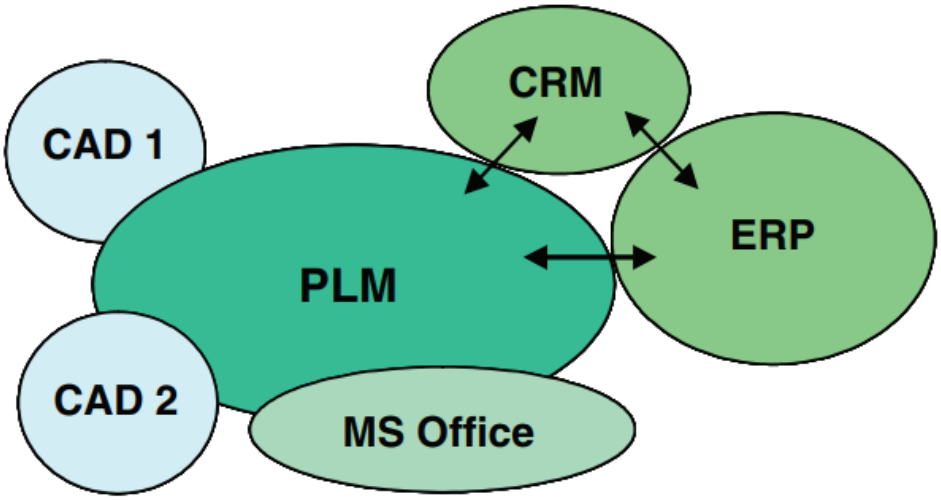

Figure 4. Illustration of PLM integrations. [11]

The level of integration can vary between systems. The information can move between applications in several ways, from manual file copy to automated system synchronisation. The integration can acquire the information in two ways: transfer or sharing. It is often easier to transfer the information than to share it, because sharing often requires more tailoring between systems. The problem with information transfer is that it is hard to keep information harmonized after the transfer. [11]

4.2 Importance of data management

Data is increasingly seen as a business resource that can be used to make informed business decisions, improve marketing campaigns, optimize business, and reduce costs, all with the goal of increasing revenue and profits. However, a lack of proper data management can harm organizations with inconsistent data sets, and data quality issues that limit their ability to maintain business intelligence and analytics applications or, worse, lead to faulty findings. [12]

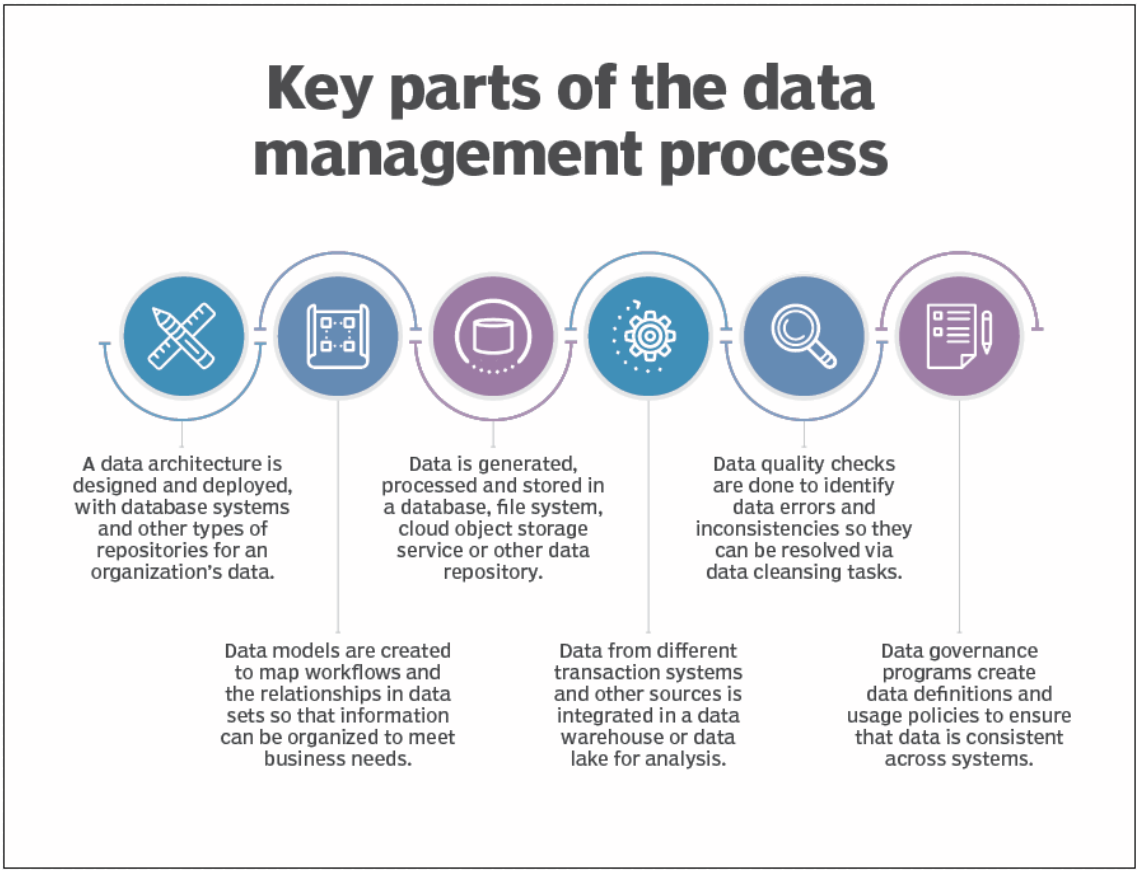

Figure 5. Illustration of proper data management steps. [12]

All data has a great impact on everyday work functions and nearly all areas in different systems environment. Great data management makes all functions work as intended and reduces costs in many areas that poor data control would cause. The good data management always requires proactive work to create the environment and practices to make things work as wanted. The poor data management usually is noticed when things start to go wrong, and the data corrections and fixes combined take a lot more time that the proactive work before would have taken. Also, poor data management always has an impact on the work it is related for and in a long period of time slows down work tasks – costing more money to the company.

4.3 Best practices

A well-designed data management policy is a critical part of effective data management strategies, especially in organizations with distributed data environments that include a diverse set of systems. A strong focus on data quality is also essential. In both cases, however, IT and data management teams cannot manage it alone. Business executives and users need to be involved to ensure that their data needs are met, and that data quality issues do not persist. The same applies to data modelling projects. [12]

The proper data management requires action from the whole personnel. Everyone must have the mindset of doing things as planned. When most of the personnel manage data as planned, all misuses are noticed easily and most of the time are noticed by other users and fixed before it becomes an issue. This way the system maintains itself with the help of everyone.

4.4 Benefits of good data management

A well implemented data management strategy can help companies gain potential competitive advantages over their competitors, both by improving operational efficiency and enabling better decision making. Organizations with well managed data can also become more agile, allowing market trends to be detected and to take advantage of new business opportunities more quickly. [12]

Effective data management can also help companies avoid data breaches, data protection issues and compliance issues that can damage their reputation, increase unexpected costs, and jeopardize them legally. Ultimately, the biggest benefit a great approach to data management can provide is better business performance. [12]

5. RESEARCH

The purpose of this research is to find out comprehensively all the important data in a product lifecycle and the systems the data goes through in MO Tampere. With this information, also recognize systems and user groups for different data areas when all the collected data is unified.

With this information, MO can find the things in the systems that require most attention and the areas in use cases that require improving. Every research project has some challenges to overcome, and this is not an exception. There were challenges with scope of the research, getting the relevant information from interviewees and the understanding of the extent of the research requirements.

5.1 Scope

From the start it was clear that MO wanted to take one project to close inspection for this research. The project had to be in its final states or end of lifecycle, meaning the product should be at least in its service state in the lifecycle standpoint so we could inspect the whole lifecycle of the product and not mix any other products with each other.

Project also had to be relatively new to have up to date information for this research. Two projects were brought to table: MX4 cone crusher and Lokotrack LT200HP mobile cone crusher. At first the MX4 was a preferred choice but when looked closely it had quite a complicated lifecycle and the scope changed to Lokotrack LT200HP with an example worthy lifecycle for this research.

Figure 6. Lokotrack LT200HP mobile cone crusher. [13]

The goal was to collect all information related to project data production during LT200HP's lifecycle from the ideation phases to the product maintenance phase. Then to use this data to form visualization to understand the dataflow.

The scope of the research was not clear at first and it changed during the project also. At first the discussion was that MO wanted to do the research for MX4 crusher unit but eventually it was changed to LT200HP mobile crusher. This was preferred choice because MX4 project was much more complicated compared to LT200HP and the thinking was that the LT200HP reflects better to the ideal project workflow. This decision was made early and it had negligible impact on the project. Only later it was a bit confusing for some personnel, why the product was changed from MX4 to LT200HP.

5.2 Interview survey

The chosen way to get the needed information was an interview survey. The people for the survey were chosen from the LT200HP project personnel and they were mostly in a supervisor position and had good knowledge of their subordinates' work. The initial list of this personnel was provided by the research supervisor from MO. The list got more additions during the interviews, but the list was comprehensive from the beginning.

The list consisted personnel from the LT200HP project team, business and product management personnel, general technology personnel, procurement personnel, quality and supply chain personnel, sales and services personnel and many others to get information from all important sections. During many interviews new names were added to the list to get more information from if the interviewee could not know the answer to something. The total number of interviews were 23 in some interviews there were multiple personnel and the total number of personnel to interview was 30.

Interviews were arranged mostly over Microsoft Teams meetings and some of the first meetings were arranged at MO's meeting rooms at Lokomonkatu, Tampere. All the interviews on Teams were recorded for research purposes only to listen to the conversations again even though meeting notes were taken from every interview.

The interviews included five main questions. Following paragraphs explain these questions and the goal of these questions for the survey.

What were the interviewee's and his or her subordinates' work tasks? Even though the title of the interviewee was available, it was important to get better knowledge of the work tasks and the area the interviewee worked on. Many interviewees were in a supervisor position, so the information of their subordinates and their work was also relevant to know. If the interviewee did not have comprehensive knowledge of their

subordinate's work tasks in a data standpoint, an interview with one of the subordinates was arranged. Most of the supervisors had comprehensive knowledge of their subordinate's work tasks so in most cases the information needed was acquired from the supervisors.

What systems do they use for their work? With this question, the idea was to collect all the systems they use for their everyday work and what they do with that system. This formed a list of systems and the data uses for each system from each interview. This also gave a good overview of the systems and often interviewee shared their screen to give information of the system to understand how the system worked and what kind of tasks it was for.

What data they produce or work with? This was a more specific question to understand exactly the data the users worked on. With this question interviewees told specific data they worked on in different systems and the importance of that data and how it is managed and used. They also explained where the user gets the data to work with, to better understand and build the data flow within the systems.

Where the data is forwarded after being produced or used? With this question the needed information was, where the data goes from the user. This idea was to understand better the data flow within the systems and to find the connection points of the data flow.

What are the challenges or obstacles during the work tasks? This was an observation question for the interviewee to get his or her personal information how the work tasks in the systems are done and are there any mention worthy issues in the workflow. This question became more important than it was initially thought it would be and produced very good and specific information from some system use cases and challenges.

When the interviewing began, it was challenging to explain the interviewees exactly what kind of information was needed from them. The questionnaire was not fully complete at the beginning and first few interviews had lower quality output than the later interviews. Although any crucial information was not missed on these interviews.

The questionnaire finalizing before any interviews is one thing that should have been done better. It would have been clearer for both sides. The questions were also sent before meetings after the first couple of interviews. This should have been done from the beginning also.

5.3 Systems

MO has lots of different systems in use. Some systems are in place just for a specific use case while some have wide functionality and use cases. Next up is a listing of all the systems that were listed across the interviews and explanation of the primary functions for MO.

Teamcenter is a PLM system owned by Siemens that connects people and processes across platforms. MO uses Teamcenter mainly to store core CAD data like models and drawings, but the plan is to use Teamcenter to store all CAD related data like documents and much more. Teamcenter has integrations to different CAD systems but the most used CAD system in Tampere site is Siemens NX. Teamcenter also has integrations to many other systems like Aton and SAP so it works as a master system in many cases.

NX is a CAD software owned by Siemens and in Tampere site it is the most used CAD software. NX has all basic CAD software functionality and it is integrated to work with Teamcenter when getting and saving data. Metso also has other CAD products like Autodesk Inventor but those are not mainly used in Tampere site.

Aton is used as a PDM system at MO and it is owned by Roima [14]. In early 2000, former Metso started to use Aton but over the years, Teamcenter has taken more and more Aton's place and nearly replaced it in all areas. There are still some use cases where Aton is preferred over Teamcenter. One important case is that unique product structures are still stored in Aton instead of Teamcenter. There are also some data stored in both Aton and Teamcenter in parallel. The main point is that MO wants to move out from the Aton environment and have all the functionality in other systems.

SAP is used as an ERP system in MO. It is widely used over MO and it is linked between many systems. It has data linked from Teamcenter, Aton, LeanwareMES, Power BI and lots of raw sales related information and from Prime. It stores item information like Teamcenter and Aton that it uses to link all the data to specific items.

SharePoint is Microsoft's web-based software that empowers teamwork with dynamic and productive team sites for every project team, department, and division. Every team at MO has its own SharePoint pages where each team can share files, data, news, and resources.[15] It is in use across whole MO personnel.

Teams is Microsoft's software for chatting, calling and meetings. It is also used to form groups and share files. Some teams at MO have started to use the group and file share features with Teams. The files shared are mostly lightweight like meeting notes.

Network Drive in this work primarily focuses on the most used drive location M in the MO network. The M drive stores a great amount of all kinds of information and has a large folder structure. The folder structure is built to divide different work tasks and departments from each other but over time some folder structures have become inconsistent and data has become harder to manage and find.

Ansys is used as simulation software. Most work done in Ansys are mechanical simulations done for CAD models that are exported from NX. There are also other simulations done like fluid simulations, but the mechanical side is the primary use for Ansys.

LeanwareMES (manufacturing execution system) is for managing and tracking operative functions in production and for relaying information between different systems and production automation. It displays the necessary information at the right point of the manufacturing process in real time. The system differs from conventional manufacturing execution systems, as it only provides the employee with the information they need for the task at hand. [16] MES also sends data to Power BI.

Sievo is a procurement analytics software that is used to create price analytics data of the procurements at MO. It also sends data to Power BI. [17]

Power BI is a data visualization software by Microsoft, that collects data from other systems. It is heavily used at MO to create presentations and analyse data from different aspects. [18] At MO it uses data from MES, Sievo, Jaggaer, SAP and raw sales data.

Magma is a cast simulation software that gets its data from Teamcenter. It is always used for new products. It does not have many users, but it is important software for its use.

Lotus Notes is an older software that was widely used across Metso as an email and documentation software. Today it consists of older data, but it still has some usage for new data. Lotus Notes still holds information about the production pipeline and an installed base of MO products. It also stores machine card data and lots of old documentation that is not stored anywhere else. SharePoint is replacing it for new data, but older data is still just maintained in Lotus Notes.

SalesForce is one bridge between MO and customers. The most important function that it is used for is the warranty cards. Warranty cards are requests made by customers of their products and the warranty handling starts from there.

Jaggaer is an interface software between suppliers and MO. It is used for conversation over tickets and reclamation conversations are had in Jaggaer. Material certificates are also treated in Jaggaer.

Bruno is a simulation software for mechanical simulations. It has a low number of users and most of the usage happens in local computers and the data is stored in those computers locally.

E-Parts is software for spare parts management. It holds SPP (service parts planning) documents from Aton. It is also used by distributors.

my.metso.com is another interface software for customers. Every customer has their own account for my.metso.com. The systems store product data and customer data and it also is for purchases and offers.

Prime is a warehouse management software for MO and it has warehouse usage history information and it is linked to SAP warehouse stock information to manage product stock.

SalesHub is a system that stores all kinds of sales material.

Docuport is a system that is used by Etteplan to create user manuals for MO. The manuals are exported as pdf files to Teamcenter. MO does not maintain this system.

5.4 Division of lifecycle

The observed lifecycle was divided in four main sections. The sections are Plan and R&D, Development and Engineering, Build and Supply chains, Support and Service. The idea of the splitting was to recognize different functions in these sections and to make the whole lifecycle clearer.

Plan and R&D (Research & Development) consists lifecycle first steps that mainly include the Metso innovation process (MIP). MIP provides a strategy framework for new products and solutions. It is also used for existing products with technology development and research as project types. In this case the MIP was looked at as a product development standpoint. In short, the MIP has different steps, and each step has a goal that must be reached before the next step can be started. This all is well controlled and documented. MIP is new in MO and in development still, but at data standpoint, the procedures are clear and simple. Prototyping is also included here and Ansys is the one system that is used for simulation for example.

Development and Engineering consists designing and planning the product to the point it is ready to be manufactured. This section is the core of MO’s product data production

and this is where things start to get more complicated within the systems. The main systems in this section are Teamcenter, NX, Aton, SAP, and some smaller systems.

Build and Supply chains consists production steps where the product is manufactured, built, and sent to the planned supply chain where it reaches the end customer. This section contains many relatively smaller systems like Jaggaer, Power BI and SalesForce.

Support and Service consists connections between MO and the customers and distributors. The main systems in use are SAP, SharePoint and myMetso.com.

Many systems have use cases between different points of lifecycle and those connections are better explained in later chapter where each interview is discussed and explained. Also, some systems have use cases between these four main lifecycle sections and systems mentioned here as main systems are the ones that clearly have more activity within the section than other systems according to the interviews.

5.5 Interview data

The target for the interviews at first was to get as precise information as possible but it soon turned out that it is not possible to get all the information that moves and changes in the systems during a product lifecycle. The amount of work would be just too much, so the focus was changed to the most important and relevant data. Meaning that the information of the data was not always precise, like file types and exact attributes that the data holds. The goal was to understand the contents of the data and what it is used for. With this decision the project came more manageable but in expense of less precise data collected.

5.6 Extent of the research

Even though the systems and data usage were partially known before the research, it was not clear, how the whole product lifecycle goes in the company. One big challenge was the realization of the extent of the project, and it was realized a bit late. And because of that the amount of information data and the scope had to be smaller. It just was not possible to collect all and exact data from the product lifecycle at the point the project scope was understood properly. With better planning this could have been avoided and the data would be more precise, but overall, the project went fine after the scope change and became more manageable and provided good information for future processing.

6. DATA VISUALIZATION

The idea of the access model was not clear from the beginning. Dataflow through the systems had to be illustrated in a way that was understandable and informative and provided a platform for analysis.

The interviews provided mainly system information and data that the systems stored or handled. The first chart that was familiar and felt fitting was a swimlane diagram. It is a type of flowchart that illustrates how processes involving multiple contributors progress through their various chronological stages. Swimlane chart is also a great way to illustrate complicated data in an uncomplicated way [19].

The chronological chart would be ideal for the product lifecycle and the dataflow would fit to the connectors well. The issue with just a swimlane chart was that the number of lanes was getting too high, if all the system lanes were marked. This would defeat the purpose of the swimlane diagram by making it too complicated.

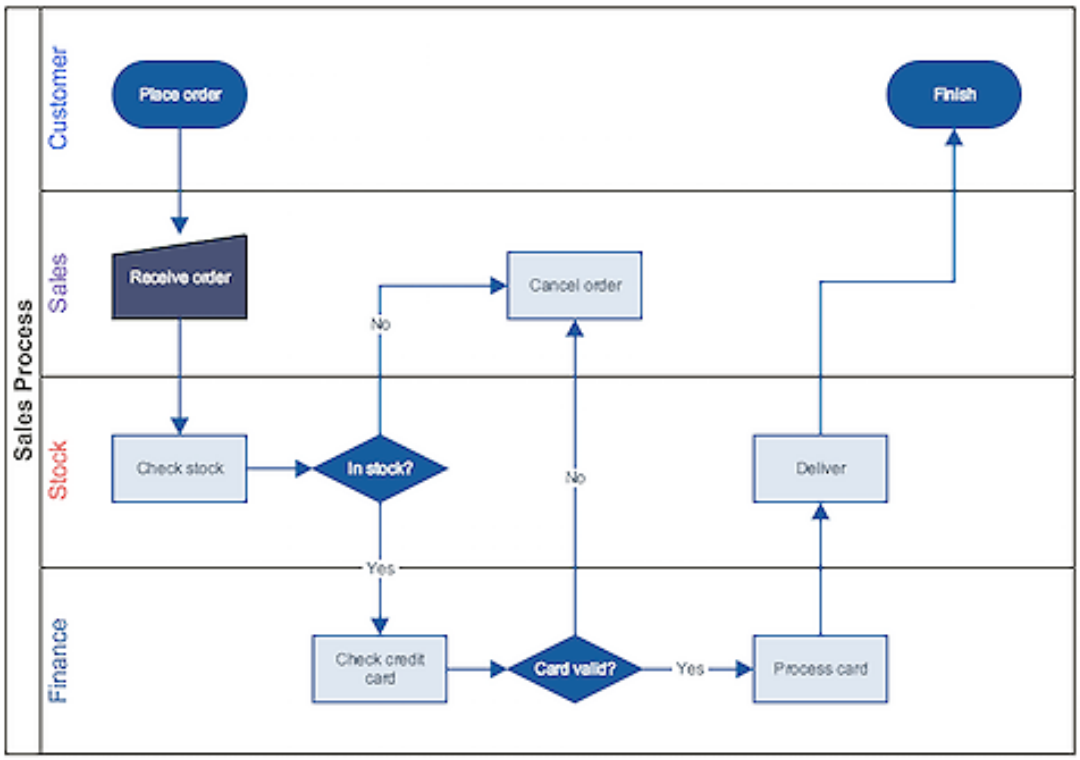

Figure 7. Example of a swimlane diagram. [19]

The other type of flow chart that was considered was a specific type of flowmodel that represents every little detailed point on a timeline and every point must connect from a starting point to the end point forming a web of connected points. This chart is a bit more

complicated to understand by looking but provides more data to analyse. The flowmodel has it benefits over swimlane diagram but flowmodel also makes the reading and understanding harder.

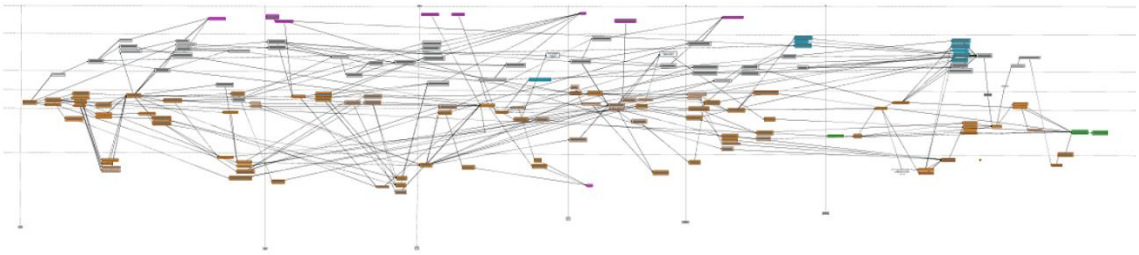

Figure 8. Example of a flowmodel. [20]

The idea was to bring good sides from both a swimlane diagram and a flowmodel together forming a hybrid diagram that takes some simplicity from a swimlane diagram and combines it with the data rich side of a flowmodel. This way the chart would provide a good base for future processing as an understandable and informative chart.

6.1 Access model

The access model's main purpose in this case is to represent all the important data events and the systems in the product's lifecycle. Ultimately forming a web of connected data events and systems that represent products lifecycle data usage.

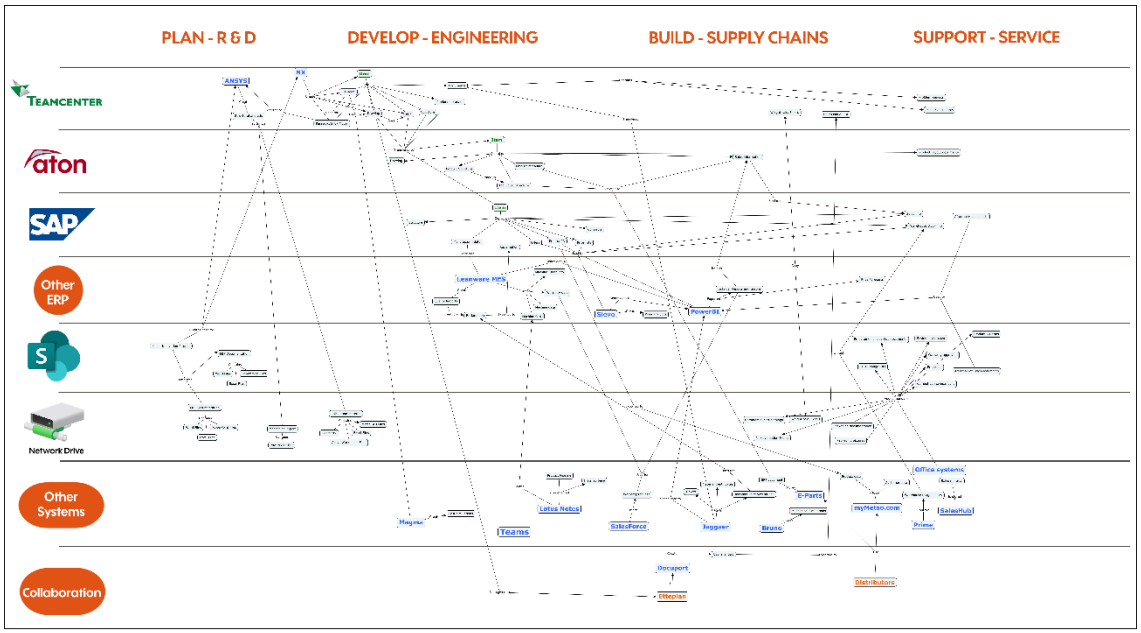

Figure 9. The access model of the interview data. Larger presentation in appendix 1.

The data event points, systems points and connections between them were made with CmapTools software version 6.04. Swimlanes, definition images and timeline sections were made and added with Adobe Photoshop CS6 version 13.0.

6.2 Timeline

All the steps are connected via different routes and the steps from a timeline. Timeline is not relative to actual time in a product's lifecycle in this case. The main purpose of the timeline was to divide the lifecycle to four main sections; Plan and R&D, Development and Engineering, Build and Supply chains, Support and Service. These sections are open enough to set the data points to the model without trying to be too precise. In this case, trying to be more precise with datapoint timelining would be hard. In many data point cases the timeline positioning is not quite clear. Some data points would fit to other positions in the timeline so the positioning in this case is more of an order of data events and less of a precise point in the lifecycle.

Now the data events and systems are presented in the model action points that happen roughly in order from left to right. Some actions have feedback functionality or action to earlier data events. This will be explained in the next chapter, where the connections between data events and systems are visualized.

6.3 Swimlanes

The horizontal areas are the swimlanes. They provide defined areas and systems where the data is handled and distribute the data points accordingly. Swimlanes are specified with the icons on the left side. Some are specified with relatively important systems: Teamcenter, Aton, SAP, SharePoint, network drive. Rest of swimlanes include collection of other systems marked as "Other ERP" and "Other Systems." These collections work as areas to mark the rest of the systems as system points on the model. There is also swimlane "Collaboration" that have points outside of MO's systems and other companies and distributors.

6.4 Connections

The data events and systems are connected forming all connecting web. The exception is that major systems are defined in major swimlanes; Teamcenter, Aton, SAP, Sharepoint and network drive. Everything else is connected and forms the timeline. The lines have direction arrows except for downwards pointing ones. The software is

programmed to not add an arrowhead to the line if the direction is clearly down but knowing this the directions are clear to understand and read.

Data events and systems also have arguments between them specifying the action to the next point. Few of these arguments are “contains”, “used for”, and “create”. These arguments give the model more information than the lines alone cannot provide.

6.5 Systems and data events

Systems in the model are highlighted with blue colour. Few system exceptions are Ansys and NX that do not literally work in Teamcenter environment but are tightly related to Teamcenter that is the reason why those are positioned under Teamcenter environment.

Data events are marked with the smaller black font and are inside a rounded box. These are the actual data packages, and the content is defined by the name of the data event.

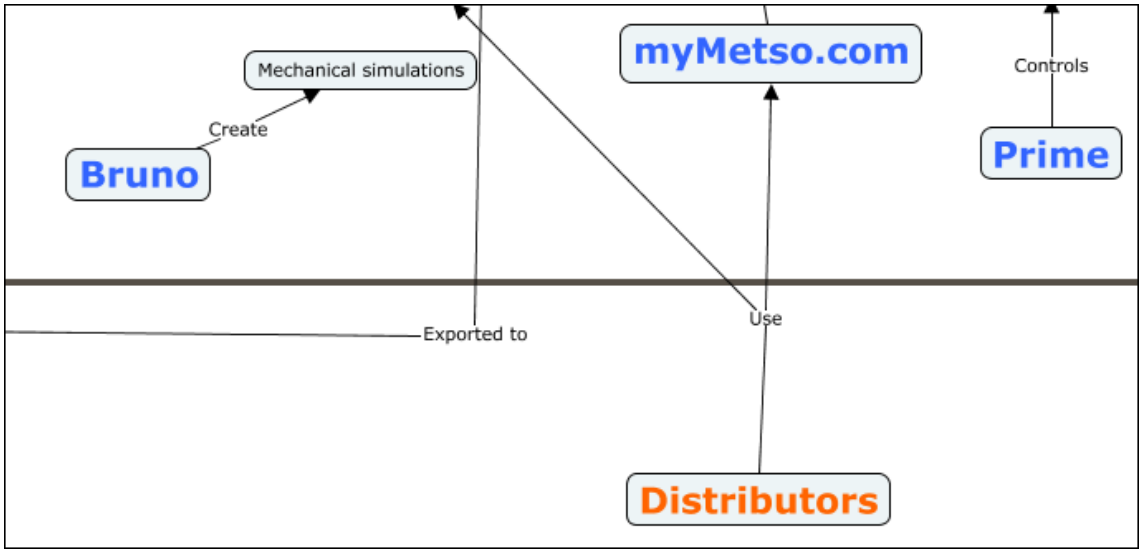

Figure 10. Example of the different point types in the access model. Bruno, myMetso.com and Prime are systems. Mechanical simulations are a data event. Create, Exported to, Use and Controls are connection arguments. Distributors is the outside of MO environment.

Few exceptions and highlights are items marked with green font on Teamcenter, Aton and SAP swimlanes, and Etteplan with Distributors on collaboration swimlane marked with orange.

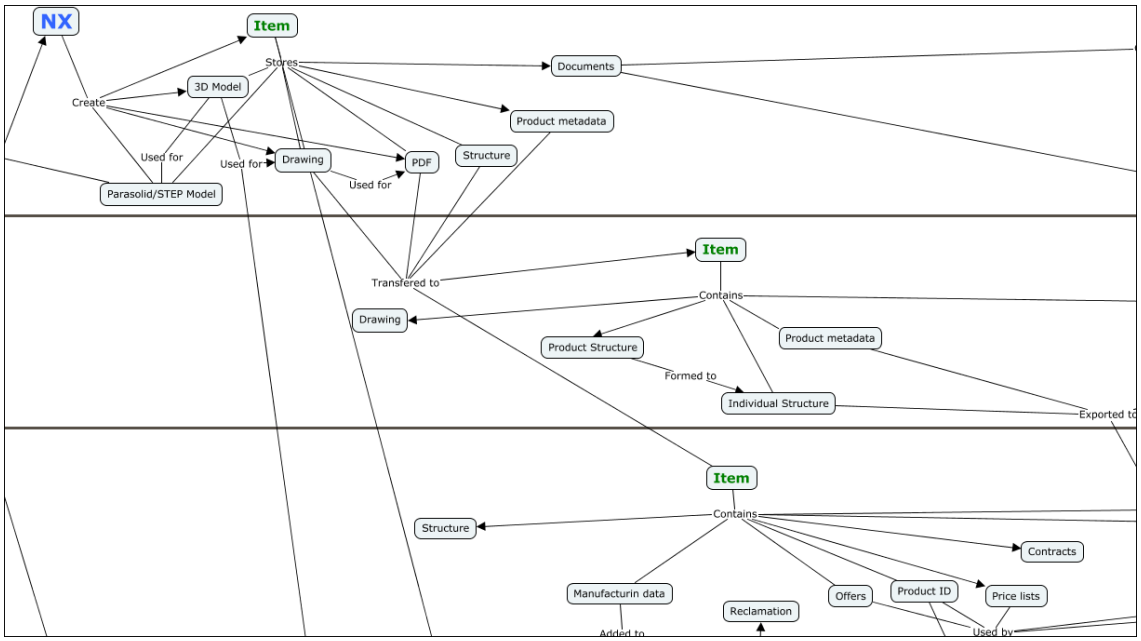

Figure 11. Item data events highlighted.

Items are highlighted because those are crucial data collectors in the systems they are in. The item in this case means the actual item code that can be single part or assembly in the system. In these systems the data related to the part or assembly is stored under the item. Item codes are the same between the systems and work as identification.

7. FINDINGS

The findings and conclusions are split into two main categories. System zones and data usage within the systems paragraphs include analytical findings from the access model. Ongoing challenges and own observations paragraphs include discussed challenges from the interviews and observations that were found during the interviews.

7.1 System zones

The access model analysis was done by taking every interview data to Photoshop and adding layers for each interview. The zones were created on the model to highlight the systems that the interviewee mentioned in the interview. This was the way to visually recognize the scope of each interviewee had to the lifecycle of the product data. When the data event was highlighted on a swimlane, the system icon from the left side was highlighted also to represent that the swimlane had usage in it.

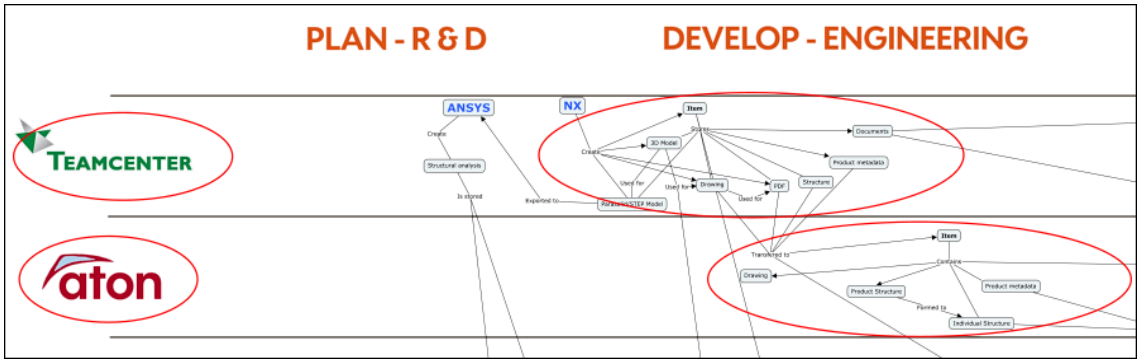

Figure 12. Example of a zone markings of the layers in Photoshop.

Most of the results were quite similar in size but the extremities of the results were interesting. One user could work with just two systems and two data points, but some users had quite a large scope of systems in use.

These layers alone do not provide much to analyse but in the following paragraph the combination of the layers gives much more information to analyse.

7.2 Data usage within the systems

After creating the zones to the layers, the layers were combined to form one model with all the zones, and this was the model that gave better information to read on. It is noticeable that some systems have same data event usage nearly every time it is used

but Teamcenter, Aton and SAP have the most variety of usage when it comes to using different data in the systems.

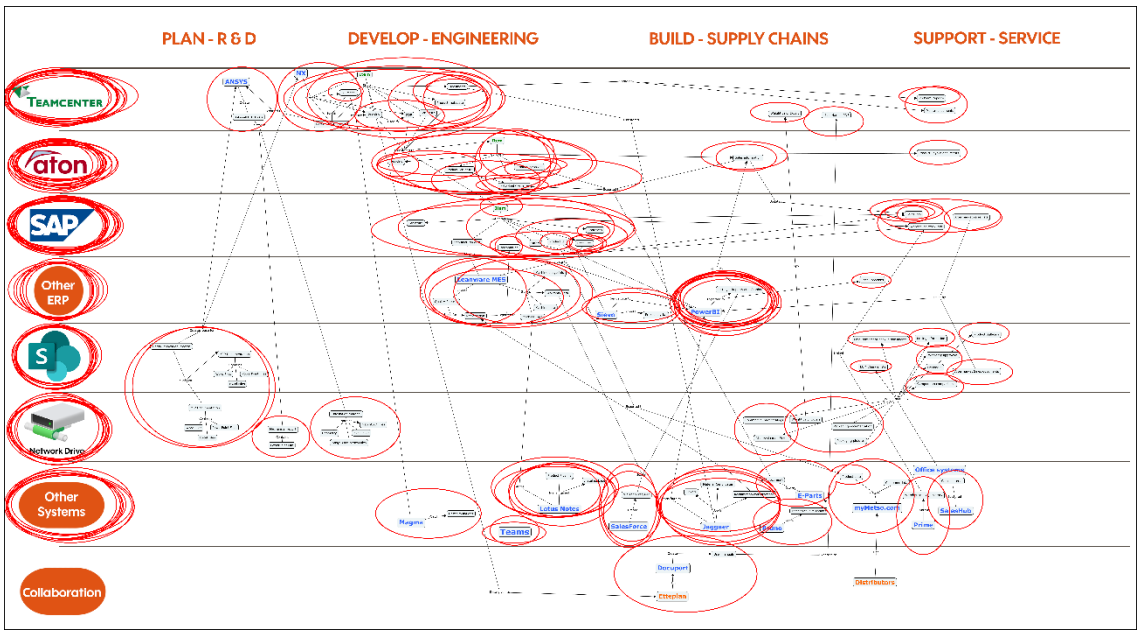

Figure 13. Combination of all the layers to form an access map to the data. Larger presentation in appendix 2.

The initial thinking at MO was that some systems need a proper access groups and this proves that. There is a need to look at these three major systems. Teamcenter and SAP especially need data management change because of the usage and different data in those systems is increasing. Aton usage is becoming less relevant, so the issue solves itself when MO finally implements Aton features to systems like Teamcenter. These issues came up also in some interviews where the data amount, the systems are offering, is just too much. Most of the data is not relevant to the user causing the relevant information to be hard to get.

Roughly all other systems have really specified usage and most of the time the usage is identical between others. This means that those systems are having fine control in data access management.

7.3 Ongoing challenges

This section is about the open challenges that were discussed with the interviewees as a last question of the interview. This section proved to be more important than it was initially thought and provided very specific information about different challenges in the everyday system usage.

The mentioned challenges have been divided to the four sections of the access model. Meaning that the challenges or issues mentioned under section means that the

interviewee works under that section. This means that some of the issues mentioned are mentioned twice to highlight that the issue is present in more than one section.

Plan and R&D section does not have many different systems and the amount of noted issues is quite small. The plan and R&D personnel mainly work with Microsoft office products and use SharePoint with network drive. Metso innovation process usage on SharePoint was noted to be still a bit in the development stage and this is a known issue to the people responsible for developing MIP. The network drive as a document storing location was told to be disordered on location M drive in folder “Cosprojects”.

Development and Engineering section consists of more systems, but all the PLM related systems were fine according to interviews, at least about the data management side. The data management issue noted, was again the network drive data storage. Much used M drive and folder Engineering is quite widely used among the workers in this section. The folder structures in the drive were experienced messy and unorganized. The issue is that there is data from many years and the principles for data storing have not always been as strictly maintained as it is now. Some of the data is not stored the way it was initially intended. The new data that is stored to the folder structure however is well structured and organized. The problem is the older data, usage of the old folder structures and finding the information.

Build and Supply chains had the most challenges across the systems. This section includes personnel from the factories to people who keep straight contact to customers. Some challenges are specific but still important to mention. Next those are mentioned in order that represents the importance and extent of the issue. Meaning that the last issue mentioned is affecting least people and is quite specific and first ones having the biggest impact.

Leanware MES system had challenges on the usability. The issue being that all the drawings had to be translated manually because of the old data. Also, all input to the system needs to be done manually. Some automation to system workflow would have a positive impact on usability.

The remaining physical data had its challenges. There are still physical binders created for every work in use and there is great interest for digitalization of physical data. Also filing was experienced as a challenge because of the physical paper data.

Software system issues were quite significant also. Teamcenter, SAP, Aton and physical data have cross usage between them, and this creates an uncertain environment in some cases and causes misinformation about attributes. The logistics were mentioned to suffer most about this misinformation when system attribute data was compared.

SAP pricing system in MO has been initially created for local usage and it has grown to global and today's modification in pricing information is complex. Even small category change may cause big impact on pricing information.

The routes between MO and customer were not clear for the users. The information routes between MO and customer are not clear and it was experienced as an issue. Also, customer data management felt challenging because the data comes from many different departments.

Lotus Notes application guidelines are not clear to users. Some data like rock tests are not available like they should, and sales data is not easily available. SharePoint was experienced difficult to use as an everyday tool.

Product specifications are not properly available. Network drive M has memos that are not stored anywhere else.

Support and service consists of personnel from the business side and people who are responsible for product maintenance services and support. There were not many in this category but few quite important ones.

The contact and information route between the engineering department and the service department is not as clear as it should be. There is a feedback loop between these two and it is quite an important because service gets feedback from the field and this information is valuable to the engineering teams. If this information has trouble getting from service to engineering, this is an issue to look at closely.

The definitions for items that go obsolete and are replaced are not clear. Products have parts that have gone obsolete and are replaced by new parts. Now the teams are having trouble confirming the correct replacement part for customers.

The attribute tags of the machines are not updated. This makes that sometimes new parts are sold with old product attributes.

Some of the systems in use have requirements to be connected to internet in order to work and there have been issues with suppliers on the field that these systems have not been working properly. Some type of offline mode was requested by the users.

7.4 Own observations

These observations are from the interview conversations with the employees at MO. These are not quite specific but still important to note here.

Aton still has many users even though it has been slowly replaced by Teamcenter. Whenever an Aton user was encountered during interviews, the followed-up questions were asked regarding Aton usage. The reasons why the user was using Aton or other systems were interesting. Some of these reasons were that the user does not have permissions or account to Teamcenter. Also, Aton usage is more familiar to some users because some procedures have been done in Aton for so long.

Some data has a middleman before getting the wanted data. This issue popped up a few times and one case was that the wanted data was in the Teamcenter and user gets that data by asking another user to get it from Teamcenter. This is an issue that needs to be looked at overall and not just the Teamcenter case but every system because this is not a working solution in the long run. Users need to have straight access to data they need. Of course, if the data is highly restricted, it is understandable to have a middleman to control the usage of the data. When the data is open to use within the MO environment, then the data the user needs, has to be available.

Some users require training in the other systems to understand how to take advantage of them in their work. This issue came up when Teamcenter and Aton usage was brought up. There are users that would be able to use Teamcenter but due to the lack of Teamcenter knowledge, they prefer Aton because they know how to use it. This holds some users back on parts of their work, when they do not take all advantages of MO systems available.

8. SUGGESTIONS FOR IMPROVEMENT

The findings were split into two main categories and it is logical to split the improvement suggestions also into these categories. The future work to improve the systems and data usage must be prioritized so the following suggestions are also prioritized. All the findings mentioned earlier are things that MO should solve to improve but of course some of them are impacting a small number of users, so the priority is quite low, and some are affecting users from all departments, so the priority is quite high for those.

Some challenges are also hard to take control fast and in a big company like MO, everything takes its own time. In these suggestions the goal is to give the right direction on those big cases and not a complete solution.

8.1 Suggestions based on access model

The access model brings a clear but big improvement case for MO. The systems are Teamcenter and SAP that require most of the attention. The challenge now is that the systems offer a great amount of different data but the data that is available to users is too high. As an example, if a user needs to access only product maintenance documents in Teamcenter, the user now gets to see product drawings and model data and much more in the system.

In an environment like Teamcenter it is possible to restrict the system data visibility, but it requires work over Teamcenter group rules that are now present in MO. The process also requires much deeper investigation of the data usage in Teamcenter. The research done now is much more general data usage over the products lifecycle but if the same process is done just for Teamcenter or SAP there would be enough knowledge to understand the data usage in these systems thoroughly.

The suggestion to this issue is to extend this research to these systems and get all the usage information and future for Teamcenter usage mapped. From this information MO could build a new type of Teamcenter and SAP access grouping for the data to restrict it in a way that users always have access to the data they need.

8.2 Suggestions based on interview findings

From the interview findings there are many things to point out but there are few challenges that stand out from the others. First one is the network drive usage. This affects a large amount of MOs personnel and needs proper actions. The biggest

challenges are the way network drives operate. In today's system environment the network drives are not the ideal solution for data storage. When the data amount gets bigger, the network drive usability gets lower. In MOs case, the usability has already started to get bad on the network drives. MO must act to further encourage usage of other systems for data storage and make other systems like Teamcenter more available for the data. Especially for data types that have relations to other data. Like documents that relate to products in Teamcenter. For those types of documents, the correct place is the Teamcenter as priority.

MO already has taken great steps towards this and is on a right track for getting rid of the network drives for new data. And this is the correct way of doing, getting the new data to the correct places and new ways of doing things to the everyday actions. The old data in network drives is the whole other case and it is on much lower priority right now what happens to it. The data is on the drives already and is not going anywhere. When MO gets to a point where no more new data is stored into network drives, then it is time to start planning old data migration and if that is even necessary for the older data.

Data management quality control needs improvement and policies in all systems. MO has policies for most of the systems, how the data should be managed, but the quality control is lacking in some areas. The quality control means that there should be more data management checking in the systems by users or dedicated personnel to make sure the data is managed as stated by policies. For smaller systems this should be done by the users themselves but for larger systems, the quality control should be done by dedicated personnel along with users.

MO personnel already do some quality control for data during their work, but this should be more of a work obligation than optional work duty. The power of the user-based quality control is great because of the amount of people doing it. Large user groups also notice data usage errors easily and the system users know how to correct them. It takes a small effort to keep the system well maintained but fixing a poorly maintained system takes a lot of effort.

The systems that handle the same data need a master data check. These systems are Teamcenter, SAP and Aton mostly and it was noticed that it is not always clear to the users which system contained the up-to-date data or attributes. This means that the different attribute values are different in the systems and it is not clear what data is the data the user can trust to be up to date.

This is not an easy task to go through and requires a lot of help from the users. The right direction would be to recognize if there is any master data maintained at Aton and

transferring it to the other systems to be maintained. Next would be to have policies for the different types of master data so the users would know where to find the data they look for and they can trust to be updated. It is the nature of MOs systems that some data is stored in many systems and there is nothing wrong with it if it is clear what data is the master data and the up-to-date data.

One of the challenges was the user knowledge about systems they use or could use. It was noted in a few interviews that the users had limited knowledge on the system they could use, and this prevented the usage of the system. One of these systems was Teamcenter and in that case the user was using Aton for product data and they knew the data would be available for use in Teamcenter, but they preferred Aton over Teamcenter, because the Aton was more familiar.

The suggestion to solve these types of issues would be to directly encourage users to contact their supervisors to get some type of advanced training for the systems they are using if needed. It would also be preferred to encourage supervisors to have conversations with their subordinates to understand how they all use the same systems and make them share their knowledge of the system usage. MO should make sure the users take all the advantage of the systems they are already using. There is more potential in the systems if the users had more information about the system features. One way to make sure everyone knows the system features are guides for doing different types of work tasks in the systems. MO already uses the guides but making guides mandatory for critical work tasks would make sure the information is shared with all system users.

In the findings part of this thesis, there were a lot of different cases mentioned and it would be recommended that MO takes them also into account. Those all are ongoing challenges the users have and should be investigated. The priority should be with the ones that affect most users.

9. CONCLUSIONS

This thesis represents product lifecycle data management's current state at Metso Outotec Tampere site and focuses on the identified challenges and issues in the data management process. The data was collected with a qualitative interview survey, done with key personnel at Metso Outotec Tampere site. With that data the PLM access model was created, and it represents the product lifecycle data flow through the systems from the innovation stages all the way to the product support stages. The survey also gave information from the ongoing challenges in the current data management.

The access model was analysed, and it confirmed the need for new system grouping that is needed for the company's largest growing systems like Teamcenter. The system now does not restrict the visibility of the data enough and creates issues with data privacy and data searching. The model shows this when all the use cases are combined, that the different users need different data from the systems and not all that is available. By restricting the data to the proper groups, it makes the system usage better by offering users the data they need and hiding all the unwanted data. It also gives possibilities to store more restricted data to Teamcenter that is not possible now. To implement this change, there is a need for higher precision investigation of the usage of the data in the system. This research does not provide data to properly understand the exact data usage within the systems but provides a good base for future research to take the understanding to the needed precision.

The ongoing challenges that were collected in the interviews proved to be quite important. This is a list of challenges that interviewees struggle nearly every day with data management and usage. These are all mentioned in the findings and for the most impactful challenges are listed on the suggestions for the company on a dedicated paragraph. Most impactful ones are the challenges with the network drives data and the data management quality control improvements. Though it is important to take all the challenges mentioned seriously because these are issues that affect users in their work.

The object for this thesis was to create a PLM access model based on the product lifecycle data with an interview survey and to use the model and information from the interviews to identify the data management challenges and provide Metso Outotec a better understanding of the data flow in the systems through product lifecycle. The access model would be more comprehensive if the coverage would consist of other sites but with the Tampere site in mind, the goal was reached.

This thesis provided a lot of information for the company to use and act on. The access model can also be used in future projects as a reference point and the findings and the suggestions made for Metso Outotec include an important list of issues to solve to improve the company's data management.

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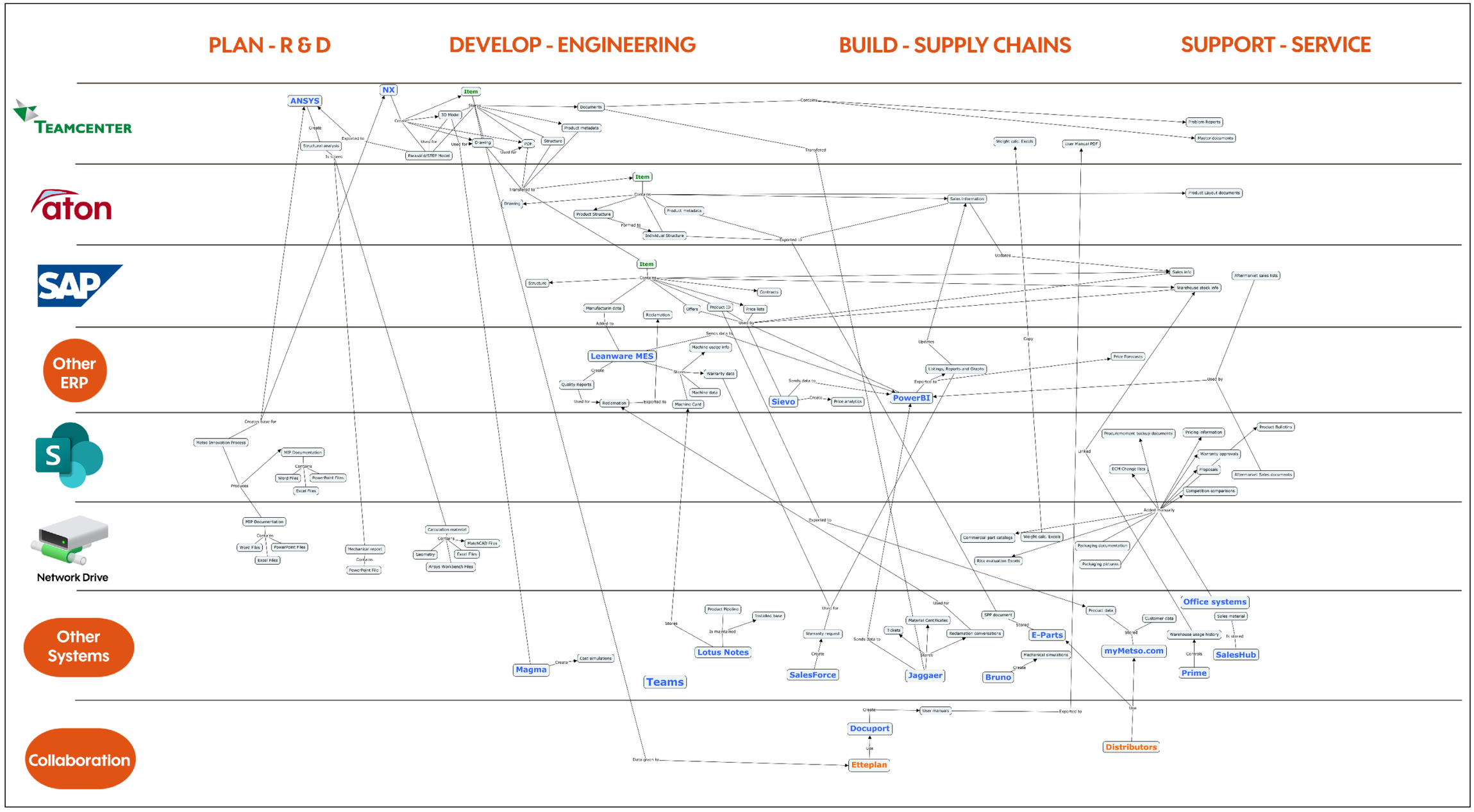
APPENDIX 1: ACCESS MODEL



APPENDIX 2: ACCESS MODEL ZONES