Expertise
and insight
for the future

Juho Salmi

Developing Item Policy to Enhance Proprietary Item Data Quality

Metropolia University of Applied Sciences

Master’s Degree

Industrial Management

Master’s Thesis

29th May 2020

Author(s) Title Number of Pages Date	Juho Salmi Developing Item Policy to Enhance Proprietary Item Data Quality 78 pages + 1 appendix 29 May 2020
Degree	Master of Engineering
Degree Programme	Industrial Management
Specialisation option	Service Management
Instructor(s)	Dr. Thomas Rohweder, Principal Lecturer Sonja Holappa, Senior Lecturer

The objective of this study was to research issues in data quality in the context of proprietary items. Proprietary items have historically had little limitation of how the data should be displayed and what the minimum requirement is for data quality.

The large variation in data quality creates waste in the later stages in the products' lifecycle by creating unnecessary workload, confusion and increased response times which could have been avoided if the data had been in good shape. Good quality data, especially in the engineering context, significantly reduces the risk of supplying incompatible or wrong items to customer, whose location may not always be the most convenient possible.

This study is based on conducting a current state analysis concentrated on systematic issues rather than humane issues. This approach justified itself as there were no systematic rules of data creation, which rendered local differences in working processes insignificant.

The current State Analysis revealed issues in the current item data, where the fluctuation in data quality was clearly visible. It also revealed the difference between applied processes regarding item creation, modifying and release. In relation to the Current State Analysis, the Conceptual Framework provided some essential and relevant findings for building the proposal. The Conceptual Framework of this thesis was created on three key topics to solve the issues found.

The outcome of this study is a global item policy for one product line which allows the implementation of this policy for multiple product lines later.

Keywords	Itemization, Product Lifecycle Management, Data Quality

Preface

A lot has happened during the last year. The world and I did experience a lot of new things in a very short time. During that time the journey I've went through has been a very educative and memorable experience. I have learned not only lot from business management but also developed my personal skills at the same time. When comparing myself to myself before studies the development is massive in theoretical knowledge and in personal skills.

I want to thank all those who supported me during this entire process. For my family who helped and supported me during the entire period. Without their support the journey would have been much harder to navigate through.

I also want to also thank my instructors in this thesis, Dr. Thomas Rohweder and Sonja Holappa for their great support to overcome different issues during this journey.

And last but not least, my gratitude goes to my employer who gave me this opportunity and time to develop not only this thesis but also myself on the side.

Juho Salmi
Vantaa
29th May 2020

Contents

Appendices

List of Figures

List of Acronyms

AI – Artificial Intelligence

BOM – Bill of Materials

CAD – Computer-Aided Design

EBOM – Engineering Bill of Materials

ERP – Enterprise Resource Planning

IT – Information Technology

KPI – Key Performance Indicator

MDM – Master Data Management

MEP – Manufacturer Equivalent Part

PDM – Product Data Management

RDO – Responsible Design Organization

SBOM – Services Bill of Materials

1 Introduction

In a business environment, efficiency is playing a bigger and bigger role in the competition regardless of the area where the company operates. In the engineering world where equipment is built, operated and maintained the quality of different information plays a crucial role as a business efficiency booster. Different companies take different approaches to master data and its management, development and maintenance.

1.1 Business Context

Itemization is a part of productization and product lifecycle management. The idea of Product lifecycle management is to set the product itself in the center of operations (Stark 2015). This allows all the sub-organizations of the company to work with the same product data and enforces a certain view of the product. When the process is product-centered no sub-organizational views of the product that differ from other sub-organizations start to form (Stark 2015).

When a company starts to implement product lifecycle management to its processes, the products of this company must undergo a productization process. In this process all data that a certain product contains is harmonized to a single frame. In engineering context, a product structure will be broken out in parts and implemented in the PLM system. These singular parts are called items and each one of them represents a unique record in the database. In the case company's PLM system, an item can be defined to be various types. These types can be component-type or assembly-type. When the type is set as component the item represents itself as a whole. An assembly-typed item can contain relations other items, assemblies or components. Thus, it contains a Bill of Materials (BOM).

1.2 Business Challenge, Thesis Objective and Outcome

The business challenge where this thesis emphasizes on, lies in company master data management and data quality. In case company productization efforts began early 2010's by implementing a new PLM system and this system has been gradually deployed around the world for different product lines ever since. As the case company grew by buying and merging smaller companies around to globe to itself a need for single system was discovered. As the mergers brought in lot of different data a cleanup was needed to identify master items to be used globally. These items are something that could be easily bought by anyone in the company. A separate sub-organization was set up to handle these items. These items were called 3rd party components as they were supplied or designed by others.

The itemization process started by importing the existing data to the new system and recognizing all the existing items that could fall under this 'supplied by others' category. At the mean time policies were developed how these items should be handled by the item specialists. The efficient usage of these policies cannot be efficiently used for other than 3rd party components which leaves the in-house created items to a lawless state.

As the 3rd party component library has been harmonized by now the case company has its items harmonized and itemized to comply these policies. All the items meet a certain quality level before released to use. This quality level means that the item contains all the data so it can be bought and has its duplicates marked.

However, as the emphasis has been shifted gradually more and more to after-sales side it has been noticed that proprietary items have a very different situation. Those items that are created in-house by the case company are called design or proprietary items. As the item specialists managing the 3rd party items had a policy to comply on when working with items, designers and product managers do not have a respective item policy to lean on. This leads to the situation where there are as many quality levels as there are item creators.

When the quality of item data fluctuates from end to end it eventually has an effect on the services-side of product lifecycle. Efficiency is lost and quotation response time, a major KPI in the case company, grows when the service quotation specialist uses a lot of time with spare part quotation that has very bad quality data created in the delivery phase by the item creators. In a worst-case scenario a wrong spare part is delivered to customer.

The objective of this thesis is to propose a uniform item naming guideline and a supporting process (policy) to be implemented in design items for one pilot product line to act as a guideline for design engineers, product managers and item specialists.

As an outcome a global item policy is formed for one product line with a potential of multiple product lines implementing this policy later.

1.3 Thesis Scope and Outline

As the case company product portfolio is very extensive, a pilot project is made with one product group to form a basis for global policy. Thesis includes researching the minimum viable requirements that this single group of products require from the policy to produce harmonious items with stable quality. Scope of this study is limited to design items and their related processes. However, some points are compared to previously mentioned 3rd party items and their policies, guidelines and processes to achieve a holistic viewpoint.

This thesis is written in seven sections. Firstly, thesis topic, objective, outcome and outline are described in the first chapter. The second chapter describes research methodology. The third chapter concentrates on current state of itemization, related processes and current status of data quality. The fourth chapter focuses on existing knowledge on master data management, data quality issues, product lifecycle management and their relation to engineering. The fifth chapter proposes a solution in a general level and applied to items representing a single product group. The sixth chapter describes received feedback for the proposal and possible modifications to it. Lastly, the seventh chapter concludes the Thesis with self-evaluation and next steps in proposal implementation are discussed.

2 Project Plan

This section describes the research approach and data collection methods used in this thesis. The first subchapter describes the research approach used in the thesis. Second subchapter is dedicated to research design and methodology**.** The last subchapter explains how the data collection is planned.

2.1 Research Approach

According to Saunders et al. (2012) there are two main frameworks for research studies, basic research and applied research. Whereas basic research emphasizes more on theoretical analysis to implement existing knowledge of certain issue, the applied re-search method focuses more on creating a practical solution to a certain issue. Thus, in basic research minimum attention is given to actual problem-solving activities and resolutions and their implementation and in applied research the attention is less on theoretical knowledge and more on creating and implementing a practical solution to tackle a certain issue.

Action research implements qualitative and quantitative sources in data collection. As Kananen (2017) defines it as “blended” or “mixed methodology” where both styles of data collection are used are often implemented in action research projects. Qualitative data collection implements spoken and written data collected through interviews and feedback collections. Quantitative research data is more measurable, as it is collected from numerical sources and statistical analyses. Unlike qualitative data, quantitative data provides more absolute information of data as qualitative data is prone to change in richness due to human nature.

Action research however relies on reoccurring cycles presented in Figure 1. This cyclical nature makes it difficult to implement in time-limited environments as there might not be enough time to implement a new research cycle. Kananen (2017) introduces a new type of research alongside action research and case study: “Applied Action Research” or “Design Research” where the intention is in solving of organizational issues, such as process problems, but is more suitable in time-limited situations. Design research method is intended to function amongst borders of existing business environment, making it excellent choice as research method when intention of the research is not to invent the wheel again, but rather make it more efficient by introducing an upgrade package to it. It can be used to improve operations concerning products, processes or services (Kananen 2017).

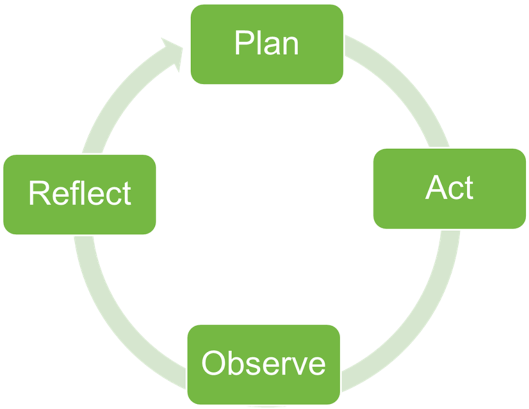

Figure 1. Continuous Action Research Cycle

In context with the business challenge and the objective of the thesis both quantitative and qualitative methods are included in the toolkit. Thus, design research method allows mixing of both data collection methods while allowing to operate within and produce a viable increment to tackle the business challenge described in chapter 1 and therefore it is chosen as research method.

2.2 Research Design

The research was conducted in four phases which included collection of three different data sets (Figure 2). Firstly, a current state analysis was conducted with qualitative methods such as interviews and quantitative methods such as data queries from item database. The collected dataset mapped the pinpoints in the current itemization work and some preliminary ideas also were found how to tackle these pinpoints. Secondly, a literature review was conducted to compare current state against master data literature and how the item data could eventually be improved by creating solutions based on literature to hit these pinpoints. Thirdly, a second dataset was collected by identifying product-relevant attributes which were mapped in a table format to form the proposal. Lastly, this data policy was validated amongst other product groups to ensure future compatibility and allow expansion to other products as well.

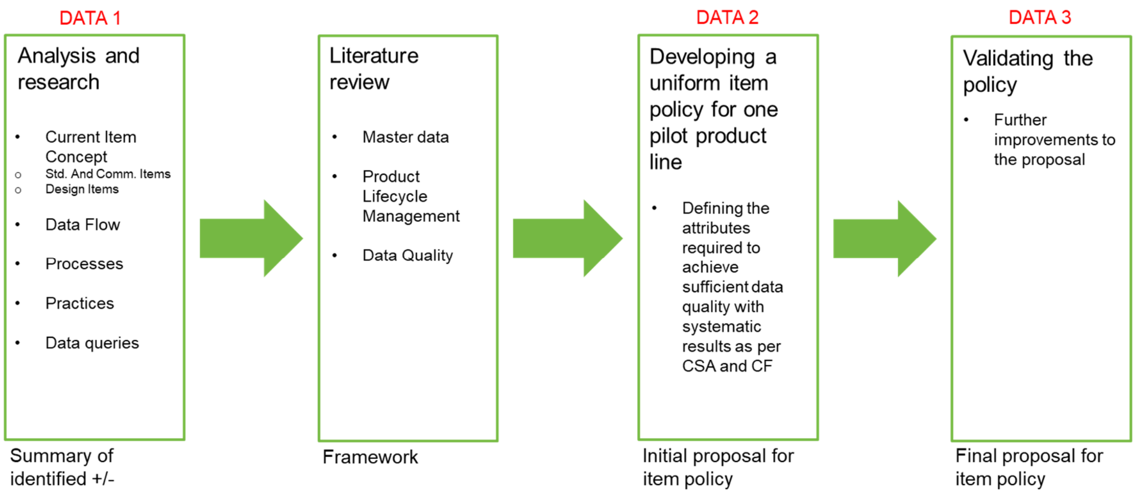

Figure 2. Research Design of This Thesis

2.3 Data Collection Plan

Quantitative and qualitative methods are used to source data in this study. The quantitative methods include interviews with different peers related to the development area in the described business context. These interviews are used to gather information from the related product, its configurations and current state. The qualitative methods are traditional self-sourced data mass, which is filtered to serve this study as well as possible. The data collection plan for this Thesis is shown in Table 1.

Table 1. Data Collection Plan

	CONTENT	SOURCE	INFORMANT	SCHEDULE	OUTCOME
DATA 1 **Analysis of current practices**	• Current Item Concept o Std. And Comm. Items o Design Items • Data Flow • Processes • Practices • Data queries	• Operating model • Legacy policies from product line • Product data • Interviews • PLM/PDM	• Itemization team • Service Product Manager / Product Owner • PLM/PDM	• January	• Summary of identified +/-
DATA 2 **Developing a uniform item policy for one pilot product line**	• Define required attribute types in policy	• Interviews with stakeholders • Workshop in local office	• Product Manager • Itemization Team	• March	• Uniform item policy for one pilot product line
DATA 3 **Feedback on global item policy proposal**	• Validate proposed policy • Collect improvement ideas	• Interviews with stakeholders • Operating Model	• Product Manager • Itemization Team	• April	• Final policy proposal

The project plan introduced in this chapter along its data collection will be implemented in this thesis in the analysis, development and feedback phases. The next chapter is dedicated for current state analysis where first set of data is collected.

3 Current State Analysis

This section describes how the itemization process is currently done with a selected product group in the case company. This section is divided into five subsections. The first chapter is an overview which explains how the analysis was conducted. The second chapter describes the concept behind itemization currently applied in the case company. The third chapter opens up how itemization is divided between item policies and maps the item creation processes in different contexts. The fourth chapter analyses current itemization practices in a single product group. The fifth chapter concludes with summarizing the strengths and weaknesses found.

3.1 Overview of This Data Stage

Data collection was conducted using several methods to obtain a clear view of the current situation. In the first phase product information was obtained from brochures, data sheets and internal process maps and policies to support in development of attributes in later phase. Secondly, interviews were held with the product owner, itemization teams and quotation support team to gain knowledge of the current situation.

3.2 Item Concept

Item concept is the foundation for itemization in the case company. It defines what an item is in the case company context and what type of data it contains. These types are illustrated in Figure 3.

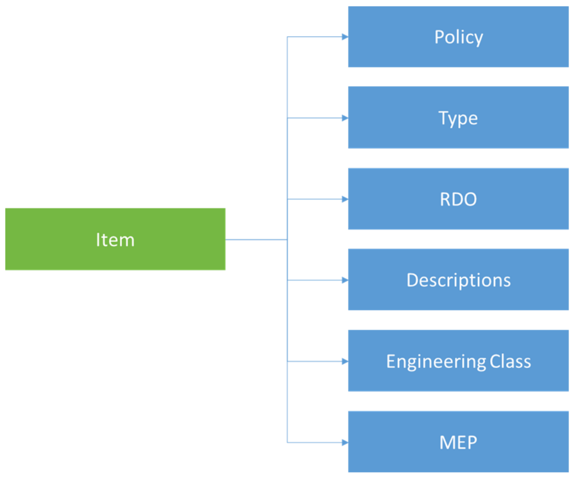

Figure 3. Variables in single item

The policy of the item defines the behavior of the item and acts as a main classification for an item. Depending on the policy, the item has different attributes available concerning lifecycle, relationships to other items and attributes. The available policies for items are illustrated in Figure 4.

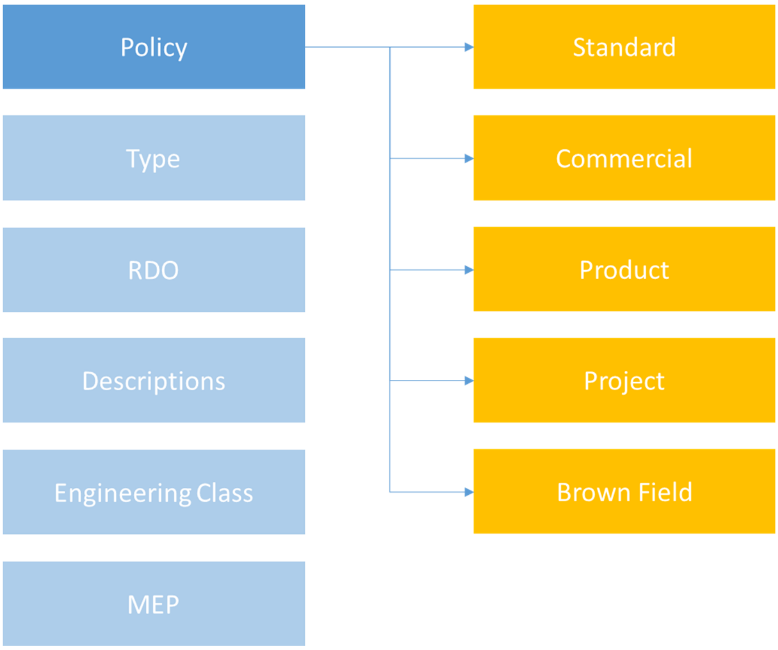

Figure 4. Available item policies

The item type separates design items in the PLM system based on the structure and usage of the item. Available item types and their classificatory families are illustrated in Figure 5.

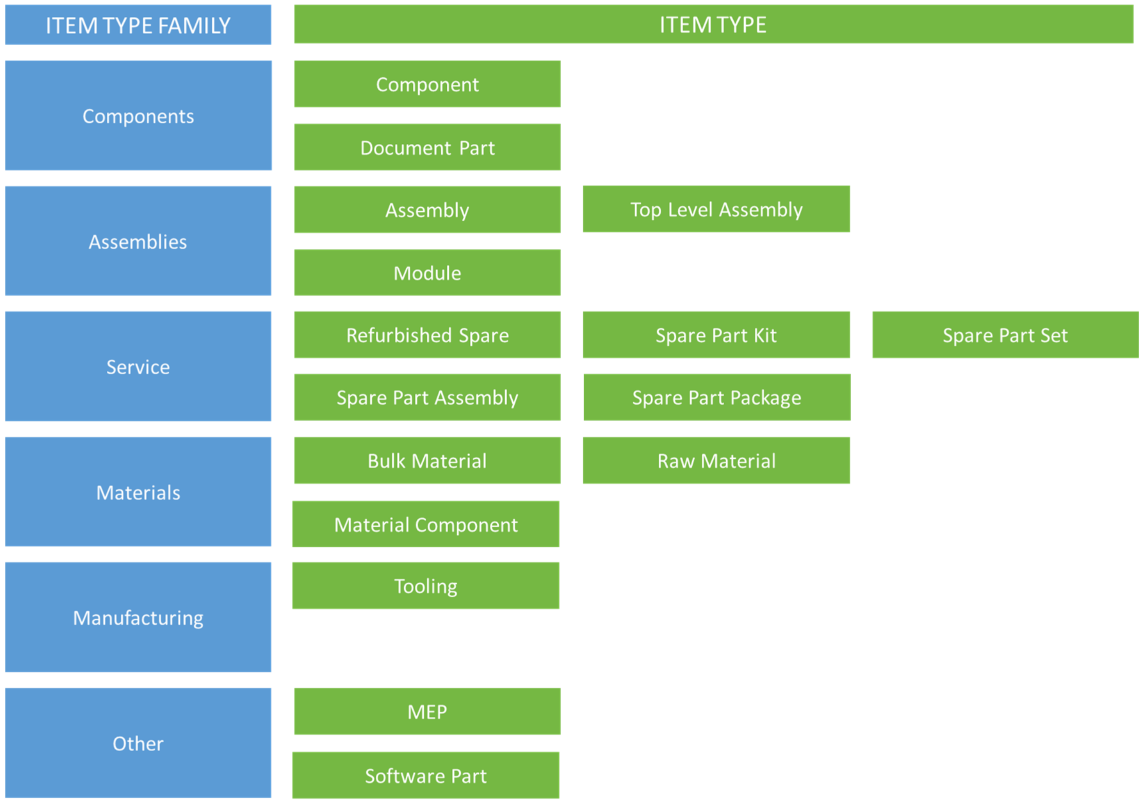

Figure 5. Available item types and their families

An item represents a single entity in a database. As a product may be an assemblage of multiple parts, all of these instances need to be identified. Thus, an item can have a relationship to another item or items in a hierarchical manner thus forming an assembly. These relationships are listed in the assembly's Bill of Materials (BOM). The hierarchical structure of an assembly and its relationships to singular entities (items representing components) is illustrated in Figure 6. Theory related to the product structures is later discussed in Chapter 4.

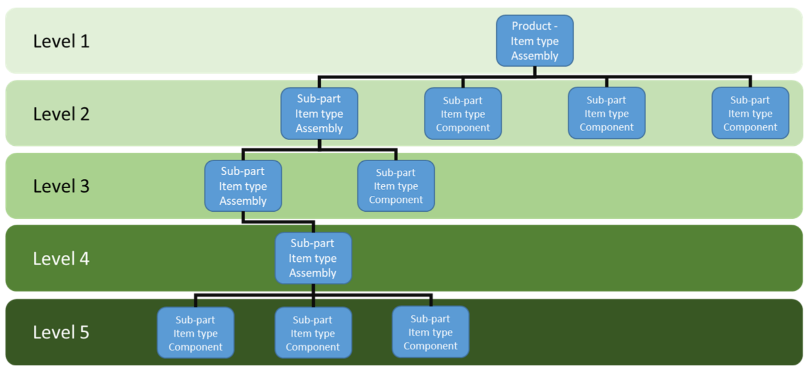

Figure 6. Graphical illustration of a multi-level BOM (Stark 2015).

Bill of Materials can have multiple functions to serve different purposes and their functionality differ slightly from each other. Engineering Bill of Materials (EBOM) shows the hierarchical structure from a design point of view and contains always the latest revisions of the items. Manufacturing Bill of Materials focuses on manufacturing view and Service Bill of Materials (SBOM) in as built and as maintained structures to record the rear world data and keep it updated. Without SBOM functionality the traceability of delivered structure would be lost as the EBOM is constantly evolving and does not make historical snapshots of the structure.

RDO defines the owner of the item. The defined owner is responsible for quality and content of the item. The items under Standard and Commercial policy are owned by a separate organization called Component Engineering. Product and Project policy items are owned by different product lines inside the case company.

The system allows multiple different descriptions defined for the item. The available description fields are described in Figure 7. For an item to be released it requires at least main description to be defined and according to policy a specification attached to it. Other descriptions are complementary information and shall be defined according to item policies to improve data quality. Depending on item policy a specification can be e.g. manufacturer datasheet, manufacturing drawing or assembly drawing.

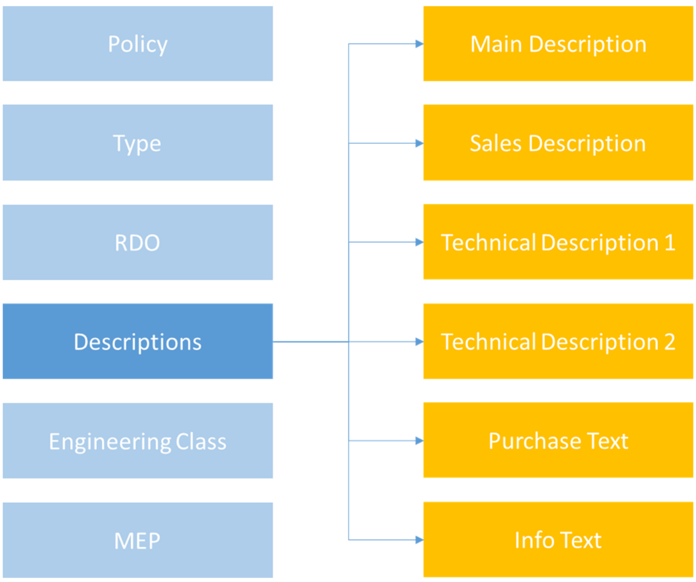

Figure 7. Available description fields for an item

The description attributes have different visibilities on different reports. In engineering a BOM printout requires all available technical data to allow designing and manufacturing of the item. Procurement requires also complex technical data to allow quotation from suppliers. For installation technical details are limited, but sufficient enough to allow installation of equipment. Customers should only receive limited information about the item and communication with customers should be done only using case company item codes and descriptions regardless of item policy. Data sharing borders are illustrated in Figure 8.

Figure 8. Description fields and their visibility for internal and external peers

3.3 Current Itemization Practices

As mentioned in the business context, the case company has already developed policies to handle commercial and standard items which are managed by a dedicated team. To identify how a certain item should be handled and by whom, an item concept exists in the case company.

3.3.1 Systems Used in Itemization and Information Flow Between Systems

In the center of information flow, shown in Figure 9, is the PDM system, Enovia. It acts as a master data holder for product design data, documentation and lifecycle status of products. It also contains itemized delivery and services data.

Figure 9. Data flow between systems in use

Commercial items are created and managed in PDM. However, design items have multiple ways to create and manage item data. The most common way is via automatic integration from SolidWorks EDM or Autodesk Inventor Vault to PDM. A item number is generated by the user and item data is inserted in the CAD design phase where it is automatically integrated into PDM when the design is approved in EDM or Vault. Manual creation of design items is also possible in PDM and the created number can be picked into EDM. This allows usage of manually created design or commercial items to be used in CAD assemblies and automatically linked to assembly BOM via integration.

Item data is sent automatically from PDM to ERP to allow purchasing when the item is released. This is valid for both commercial and design items. The same metadata originating from EDM or PDM, depending on the item, will be transferred also into ERP.

eCatalogue is an optional spare part catalogue for customers which is created from spare part drawings of assemblies in PDM.

3.3.2 Standard and Commercial Items

Standard and Commercial items are grouped into a global master library where they are available to be used throughout the organization globally in different products. By defining master items for standard and commercial components from duplicates and obsolete items, the more harmonized standard and commercial item database becomes. Enriched items in the commercial library are referenced automatically in the engineering systems EDM and Vault, thus reducing throughput time in engineering when certain components do not need to be itemized again for every product and project.

Commercial items follow a certain process (Figure 10) when a request for a new item is received by the itemization team. Users make requests to a workflow tool where it is picked by an item specialist. The item specialist then validates the request and checks if there is enough information supplied in the request. If request information is insufficient the item specialist returns the request to the original requestor and requests more information. When a sufficient amount of information is received the item specialist checks if the item has existing duplicates in the system.

The item request form also includes an option to request a 3D model to be created. This 3D model can be used in various CAD-programs and it is placed in a common library which enabled cross-company usage of single model. If the original item request includes a request for a 3D model creation, the item specialist creates a request for a 3D model which then is handled by a 3D model specialist.

If the requested item has an existing duplicate item in PDM the item specialist will check if that existing item requires enrichment. In this step of the process, whether the item had duplicates or not, the item specialist will create a new item, update the existing item if it had non-conforming data or do nothing if the item already meets a sufficient quality level. Commercial items utilize a quality level-attribute ranging from D to A, D being the lowest quality. For an item to meet a certain quality level, certain prerequisites set by the quality level must be met. To meet level B, all item descriptions and attributes must be according to policy, MEP set, and all duplicates and legacy items obsoleted and determined. Also, a specification must be connected to the item. Determination in this context means referencing to the replacing item.

The item is released for use after creation or enrichment and the ticket is closed by the item specialist.

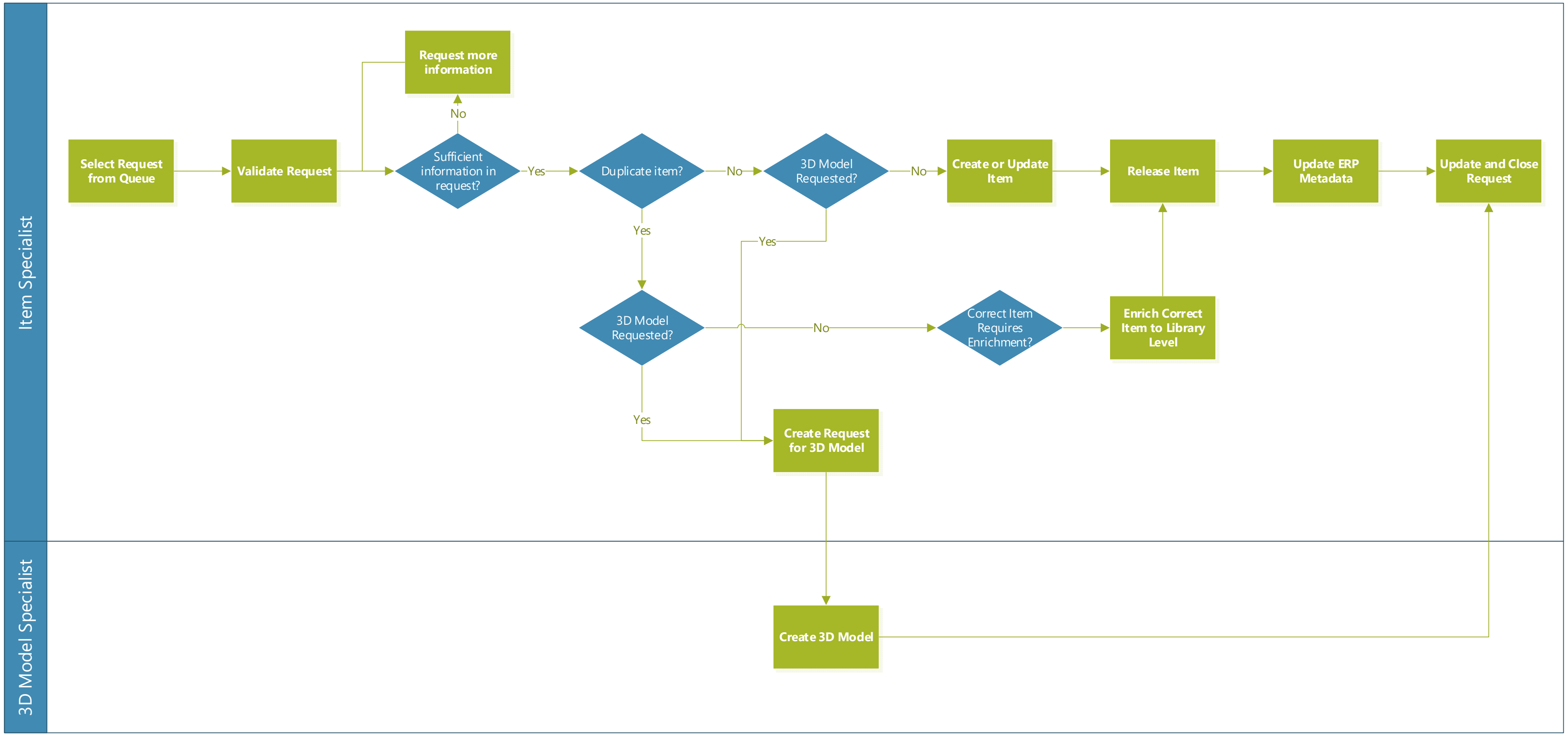

Figure 10. Commercial item creation and management process

Figure 11 illustrates the current policy for commercial items and Figure 12 for standard items respectively. The policies describe what data, how it is filled, and which attributes are mandatory, and which are optional to fill for an item to achieve requirements stated in the item policy. Type, policy and RDO are strictly enforced to a certain outcome when item is under standard or commercial policy.

The variability in item data starts when item is classified in Engineering Class, a hierarchical classification for engineering purposes. The classification is dependent on the item to be created. Engineering Classes guide users in description formation through a set of guidelines. These guidelines are syntax-based instructions which affect to Main Description, Sales Description and Technical Description attributes. Leaning on these guidelines, as enforced by the item policy, the resulted mass of item mass is generally in a harmonious condition when looking at the description data.

There are some differences between standard and commercial item policies. Commercial item policy requires a specification to be linked and manufacturer data to be inserted into the item to allow purchasing. Standard components do not have this requirement, as they can be manufactured by different manufacturer. Related dimension and material standards provide the identification for purchasing activities. Standard components also do not require a linked specification, as the standard itself provides enough information to identify.

Commercial Items

Commercial items are primarily identified by defining the manufacturer and with the unique manufacturer code for the component. Commercial items present some manufacturers equipment or component that is used in Outotec products, or it is a sparepart for some equipment used in Outotec products.

Commercial items are classified in Enovia as follows:

Field	Mandatory	Value for the field
Name	Y	Unique code for the item
Type	Y	*Component*
Policy	Y	*Commercial*
RDO	Y	*Component Engineering*
Engineering Class	Y	Engineering class is a hierarchical classification of commercial items for Engineering purposes. Value selection depends on the item to be created. Guidelines by Engineering Class
Main description	Y	Main description follows directly the Engineering class selection as described in SharePoint. Guidelines by Engineering Class
Sales description	Y	This field is used to describe the item for customers and it should contain short description of the item. Sales description syntaxes are described in detail in SharePoint. Guidelines by Engineering Class
Technical description	Y	Additional detailed technical information for the item to identify the item in Engineering. Technical description syntaxes are described in detail in SharePoint. Guidelines by Engineering Class
Manufacturer	Y	Name of the manufacturer for this item.
Manufacturer Code	Y	Identification used by Manufacturer for the item. Used to uniquely identify the requested part when purchasing from manufacturer.
Is OEM	Y	Identifies if the given company and code are original manufacturer of the item. Value Y = Manufacturer.
Weight	Y	When weight information is available, information must be filled. Weight marked in kilograms (Kg).
UoM	Y	*EA (Each)*

Other attributes are to be filled as follows:

Field	Mandatory	Value for the field
Purchase text	N	Additional information for purchase purposes. Use when necessary for the item.
Info text	N	Additional information regarding to item. Use when necessary for the item.

Figure 11. Item Policy for Commercial Items

Standard Items

Standard items present common components that are specified regarding to some standard.
Standard items are created and classified in PDM regarding to following table. The fields described with *Italic* are values user must select when creating corresponding item into Enovia.

Standard items are classified in Enovia as follows:

Field	Mandatory	Value for the field
Name	Y	Unique code for the item
Type	Y	*Component*
Policy	Y	*Standard*
RDO	Y	*Component Engineering*
Engineering Class	Y	Engineering class is a hierarchical classification of standard items for Engineering purposes. Value selection depends on the item to be created. Guidelines by Engineering Class
Main description	Y	Main description follows directly the Engineering class selection. Guidelines By Engineering Class
Sales description	Y	This field is used to describe the item for customers and it should contain short description of the item. Guidelines By Engineering Class
Technical description	Y	This field must contain the standard based description of the item. This field may contain duplication of information from other fields to support standard based description usage. Guidelines by Engineering Class
Dimension standard	Y	Dimension standard identification for the item.
Material and Material standard	Y	Material standard identification for the item.
UoM	Y	*EA (Each)*
Weight	Y	When weight information is available, information must be filled. Weight is reported in kilograms (Kg).

Other attributes are to be filled as follows:

Field	Mandatory	Value for the field
Purchase text	N	Additional information for purchase purposes. Use when necessary for the item.
Info text	N	Additional information regarding to item. Use when necessary for the item.

Figure 12. Item Policy for Standard Items

As described previously, forming descriptions for 3rd party and standard items are based on syntaxes stated on guidelines. Guidelines are available from a dedicated service, where they are grouped either by engineering class or manufacturer. As most of the description fields are free-text the guidelines help users to form their item metadata into a certain form with syntaxes and examples.

An example of this guideline table is illustrated in Figure 13. In the table users are able to see preferred descriptions, their syntaxes and example cases. Similar instructions targeting design items do not exist currently.

Class name	Ball Bearing
Class path	|01 Mechanical Components|Bearings|Ball Bearing
Parent class - Class name	Bearings
Preferred translation - Translation - Translation	BALL BEARING
Preferred material group information	
Alternate translations [Material groups] information	DEEP GROOVE BALL BEARING SELF ALIGNING BALL BEARING THRUST BALL BEARING ANGULAR CONTACT BALL BEARING Y-BEARING
Sales description free text syntax	[Inner diameter] [Outer diameter] [Width]
Sales description case	BALL BEARING 100/140x20mm
Technical description 1 syntax	[Manufacturer type/code] [Other relevant attributes]
Technical description 1 case	61920 SINGLE ROW
Technical description 2 syntax	
Technical description 2 case	
Other instructions	To be created either as Standard or as Commercial items depending on request. Standard policy items without MEPs but descriptions according to SKF descriptions. Commercial policy items as usual.
Example items in Enovia information	616520 DEEP GROOVE BALL BEARING 100/140x20mm - SKF 509250 DEEP GROOVE BALL BEARING 60/110x28mm - SKF 6689177 THRUST BALL BEARING 40/90x36mm - SKF 2321103 SELF ALIGNING BALL BEARING 35/72x23mm - SKF 535585 ANGULAR CONTACT BALL BEARING 40/80x30.2 - SKF

Figure 13. Example of item description guidelines for Engineering class: Ball Bearings

When the item is created according to guidelines it is shown in Enovia as illustrated in Figure 14. The system combines Main Description and Sales Description attributes into one string.

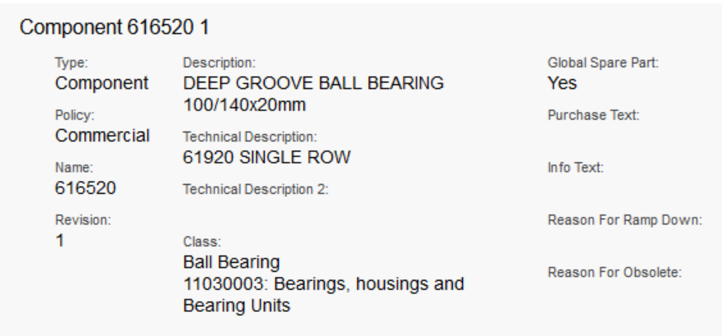

Figure 14. Example of displayed item information in Enovia

3.3.3 Design Items

Design items, also called as proprietary items which are created through engineering activities in product management or delivery organizations via EDM or Vault and represent material created in-house. Design items can also be created and managed manually in Enovia as an alternative to the integration.

Design items are placed under product or project policy and they are owned and managed by the responsible RDO. The data owner is also responsible for the quality and content of the items. The items are created either in the product development process, delivery phase of project or in services for legacy projects. All three have their own separate processes to follow: Product Management, Equipment Delivery and Service. However, as the same product is transferred from product development to services via delivery during its lifecycle, the same itemization rules should apply for all three parties and their operations.

The product lines create master items to be used as a basis for deliveries. The product items can be used directly in deliveries or copied as project items if modifications are necessary. Most of the new design items are created in the delivery or services phase.

As each product line is responsible for their items (RDO) there is no global itemization process or strict policy to enforce items into a certain form. As the case company is operating globally and developing, managing and delivering its products in a global scale the definition of sufficient item quality may vary significantly.

By conducting a search in Enovia the difference in how data is filled into items is clearly visible. The searched items represent the same product group and provide a glimpse of what the overall data will look if data is not enforced into general form and users are given a freedom to decide what data is filled into where and how it is formed. Example data is displayed in Table 2. More data is available in the appendixes.

Table 2. Example Data query showing current state of Item Descriptions

#	Name	Description	Sales Description	Technical Description	Technical Description 2
1	H1837020	BARREL NECK CLOTH		1500, MEMBRANE PLATE	[redacted]
2	NL32180	FILTER CLOTH		AINO K10;1.7X65m;P-PRO;SH2	
3	NL32218	FILTER CLOTH		AINO T32;1.7X51m;P-PRO;SH1	
4	L52372	FILTER CLOTH	AINO K16 D188mm	Outotec AINO K16	CLOTH FOR TEST FILTER. D188 mm
5	L32530	FILTER CLOTH	AINO T30 1.05x33m SH1	Outotec AINO T30	1.05x33m SH1
6	L609362	FILTER CLOTH	AINO T51 1.05x43.5m SH2	OUTOTEC AINO T51 1.05x43.5m SH2	
7	L604029	FILTER CLOTH	AITE S400 MS MFP0,3	OUTOTEC AITE S400	MS Cloth for test filter MFP0,3
8	L602344	FILTER CLOTH	ANNE T20 1.05x3m SH2 LOWER	Outotec ANNE T20	1.05x3m SH2 LOWER AUXILIARY CLOTH
9	L603227	FILTER CLOTH	ARTO S11, 200mm x 18250mm	OUTOTEC ARTO S11	CLOTH FOR PILOT FILTER 200mm x 18250mm
10	L606339	FILTER CLOTH	ASKO T54, 1.52x2.1M	OUTOTEC ASKO T54	1.52x2.1M, CS
11	L34720	FILTER CLOTH	MARO S30 D125MM	Outotec MARO S30	CLOTH FOR TEST FILTER D125MM
12	L604276	FILTER CLOTH	MARO S96 3.21X45M SH15	OUTOTEC MARO S96	3.21X45M SH15
13	H39514	OVERHANG CLOTH		1000, HEAD/END PLATE	[redacted]
14	L600965	OVERHANG CLOTH		FP1516 M50 PP	

The chosen example items belong to a specific product group These products are used for dewatering in industrial filters to act as a filtration medium. Chapter 5 describes this product group in a more through way as the proposal development highly relates to these products.

However, when looking at the example query, we are able to see some formalities in the data. Especially in the Sales Description field, the types and dimensions of the cloth are listed. The type of the cloth defines the properties of the cloth, such as shape, material, manufacturing method which all contribute to the performance of the filtration. As these attributes are affecting the performance, it is crucial to get the most suitable cloth for a specific application. Product naming and hierarchy is discussed more in Chapter 5.

When the equipment is initially delivered the formation of the data does not affect the delivery operations. However, after the equipment has been delivered it requires spare parts and other services regularly. The main difference is that the emphasis has transferred from a single specific machine in a delivery project to a one machine in a global installed base.

Having the data in a harmonized format removes the workload from spare part operations as they do not have to research what initially has been delivered and on the other end it reduces the risk of delivering a wrong part to a customer. As the customers are positioned globally and might have operations in remote locations, false data may not only introduce large financial risks but also safety risks if the delivered parts differ from the originals.

As the case company is operating globally, it has many business lines utilizing the same PLM system and all product lines have the same starting point towards itemization of their products, the issue of non-harmonized data between items representing same product groups is also global. By conducting a search with other product groups which are non-related to the items belonging to the filter cloth product group, nor even filtration products, it is visible that the issue is more a global issue than local. More data is available in the appendixes.

Table 3. Item query for items representing other product lines

#	Name	Description	Sales Description	Technical Description	Technical Description 2
1	10383090	ROTOR	FloatForce® 1750		
2	10383089	ROTOR	FloatForce® 1500		
3	N031044515	ROTOR	SkimForce™ 500		
4	10383086	ROTOR	FloatForce® 1200		
5	N048520100	ROTOR	FloatForce® 1300		
6	N031023078	LOWER LAUNDER		WITH RUBBER LINING, MSA2-50 - S	
7	N031031869	LOWER LAUNDER WITH LINING		MSA3-200-S	
8	N031092663	LOWER PART WITH RUBBER LINING		FEEDBOX, MSA3-200	
9	N031032237	MAIN FLUSHING		MSA2-80. MSA3-200	
10	N031019249	NOZZLE ASSEMBLY		SPSA DN 800/32"	
11	N031022371	NOZZLE ASSEMBLY		SPSA 500	
12	N031022531	NOZZLE ASSEMBLY		SPSA 700	
13	N031013463	NOZZLE ASSEMBLY		WASH NOZZLE ASSEM-BLY	
14	N031019856	NOZZLE ASSEMBLY COATED		PSA 300, SPSA 250	

There are however differences between products due to the more simpler nature of some equipment compared to others. This is also visible when viewing the comparison. The results of this comparison search are visible in Table 3. The samples were taken from two different product lines on top of Filters products. Items 1 to 5 are productized mechanical components which have intricate technical details but have very limited configurability, thus no technical description is required. Items 6 to 14 represent the same business line but represent different products. Items 6 to 9 in this sample provide how differently the same information of rubber lining and related product information can be informed in the metadata. Items 10 to 14 represent different variations of data input for nozzles.

Design and Assembly item policy

Design and assembly item should always have a drawing connected to the item to specify the item.
Design item and assembly is always used and owned by product line.

Design and assembly items are classified in Enovia as follows:

Field	Mandatory	Value for the field
Type	Y	*Component* *Assembly:* If a structure is required for Design item, then create it as an assembly
Policy	Y	Product/Project
RDO	Y	Product line
Engineering Class	Y	Design items must be classified under Design library and under correct product line.
Main description	Y	Select from predetermined options if possible.
Sales description	Y	Select based on drawing or EDM first description
Technical description	Y	Select based on drawing or EDM technical or second description.
UoM	Y	*EA (Each)*
Weight	Y	When weight information is available, information must be filled. Weight marked in kilograms (Kg).

Figure 15. Current Item Policy for Design (Proprietary) Items

Figure 15 Illustrates the current policy enforcing all items considered as design or proprietary items. It has similar restrictions as previously described commercial or standard item policies have but gives users much more artistic freedom to operate. The freedom is necessary as the entire product portfolio of proprietary items fall under this policy. However, it is missing description formation guidelines found in standard and commercial policies.

This missing aspect of guidelines ends up with users creating items for the same product with very variable data formation as proven in Tables 2 and 3 with data queries.

3.3.4 Current Itemization Processes

As described in Chapter 3 Commercial Items have a very detailed public process in the case company process portal where all actions regarding itemization are mapped.

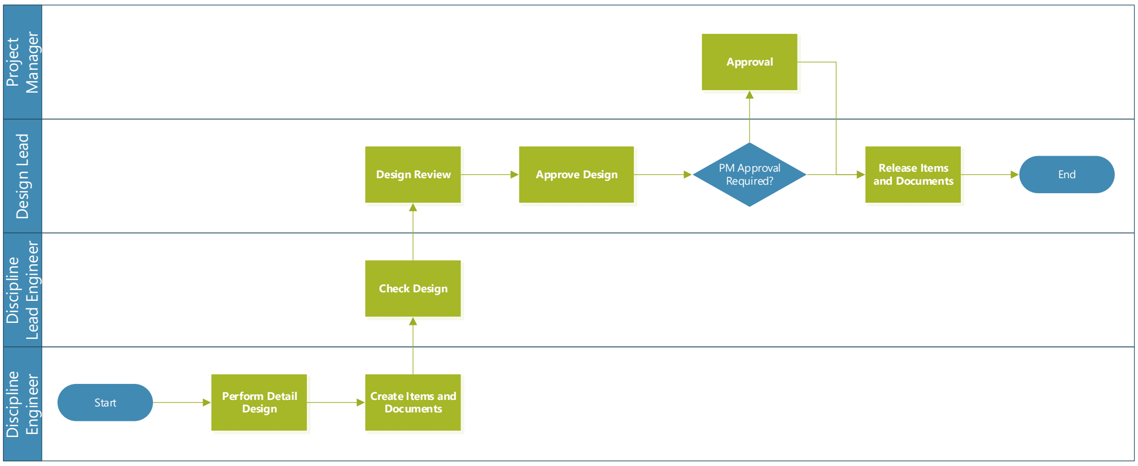

Figure 16. Snapshot of Equipment Delivery process from a point where items are created

Part of the Equipment Delivery process is mapped in Figure 16. When delivery projects reach this phase of the process, detail engineering is initiated by chief engineers and executed by design engineers. As per data flow illustrated in Figure 9, new project items are created in this phase via automatic integration from CAD systems.

Figure 17 combines the data flow with the Equipment Delivery process and describes what the outcomes of a certain process step in comparison with the data flow are.

A discipline engineer receives a work order from the design lead and performs detail design as per process. This includes detail design in CAD systems such as SolidWorks or Inventor. When the design is complete and item numbers are assigned to the required parts, the discipline engineer submits the 3D models and related manufacturing and assembly documents into the next lifecycle state in EDM. EDM has its own workflow for file lifecycles. Lifecycle states in EDM and related actions by the system when a lifecycle state change occurs are described in Figure 17. When the lifecycle has changed, data is exported to Enovia. The discipline lead engineer checks the designs and bill of materials from the item and decides whether the design is applicable to be sent for approval or demoted back for editing. The design lead approves the design and promotes files in EDM to “Approved” state which starts the integration process once more to send the approved documents into Enovia. The design lead must then release items in Enovia to allow purchasing or manufacturing of those items. Enovia sends information to SAP automatically to the connected plants after the item has been released.

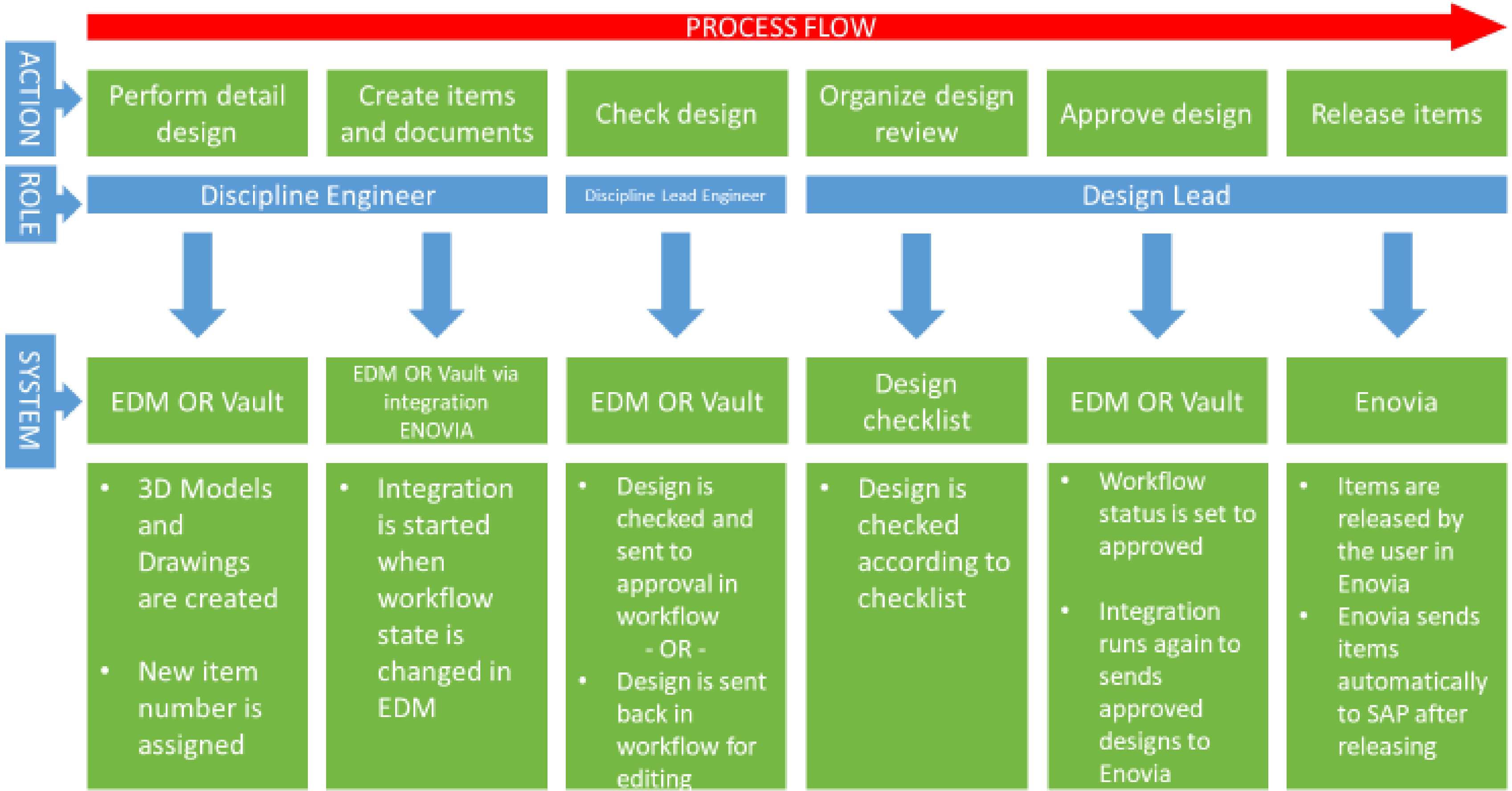

Figure 17. Data flow, creation and management in relation to equipment engineering process

When comparing the Equipment Delivery process to the commercial item creation process, where activities involving itemization are required do not have similar accurate subprocesses considering the creation of singular item. The absence of subprocesses leads to uncertainty in users as they do not have a strict process to follow and users have their own approaches to a rather simple and repetitive task.

In the service process items are mostly created or enriched to serve the spare part business in legacy deliveries. Item management is done according to the process by quotation support teams and is illustrated in Figure 18.

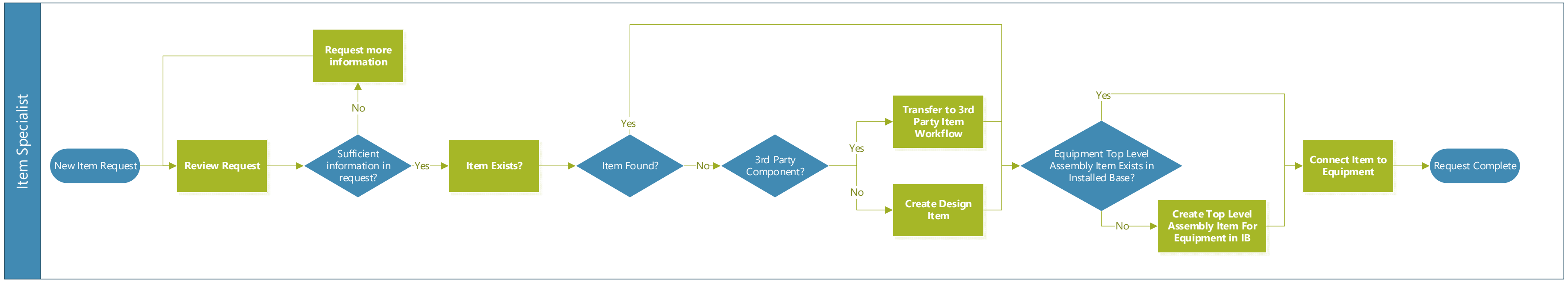

Figure 18. Services Itemization Process

The current service process has many more comprehensive steps to follow in item creation in comparison to the Equipment Delivery process. The process is also based on a ticketing-based system as in the commercial item creation process. Similarly, the user creates a request in the system which is handled by a service itemization specialist. The specialist reviews the request for missing data and returns the request to the requestor if more information is needed. The next step is to check if the item already exists in PDM, a similar step as in the commercial item creation process. If the item is not found, the specialist should next identify if the item to be created is a commercial item. The item is transferred to the commercial item creation process by the specialist if it is identified as commercial and the specialist hands over the responsibility of the item to a different organization where it is created according to available policies and guidelines. Otherwise the specialist will create a design item under a specific product line which currently do not have specific item naming policies, as described above. When the creation of the item is complete, or it was initially available, the process guides the specialist to check if the item has correct linking to the installed base. After checking the installed base connection, the specialist sends information to the requestor that the ticket is now resolved, and the item is created.

3.4 Analysis of Current Itemization Practices and Their Strengths and Weaknesses

As the aim is to create a design item policy to guide users to create uniform data a single product group with simple but logical product portfolio was chosen for development. Interviews and workshops were held with product manager and itemization team members. The interviews started with the product manager explaining the product, its naming system and its function.

The chosen product group is a relatively simple product, but it contains all the building materials for standardized product itemization: Product naming system, logical structure and simple but definite attributes. However, to gain a more holistic and grounded view of the current situation also other product owners and engineers were interviewed.

According to the product owner, there has not been general itemization naming policies or guidelines and the enrichment of old and creation of new items has been based either on old data or was solely left for the data creator to decide. Also, as the product already has a functional naming system which is not correctly utilized in PDM due to lack of knowledge of system capabilities. As an example, there are items where the sales name is hidden from customer reports and the technical details are shown. From the service sales viewpoint this generates a risk of losing sales prospects as the customer may receive too much information to order a certain spare part from elsewhere.

Firstly, the product owners did not have an easy solution where to upkeep and maintain instructions how to fill in the data in the items or in other words naming guidelines. Secondly, the design engineers did have a gap between used systems. Previously the case company had an operating model where only the CAD systems and their product management tools were used to maintain product data. When the new PLM system was implemented, BOM data was moved from drawings to Enovia. As being a separate system, which uses data integration from EDM/Vault as illustrated in Figure 9 it adds new steps in the workload to complete the task. Therefore, some of the designers do not pay much attention to the data quality. Thirdly there is a knowledge gap amongst users about the different metadata that an item contains. As stated previously, the users might not know what to type in to technical and sales descriptions and do not even pay attention to it as users are not informed about the later usage of this metadata.

However, some positives were found in the current practices. According to the itemization team in complex cases an example item is created in co-operation with the product manager and the rest of the items are mimicked from it. This requires communication between the product manager and the itemization team on every new complex case.

As the other interviewed team was mainly working with the item requests to be used in service delivery, the service itemization process knowledge of the team members was examined. Some members know that there is an existing process to follow but did not fully comply with it. Others did not even know about processes and they just did the itemization as guided by the other members.

3.5 Summary of Identified +/-

The current practices are a mixed bag of positives and negatives. As found out in the interviews, there is a common target and discipline in forming the data in harmonized order. Also, the product manager already had a clear view how harmonized data would allow simple monitoring of order volumes between products if the data allowing the identification of a certain product would be easily available in the sales description without revealing exact technical data to third parties.

However, these instructions between the product manager and the itemization team are only communicated verbally. Firstly, this creates a loop where the itemization team has to contact the product manager every time a complex case occurs. If no communication is done there is a risk of an item or group of items with bad data being released. Secondly, as communication is verbal, it is very easily lost when employees leave the company and must be taught separately to new employees. It was a general consensus that written guidelines of data formation to items would help not only in the itemization activities but also in product management activities. Thirdly, users creating items encounter items from various product groups and do not have a specialized product knowledge which may lead to a situation where the user does not know how the data should be filled to keep strategic information hidden. The same issue was occurring amongst designers as there was a lack of Enovia knowledge.

Also notable is that the processes for item creation differ quite much between business processes. Commercial items have a strict and detailed item creation process which the item specialists follow. As described previously, commercial items are segregated from design items. The responsibility for commercial items is under one sub-organization whilst the responsibility for design items is under each product line who operate either in services, product management or delivery. Services has a detailed process to create items as described previously that is based on a similar ticketing system as in commercial items. The delivery process does not have a detailed step-by-step itemization process but is packed into one step in a larger process as shown in Figure 19. As the initial creation of items for future equipment to be delivered happens in the Equipment Delivery process it should focus more on itemization, data quality and harmonization.

Building a proposal of a data policy requires also a data collection from literature, discussed next in Chapter 4. Together with the Current State Analysis and literature review the development of the proposal discussed in Chapter 5.

4 Existing Knowledge of Master Data Management

The main emphasis of this thesis is on finding solutions to create and maintain engineering data with good and harmonized quality. This chapter describes good practices found in literature to maintain and create engineering related master data. The first chapter describes what master data is as a concept and why master data has gained so much importance in modern business. After that, the second chapter describes data standards and metadata and how they relate to the concept of master data. The third chapter discusses issues related to data quality. The fourth chapter describes the concept of Product Lifecycle Management and its relation to master data and itemization. The fifth chapter introduces product data and product structure concepts. Finally, in the sixth chapter the emphasis areas to form a conceptual framework are described. The last subchapter describes the conceptual framework of this thesis.

4.1 What is Master Data?

Master Data is a very versatile term and as it is a relatively new concept existing literature has not yet widely emerged when comparing to classical business issues.

However, as the amount of data is growing every day, the importance of master data and its quality is increasing its impact to businesses. The yearly amount of new data created is nowadays calculated in zettabytes, thus underlining the importance of filtering essential data from waste and improving its quality. (Väre 2019)

Master data is that group of information that is essential to the business and the business decides what is considered essential data to its business amongst all data. Business criticality is also one of the official definitions of master data (Väre 2019). According to Väre (2019) there are two official definitions, the first one is the aforementioned business criticality and the second definition is that for data to be considered master data for a company it should be shared between sub-organizations.

Berson et al. (2010) claim that some entities have greater importance to a business than others, thus being master entities as they are distributed between organizations and managed in multiple systems. A single company can have implemented a process for Master Data Management (MDM). MDM is, according to Otto and Reichert (2010), a management process which administers data entities entered into correspondent systems. With MDM the company can monitor and develop its master data related strategy (Otto and Reichert 2010).

The primary function of MDM is to create a general consensus of core entities inside a business as an application-independent process. Quality wise, consistency and accuracy are ensured as in MDM different policies and guidelines for data management are deployed. With policies and guidelines users have a stated view of what is considered as master data in a certain business (Otto and Reichert 2010).

However, in a single company there can be multiple types of master data that are not shared with all sub-organizations and according to Väre (2019) it should not be a deal-breaker and the focus of defining master data should weigh on business criticality.

A common example of master data not being shared between sub-organizations is two different functions inside an organization requiring totally different type of data. The human resources department have very little to nothing in common with engineering considering the type of data used. Engineering inside an organization might have different data management platforms in use. If a company wants to harmonize its master data in engineering, it might face not only technical challenges but also political ones according to Berson et al. (2010).

Berson et al. (2010) give a common example of a political obstacle in master data transformation where a singular business line would see its way of handling the data best and not conforming with others. However, this does not conform with the concept of master data and information sharing between sub-organizations. In engineering it is essential for service and after-sales business to receive uniform data as they are operating with data from multiple data owners.

Both Väre (2019) and Berson et al. (2010) make numerical estimations about master data and how it affects business. Berson et al. (2010) argue that 60-80 percent of data quality obstacles are avoidable with data governance policies and this governance of data contributes directly to the performance of organizations. Similarly, Väre (2019) argues that the workload in master data governance consists of 80% of leading processes and people and only 20% developing technology that supports master data handling.

When considering the statement made by Väre (2019) it is easy to conform with Berson et al. (2010) who describe mismanagement and lack of governance as the biggest risks to master data and its quality.

4.2 Data Standards and Metadata

Data standard is described as the documented definition of master data and its qualities. Its function is to act as a middleman between IT and business inside an organization, allowing those stakeholders to speak the same language and understand each other, thus being a translation, according to Väre (2019). It is also the most important function that a data standard has.

Data standard is formed according to the needs of the organization. However, it should contain at least the elements illustrated in Figure 19.

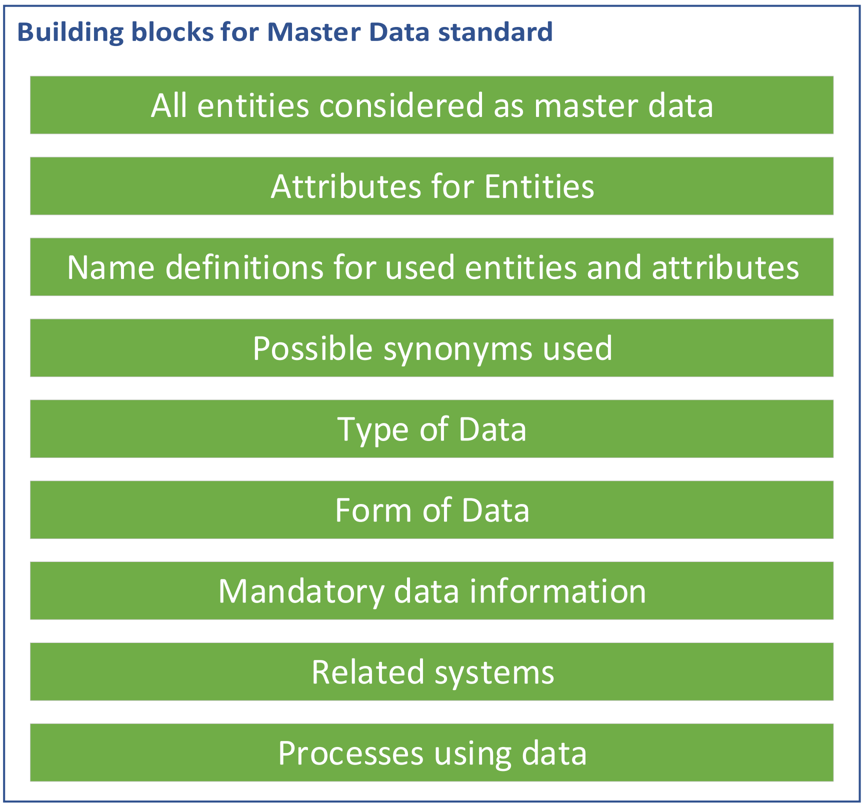

Figure 19. Building blocks for master data (Väre 2019).

A master data standard lists all entities and their attributes used in organizations' master data. The names for entities and chosen attributes require also defining how they should appear in different systems and in what context. If the data is used in multiple systems possible synonyms should also be listed for clarity. A common example of this is between engineering systems and ERP systems where item number (entity) is translated as material number in SAP which can create confusion if data originating from engineering processes contains references to raw material data. The type of data defines if the data is free-text or predefined value or something else.

The form of data defines the format of information in an attribute. According to Väre (2019) this is optional information in data standard. However, formatting data into a single format harmonizes the data mass and reduces the amount of different ways to inform certain data. This is true especially in engineering activities where data originating from multiple different starting points can end up under one entity.

Mandatory data information defines if a certain attribute is mandatory to be entered. A mandatory requirement can also be a contextual requirement that has dependencies (Väre 2019).

Related systems and processes are also linked into a data standard. These inform users what happens to data and how it flows between systems and how different processes are linked to master data (Väre 2019).

Väre (2019) lists five steps for an organization to build its data standard. These steps are illustrated in Figure 20. Firstly, the organization must identify what data it has and what attributes of that data are used and where. As an outcome for this phase the company should have identified and separated different data into their silos.

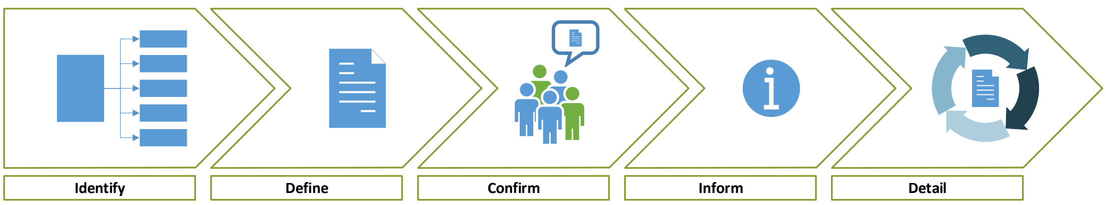

Figure 20. Steps to build a master data standard (Väre 2019).

To promote master data as an asset includes some challenges. Identifying what data is used and where in case of company has legacy data to be used as a basis on their future master data. Also, a strategy must be created to map standardizing, harmonizing and consolidating components of master data to allow master data to be presented as an asset. It is essential to provide guidelines, policies and tools to work with consolidation, integration and sharing of master data to avoid creating just another data silo (Loshin 2010).

4.3 Data Quality

Tayi and Ballou (1998) define data quality as fitness for use. They are thus hinting that the quality of data can be defined as relative to the context where it is used. Different environments have different requirements in data formation. In business context master data is usually handled by multiple users and according to Tayi and Ballou (1998) semantics is a quality-defining dimension. Data may be numerically correct, but it might be interpreted differently amongst different user groups. Otto et al. (2011) describe quality as subjective and very context-dependent. The user might see data as bad quality even if it would contain all the information required by the data standard defined by the company. A data standard introduced by Väre (2019) should help eliminate semantical issues concerning master data. As the standard defines how data is formed into entities the amount of semantical errors should be reduced.

Data quality is an unavoidable topic in business process development nowadays as the effect of poor data quality may diminish the gain otherwise accomplished with the new process (Panahy et al. 2014). Data quality can also be viewed from a tangible manufacturing perspective according to Levitin and Redman (1998). This means that creating data can be compared to manufacturing a product which is manufactured by a creator and is used by a consumer and respectively data is created by the data creator and consumed by the data user. Thus, the data creation should follow a certain production process. When solving data quality related issues, same users who create the data itself, also participate in activities relating to improving different processes, directly or indirectly (Panahy et al. 2014).

Issues in data quality often occur when data is transferred or gathered through boundaries from multiple sources such as information sharing between business units or systems used in different business activities. (Hüner et al. 2009).

Data quality and its dimensions are essential as the effectiveness of systems correlate with business processes (Panahy et al. 2014). On a more specific level data quality can be broken into dimensions. There is no general consensus of what the exact dimensions for data quality are but a few of these dimensions seem to be noted multiple times in different reports (Panahy et al. 2014). In summary, the most frequently cited dimensions are accuracy, reliability, timeliness, relevance and completeness (Wang et al. 1995). However, Haug et al. (2013) argue that the most commonly used dimensions were developed by Ballou and Pazer (1985). This theory divides data quality into four dimensions which are accuracy, timeliness, completeness and consistency (Ballou and Pazer 1985).

Wang and Strong (1996) categorize quality dimensions under four categories totaling in 15 different quality dimensions. These categories and dimensions are illustrated in Figure 21.

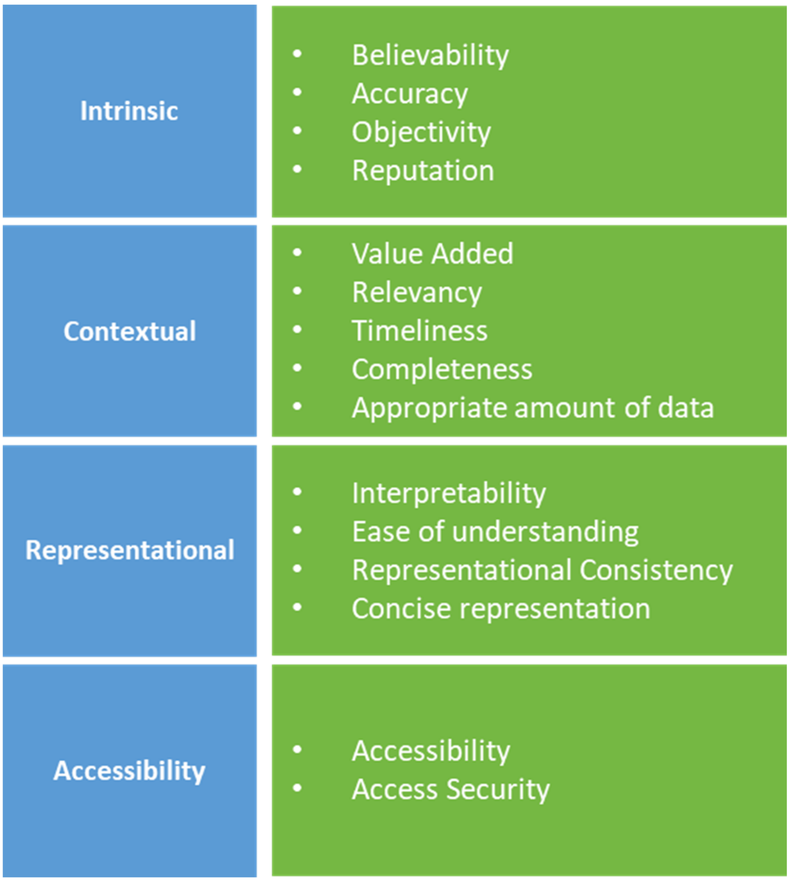

Figure 21. Identified data quality dimensions and their categories

Data quality dimensions are an essential part of information that enables the classification of the data and its requirements. These dimensions are not only used to measure current data quality issues but also to identify possible improvement points in master data and its quality (Panahy et al. 2014).

Problems in data quality can negatively affect a company's performance as the data created and used by operations is used as the basis in decision making (Ballou et al. 2004). According to Haug et al. (2013) deficits in data quality have visible negative effects on certain performance indicators such as customer satisfaction, operating costs, faults and inefficiencies in decision-making, overall performance and employee satisfaction.

Friedman et al. (2006) also suggest that deficits in data quality limit or destroy the confidence in data correctness which might lead to organizational change resistance amongst users towards any data quality improvement initiatives.

Deficits in quality of data also have significant impacts on organizational performance, however, according to Haug et al. (2013) these have proven to be hard to estimate. Some studies have estimated the magnitude of costs caused by bad quality data. Redman (1998) states that some case studies have identified costs occurring from bad quality master data. On the other hand, Redman (1998) did not point any references to these studies. Also, the academic nature of the studies mentioned was left unclear. Regardless, Redman (1998) argues few studies have pointed estimations between 8 to 12 percent of revenue. Redman (1998) also points to about multiple informal studies which have revealed that up to 40 to 60 percent of the service organizations revenue may have an impact due to poor quality of data.

Several studies have pinpointed factors contributing to low quality in master data. These are called data quality barriers. Haug et al. (2013) have identified 12 different barriers from different studies which are listed in Figure 22.

1. Missing placement of responsibilities for specific types of data
2. Lack of clarity of roles in relation to data creation, use and maintenance
3. Inefficient organizational structures
4. Lack of management focus in relation to data quality
5. Lack of reward/reprimand in relation to data quality
6. Lack of training and education of data users
7. Lack of written data quality politics and procedures
8. Lack of emphasize on the importance of data quality from managers
9. Lack of IT systems for data management
10. Lack of possibilities for input in existing IT systems
11. Poor usability of IT systems

Figure 22. Identified data quality barriers (Haug et al. 2013).

Some barriers are, according to Haug et al. (2013), rather self-explanatory and others require a more detailed explanation given below.

1. Missing placement of responsibilities for specific types of data

The first barrier cited by Haug et al. (2013) has also been identified in previous studies as "*Lack of data quality owners*" by Umar et al. (1999), "*Lack of responsibility for information quality*" by Lee et al. (2006), "*Ownership issues*" by Smith (2008) and "*Lack of delegation of responsibilities for maintenance of master data"* by Haug and Arlbjørn (2011). Haug et al. (2013) define this as having an entity, either a responsible person or team, to address if there are issues in specific data under their responsibility.

2. Lack of clarity of roles in relation to data creation, use and maintenance

The second barrier is very similar to the first one and according to Haug et al. (2013) is complicated to separate in real-world organizations from the first barrier. However, according to Haug et al. (2013) there is a baseline to divide these barriers as the second barrier focuses more on reasons behind the deficits in data quality. This barrier was also referenced in studies by Umar et al. (1999) as "*Lack of roles and responsibilities*" and by Xu et al. (2002) as "*Employee relations*".

3. Inefficient organizational structures

The third barrier is quite self-explanatory. Studies cited by Haug et al. (2013) reference the barrier as "*Inefficient organizational procedures*" by Umar et al. (1999), "*Organization structure*" by Xu et al. (2002) or "*Data exceeding the organization's ability to manage it*" by Smith (2008).

4. Lack of management focus in relation to data quality

In the case of the fourth barrier Haug et al. (2013) argue that cited studies and their results can miss a clear connection to this barrier. In the study these referenced pinpoints are "*Neglecting administrative details*" by Umar et al. (1999) and "*Change management*" by Xu et al. (2002). According to Haug et al. (2013) if administrative tasks are neglected, some procedures must already exist, and it is the responsibility of the specific manager to take over this issue.

However, if the specific manager does not emphasize on the issue, it can be counted as lack of managerial focus. Concerning change management Haug et al. (2013) mention processes regarding data quality. If a data quality-related implementation is not successful, the manager in charge of quality of data has not given enough attention to it.

7. Lack of written data quality politics and procedures

When there are no written politics or procedures the data inserted into systems will receive various formations even if the data would concern the same entity. This barrier has been identified in several studies as "*Lack of scheduling scenarios*" by Umar et al. (1999), "*Lack of procedures*" by Lee et al. (2006) and "*Lack of master data control routines*" by Haug and Arlbjørn (2011).

The remaining three barriers identified by Haug et al. (2013) are "*Lack of IT systems for data management*", "*Lack of possibilities for input in existing IT systems*" and "P*oor usability of IT systems".*

Loshin (2010) discusses early tools to cleanse bad quality data. These tools and methods are usually focused on address and name cleansing, which contextually speaking, is not very closely related to engineering data. However, the fundamentals remain the same. According to Loshin (2010), these steps consisted of parsing, standardization and cleansing.

Parsing takes semi-structured metadata into predefined elements, such as name, type and dimensions (Loshin 2010).

Standardization forces data into a certain form (Loshin 2010) and in other words meaning a creation of a data standard as presented by Väre (2019)

Cleansing is a process where data value is evaluated against parsing rules, identified if there is a recognizable pattern in data and lastly mapped into respective places and standardized to conform with the effective data standards. If there is no recognizable pattern the user is required to attempt to determine if there are any similarities to known patterns. Errors in data are more visible when patterns are resolved, and the data can be sent to its respective owner for further analysis (Loshin 2010).

The efficiency of the cleansing process will increase over time, as the master data library is there to represent items with good quality. However, to keep consistency in the future and avoid these batch-cleaning manual operations, the methods and lessons learned to maintain and generate good quality data must be integrated into processes. And not only processes that require implementation, also tools and guidelines concerning data quality must be kept available (Loshin 2008).

4.4 Product Lifecycle Management

Since the introduction of Product Lifecycle Management (PLM) as a concept, data management has expanded to cope with more product information types and how this data is stored, edited, used and managed inside PLM has changed vastly (Saaksvuori and Immonen 2008). With this expansion of scope, the types of master data have expanded from items, BOM's and documents to cope also with different product specific specifications, supplier and manufacturer data, change orders, quality standards and engineering requirements (Saaksvuori and Immonen 2008).

Even with added complexity PLM offers great versatility for companies to improve their efficiency as different departments start using a common view of a certain product as the data is shared between organizations (Stark 2015). Previously, as decribed by Stark (2015) companies used to operate in a departmental paradigm. In this departmental paradigm organizations were divided into their own departmental silos which did not cross each other's boundaries. Stark (2015) describes this workflow as following: Marketing knew what products the market wants, engineering knows how to design it, manufacturing knows how to manufacture it and service knows how to support it via maintaining and repairing activities. This departmental paradigm is illustrated in Figure 23.

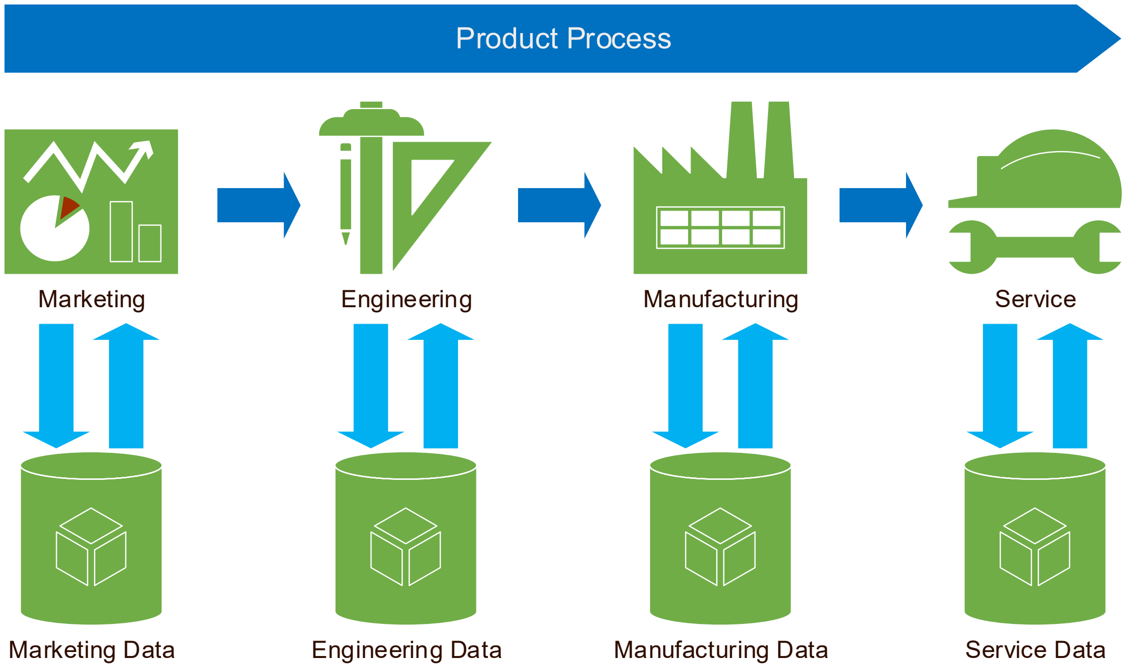

Figure 23. Departmental product management paradigm (Stark 2015).

The main idea behind this departmental approach was, according to Stark (2015), that each department had the best resources, whether they were personnel or tools, to carry out certain activities inside that function. However, departments have a tendency to dig in deeper into their hole over time and start doing activities inside their department that essentially would belong to other departments. Eventually this leads into a situation where every department has their own perspective on the same product. Also, every department would decide how their data is set, what systems they use and so on. Incompatibilities in departmental borders start to appear along with duplicate activities, different but same versions concerning the same data and serial work leading to massive deficit in efficiency (Stark 2015).

In the late phase of the departmental-style approach deficits that came along it started to become clear. Around the same time a new paradigm, PLM started to emerge. PLM is an approach to product management best described with the words *holistic*, *joined-up*, *product-focused* and *digital*. PLM focuses on creating a cross-functional environment where all roles and activities related to product management are defined and documented. As the environment is cross-functional, documentation and data is shared between business functions and managed in a single system, the forming of separate departmental views to products is avoided (Stark 2015).

PLM can be considered a business activity, as its purpose is to increase product revenues, reduce product-related costs, increase product portfolio value, maximize value added to customers and shareholders in relation of current and future products, and therefore meet business objectives (Stark 2015). Additionally, PLM aims to improve in time-efficiency and quality aspects along with financial improvements. It is described as an activity to reduce product-related risks to minimum for the business. In contrast to the departmental paradigm, Stark (2015) argues that with implementing PLM the risk of departmental methodology and techniques in product-support activities are limited as all departments are focusing on the same data. According to Stark (2015) companies had accumulated multiple acronyms of tackling different issues rather than holistic approaches to solve a product related problem. This was seen with companies having objectives focusing on detailed technical issues rather than holistic business-related objectives (Stark 2015). Figure 24 depicts the PLM paradigm.

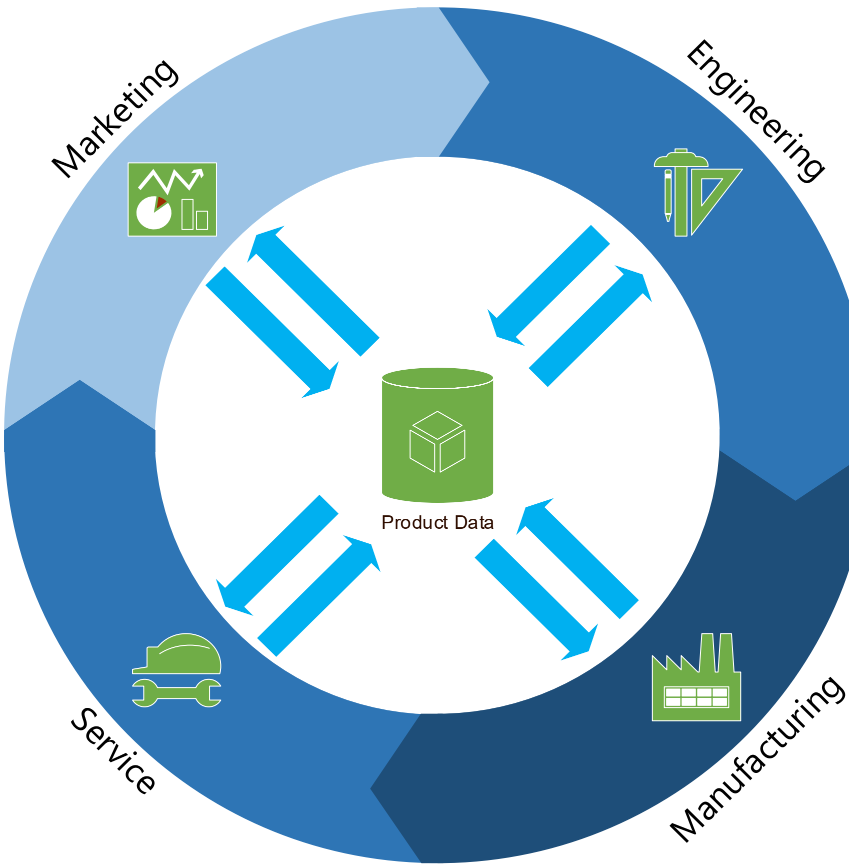

Figure 24. PLM Paradigm (Stark 2015).

Product data sharing between departments in PLM environment through the entire product lifecycle is illustrated in Figure 24. The illustration shows how all different departments access the same product information and therefore avoid generating their own views of product. (Stark 2015) Without management this information is managed per department and will lead to variance in information (Abraham 2014).

The product, whatever it may theoretically be, is defined by the product data. As companies generate their revenues by selling these products, product data itself becomes a very valuable part in business, no matter the product (Stark 2016). Product data management is related to master data as the products are described through entities, which combined together, or alone form a product. These entities are also called items in this context. Master data is created, developed or managed via these items and therefore product data is updated and the product itself is defined via usage of items. Product data represents the collective technical and practical knowledge of a business and hence should be considered as a major asset and strategic resource which differentiates a company from other companies providing or manufacturing similar products or services. (Saaksvuori and Immonen 2008).

As PLM systems are intended to support in global operations, where an engineer in Australia sees exactly the same data and view as an engineer in Europe the systems need to be physically decentralized to offer a viable service rate and sufficient performance to users. Practically this means that every global region has its own dedicated servers which mirror data with each other automatically. (Saaksvuori and Immonen 2008)

In a situation where product data is corrupted, it will have almost certain consequences. And consequences require actions from the business, which means increased costs. Through the lifecycle of a product, the product data from the beginning of the lifecycle, meaning the initial product idea has to be available to whom may need it at all times. Getting this product data neatly organized through the entire lifecycle of a product is a major challenge as the amount of data created in the conceptual, developmental, manufacturing and after-sales phase is immense regardless of the product. Unless there is a technological revolution in AI, this data does not repair itself. It will start to decay and operational performance is affected. If not maintained at all, once usable data library will turn into a pile of legacy data needing extra effort. Consequently, the importance of product portfolio for a single company cannot be understated, as the product and related services are the tangible or intangible assets that the customers want to buy and therefore generating revenue stream for the company. Investing in data management throughout the lifecycle of the product is an investment to the product itself which will pay itself back (Stark 2016).

As the product data is formed from single or multiple items connected together with relationships, eventually forming a Bill of Materials, the importance of a single item rises as the products are formed using items. Thus, high quality and consistent information in items has a significant role in networked businesses and emphasis should be put to data management to enhance this business (Otto et al. 2011). Item is an entity, which enables unique identification, encoding and naming in a systematic and standard way of a product, part of it, material, or a product-related service (Saaksvuori and Immonen 2008).

The PLM system typically has certain basic features. One of the most basic functions of a PLM system is item management where the item data, its lifecycle status and relationships are controlled via a single user interface allowing user to create and maintain items. Managing product structures is also part of tools usually included in PLM systems. This is done via identifying and registering relationships between items, thus creating product structures with hierarchical construction. These systems are also used in information retrieval and gathering, thus supporting one of the key functions of the entire PLM paradigm to utilize existing information in a more efficient manner. In contrast to information retrieval, its creation is also supported and with existing information already available, new development projects to a product are implemented more efficiently (Saaksvuori and Immonen 2008). Item data quality is a key parameter how successfully a new PLM system is received and implemented into use (Otto et al. 2011).

According to Abraham (2014) the majority of PLM systems emphasize mainly towards product development stage and support other lifecycle stages via sharing data created in the development stage. The perspective is logical, as the most important information concerning the product is created in the development phase. Typically, these are items, bills of materials, item relationships and product structures which include installed base item traceability. Saaksvuori and Immonen (2008) also emphasize the traceability of a single entity and how it is used in relation to other items. For the user it is essential to find out where a certain item is used and if changes are required, change management is simplified. Figure 25 shows an example of installed base record for a single item, where relationships for a single item representing a component in a machinery.

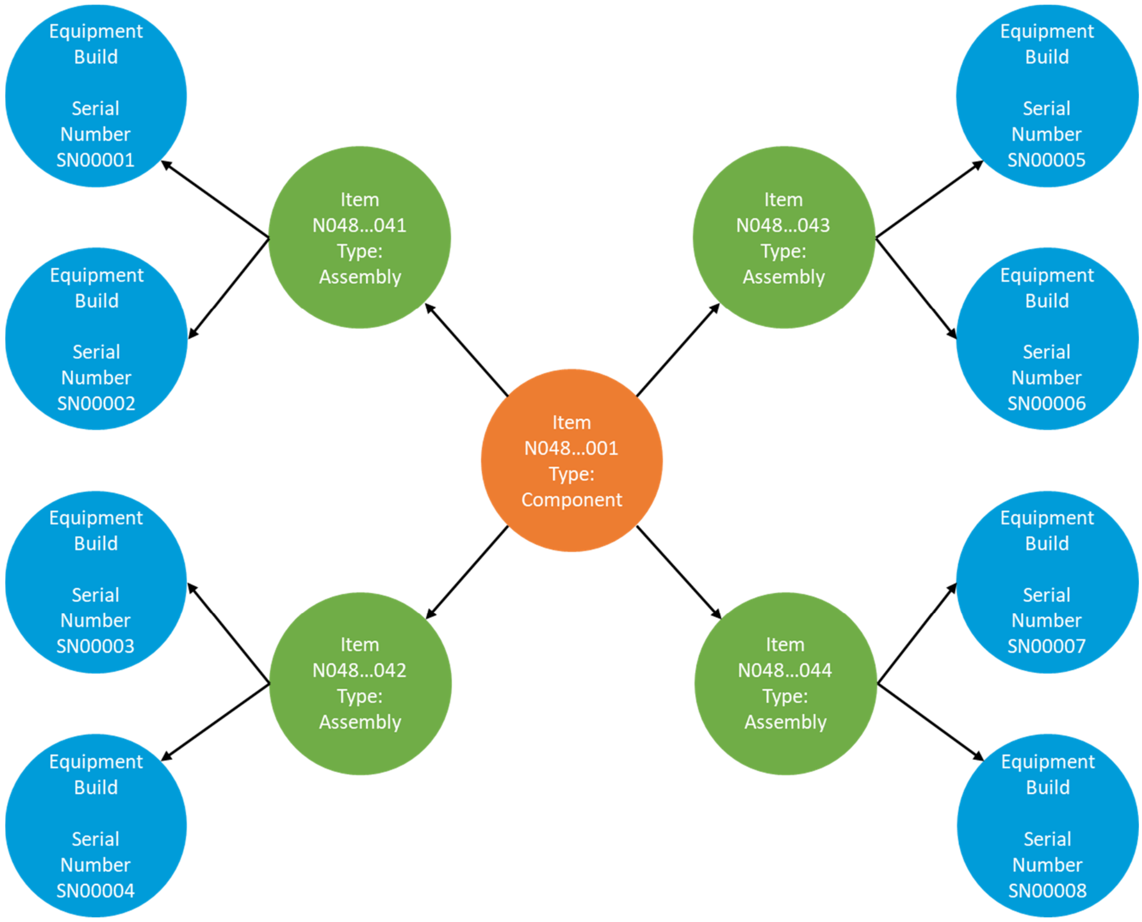

Figure 25. Example of installed base record for a single item.

In the illustration the component item has four relationships to assembly-type items. Every assembly item has a relationship to multiple equipment builds which represent an actual delivered equipment. With traceability the usage of a certain component can be tracked, in this example into eight different instances of delivered equipment. In a case of component reaching its end of production, a company knows where that component is delivered, and what to replace it with by setting a replacing item code which is reflected to the builds using that item. Contextually, this type of recording is often defined as installed base where a record of a location and current owner of delivered product is stored and maintained. Build records in installed base systems often contain at least spare part relation information to items, or the entire SBOM (Saaksvuori and Immonen 2008).

Data quality and its recording processes will grow their importance significantly in near future as market demand for product-related tangible and intangible services increase. All business units working in product context, whether that is in early or late stage of lifecycle, need to access complete product information for them to efficiently provide manufacturing, maintenance or spare part-related services as efficiently as possible (Saaksvuori and Immonen 2008).

4.5 Product Data and Structure

Product structure is a model where certain objects containing information are hierarchically related to each other and are analyzed against product information (Saaksvuori and Immonen 2008).

Stark (2016) argues that especially globally marketed and distributed products offer huge revenues if they are deployed correctly. However, if the control for a certain product is lost, there might be consequences for the company starting from minor delivery errors to fatal accidents. In relation to product data and its quality, a company can significantly reduce the risk of delivering a wrong item to a customer when all available data is easily available and trustworthy. According to Saaksvuori and Immonen (2008) product data has certain elements; Product specification data, Product lifecycle data and Item metadata.

Abraham (2014) Introduces a classification system for assist in managing the attributes. Attributes are variables defining and describing specific elements of the item such as name, descriptions, dimensions and weight. Developing and implementing a global classification system for item data could improve data quality and therefore operational efficiency as products are developed, engineered and manufactured globally (Stark 2015).

Classifications are not only introduced in lower levels of product structures as companies usually have more products than just one. Companies may have predefined groups of products to serve different activities, functions, users and market areas. A more common term to these categorizations is a product line or product family (Stark 2016). Product grouping may be based on multiple variables such as they are used in the same market areas, certain industry, same pricing category or are used in certain points of manufacturing or production process (Stark 2016).

Product portfolios are also hierarchical structures where each level contains certain identifiers to divide entities in that particular level. This hierarchical structure is illustrated in Figure 26. Viewing from top the product portfolio consists of product families, lines or group. Each one of these then contain assemblies of products which consist of multiple parts (Stark 2016).

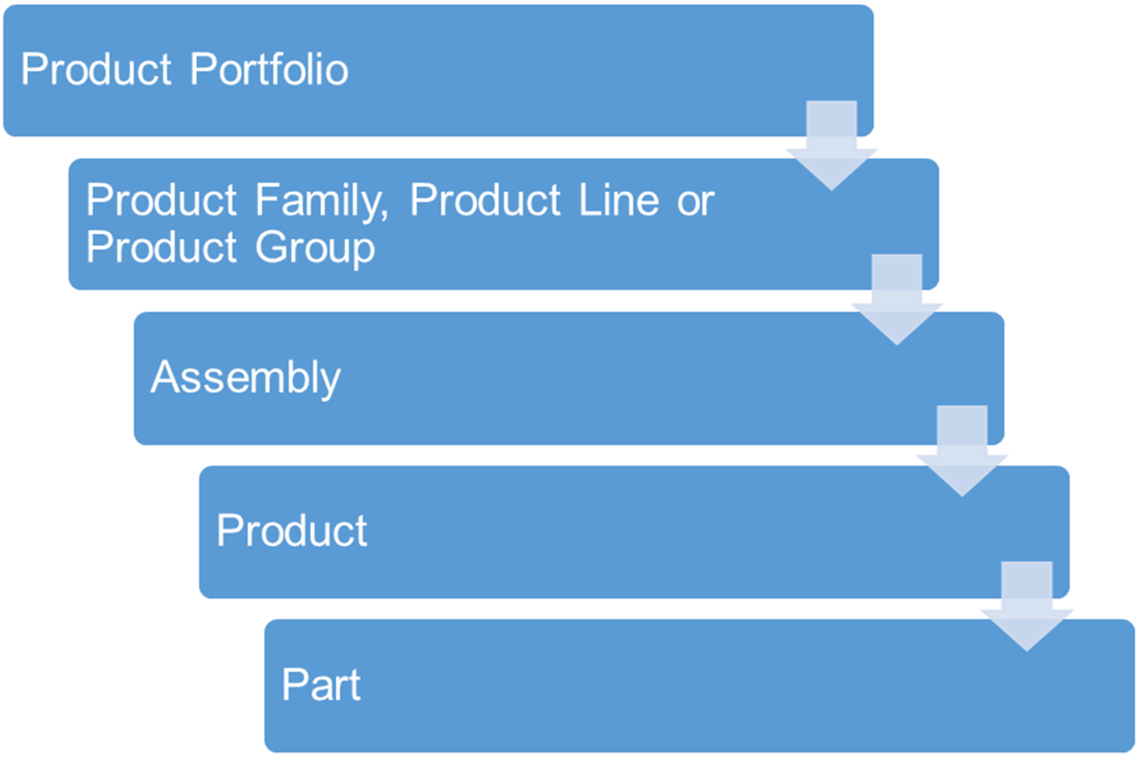

Figure 26. Product Portfolio structure (Stark 2016).

The term “Product data” spreads to cover not only numerical data in variables but also all that data created when the product was designed, engineered, manufactured and serviced. In relation to product data, singular items are actually the sole building blocks for it as every unique entity, whether it is an assembly or a single component, eventually forms a product portfolio when combined with other items. To help with imagining this, the product portfolio structure, illustrated in Figure 26, must be viewed from bottom to the top. (Stark 2016).

4.5.1 Product Introduction

This chapter introduces in brief the product group and its functionality for which the proposed policy is created for in this thesis.

Filtration is mainly used in mining and metallurgical applications and in chemical process industry. Concha (2014) describes filtration as a process where liquid and solids are separated from each other by forcing liquid through a porous bed, known as filter medium. The particles are retained in the medium while liquid is allowed to pass when external force is applied to the slurry in a contained space. As an outcome, solids form *Cake* and liquids *Filtrate* after the process is complete. There are multiple ways to establish this pressure difference to create liquid flow through the medium.

Filtration can be based on several type of functional principles. The external force applied can be produced with gravity, vacuum, overpressure, combined vacuum and pressure, centrifugal force or saturation gradient (Concha 2014). Most common type of filtration equipment are functioning on over-pressure method and currently represent the most reliable solution in filtration equipment as vacuum filters tend to have impact on their performance in high altitude sites. Pressure filters operate in constant cycles, however the process is not constant as the produced cake must be removed before the process can be re-started. Vacuum allows constant and static processing cycle. Illustration of horizontal vacuum belt filter is shown on Figure 27 where the filter belt cycles around the internals of the equipment where the vacuum pans are also located.

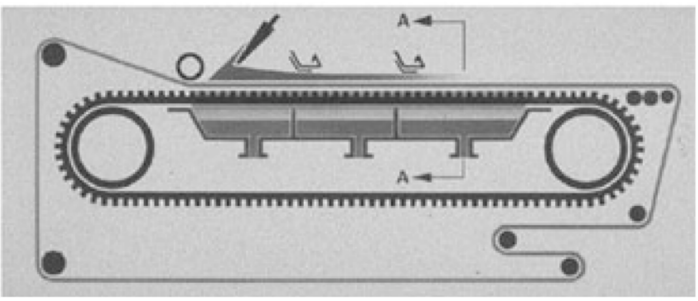

Figure 27. Horizontal Vacuum Belt Filter (Concha 2014).

For over-pressure filtration, a tower press filter is shown as an example in Figure 28. Typical features of a tower press filter are visible. Filter plates stacked vertically, consisting a series of chambers. Plates open to remove cake after filtration cycle is complete and close to form a empty chamber for the next batch of slurry to be filtrated. Amongst these plate layers runs a continuous belt of filter cloth, seen also in the picture. By multiplying the layers, filtration area is greatly increased without sacrificing any equipment footprint.

Figure 28. Filter Press (Concha 2014).

Filtration cycle in over-pressure filtration has several phases. Firstly, slurry is pumped to the chamber between plates shown in Figure 29. Solids start to form due to raise in pressure caused by the slurry pumping. Filtrate is already forced by some extent through the filter cloth, highlighted in red.

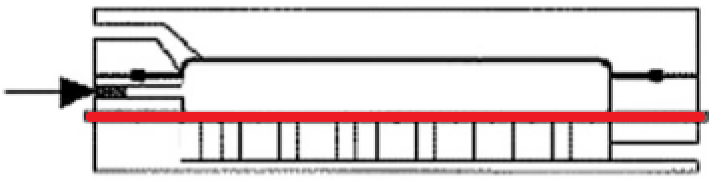

Figure 29. Slurry flows into chambers (Concha 2014).

After the chamber has been filled into desired amount, diaphragm is pressed against the slurry with external force created using pressurized air or water shown on Figure 30. This pressurized air or water does not come in contact with the slurry as it is just pushing the diagram against the slurry and filter medium.

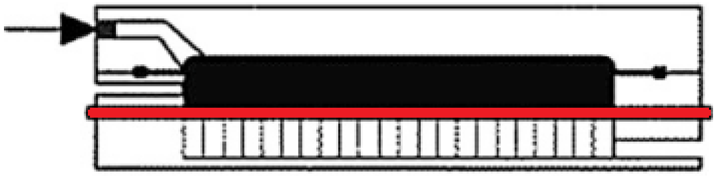

Figure 30. Pressurized water fills diaphragms (Concha 2014).

After pressing the solids can be washed to maximize solute removal (Figure 31).

Figure 31. Wash water is pumped in (Concha 2014).

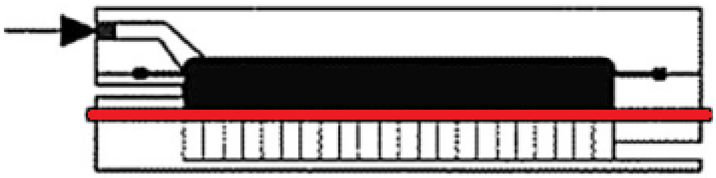

Figure 32. Diaphragm Pressing 2 (Concha 2014).

Pressurized air or water is inserted again in the diaphragm chamber to force remaining washing liquids inserted in previous phase through the solids and the filter cloth (Figure 32).

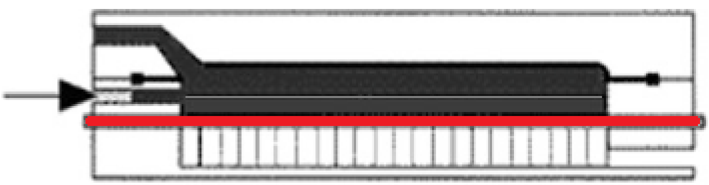

Figure 33. Air blowing (Concha 2014).

For final dewatering phase illustrated in Figure 33, air is blown through the solids and filter cloth to reach desired moisture content. After last phase the plates are opened to allow the cake to be discharged from the filter. This is done by moving the entire cloth in its track, as the belt is continuous.

Filter mediums form a large business prospect in terms of spare parts as they are considered wearable parts and are often replaced. Form and properties of these filter cloths are dependent of the equipment they are designed to. In case company there are several types of cloths used and available as spare parts for delivered equipment. Also, a definitive factor is sizing of the cloth, as filtration area is dependent on installed equipment and filtration areas are engineered to suit certain process environments and different types of filters. This thesis focuses on developing a policy and naming guidelines for filter cloth product group as a part of design item policy development.

Case company offers several types of different filter cloths to suit in different types of filters, such as horizontal vacuum belt filters of filter presses as previously described. Different equipment products and their filter cloth types are illustrated in Figure 34.

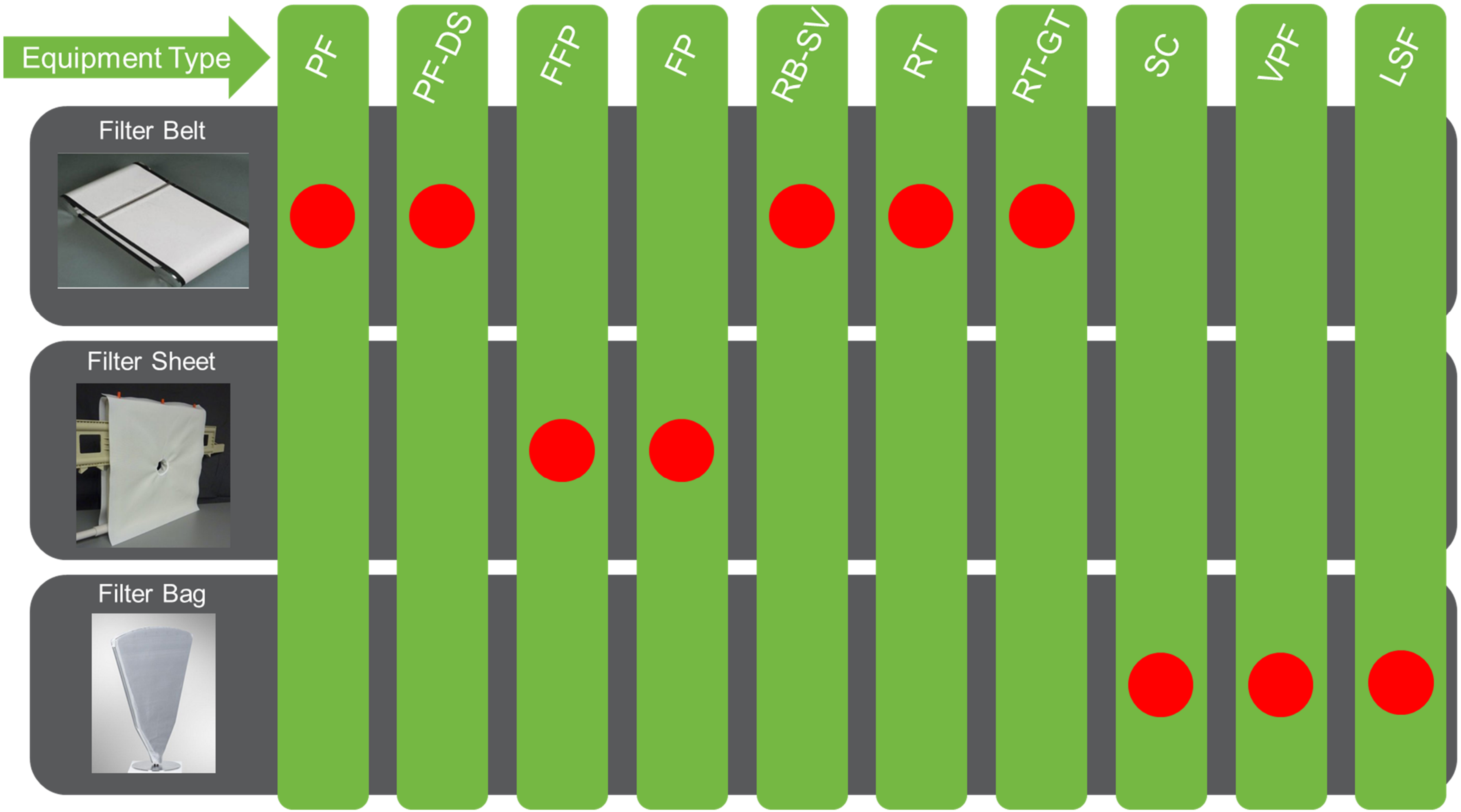

Figure 34. Filter cloth types in relation to used equipment

4.6 Chosen Emphasis Areas to Build a Conceptual Framework

The Conceptual Framework of this thesis is built on principles presented in the previous subchapters. However, not all of the principles are taken into action but rather the most essential ones related to the topic. On the other hand, Väre (2019) and Berson et al. (2010) place their focus more on master data as a concept and building and planning master data management from scratch holistically, without regard to what the data actually is.

From the data quality dimensions identified and categorized by Wang and Strong (1996) three categories are taken into the Conceptual Framework and one is dismissed. *Intrinsic*, *Contextual and Representational* are included in Conceptual Framework while *Accessibility* is dismissed.

Intrinsic, as defined by Wang and Strong (1996) represent dimensions such as *Believability*, *Accuracy*, *Objectivity* and *Reputation*. *Believability* and *Accuracy* represent dimensions which may have an impact on the other two dimensions, as if the data does not have a consistent accuracy and believability, users may start to question certain owners' data leading to a decline in R*eputation* and *Objectivity*.

Contextual categorized dimensions are *Value Added*, *Relevancy*, *Timeliness*, *Completeness* and *Appropriate amount of data*. The chosen dimensions from this category are *Completeness* and *Appropriate amount of data*. In context, the chosen dimensions relate to each other as *Completeness* will be achieved with an *Appropriate amount of data*.

The dimensions defined under the category *Representational* have the most important dimensions to focus on when concerning the context. *Interpretability*, *Ease of understanding*, *Representational consistency* and *Concise representation* all are dimensions that require attention when building the Conceptual Framework.

In relation to dimensions, comes data quality barriers, described in chapter 4. As the dimensions describe more how the quality of the data can be measured (Panahy et al. 2014), data quality barriers describe why and what reason is behind bad quality, what led to it. Thus, by increasing the focus towards data quality barriers, one may find out solutions to increase data quality by implementing these solutions.

Unlike data quality dimensions, data quality barriers have not been categorized but are presented as-is by Haug et al. (2013). The highest emphasis is set to the barrier *Lack of written data quality politics and procedures*.

Product Lifecycle Management offers views how the product is managed under PLM paradigm. As the item management is done in the PLM environment, views considering the *Product* aspect of the PLM paradigm should be taken into account and how product data and product structure are formed under PLM paradigm to achieve an unbroken information link from the essential idea to the recycling phase of the product.

To generate a product structure or compare an existing one against the current portfolio current product data is implemented into a classification structure. From the classification structure certain recognizable patterns are discovered, which are then used in the last phase.

According to Stark (2016) the importance of a formal description for a product and its subparts cannot be downplayed. If product data is missing consistency it will be difficult to manage and improve. This formal product description must be clearly documented and implemented to cover the entire product structure. For some parts, a more generic description is more viable to avoid generating waste. Chapter 5 describes the logic behind the Conceptual Framework and its parts.

4.7 Conceptual Framework

The conceptual framework is built from three main ingredients in this study. Firstly, key concepts and theories are gathered from three topics. Secondly the framework tools are sourced to support these three chosen topics.

Firstly, Master Data Management, its basic functions, fundamentals and practices are chosen as one topic. Secondly, Product Lifecycle Management and how it is connected to basic itemization is included into the Conceptual Framework. Thirdly, data quality is discussed as a topic and what the data quality barriers are that must be surpassed to achieve high data quality. When combined, these three topics form a good conceptual framework to start progress towards high quality in product data. The Conceptual Framework used in this thesis is illustrated in Figure 35.

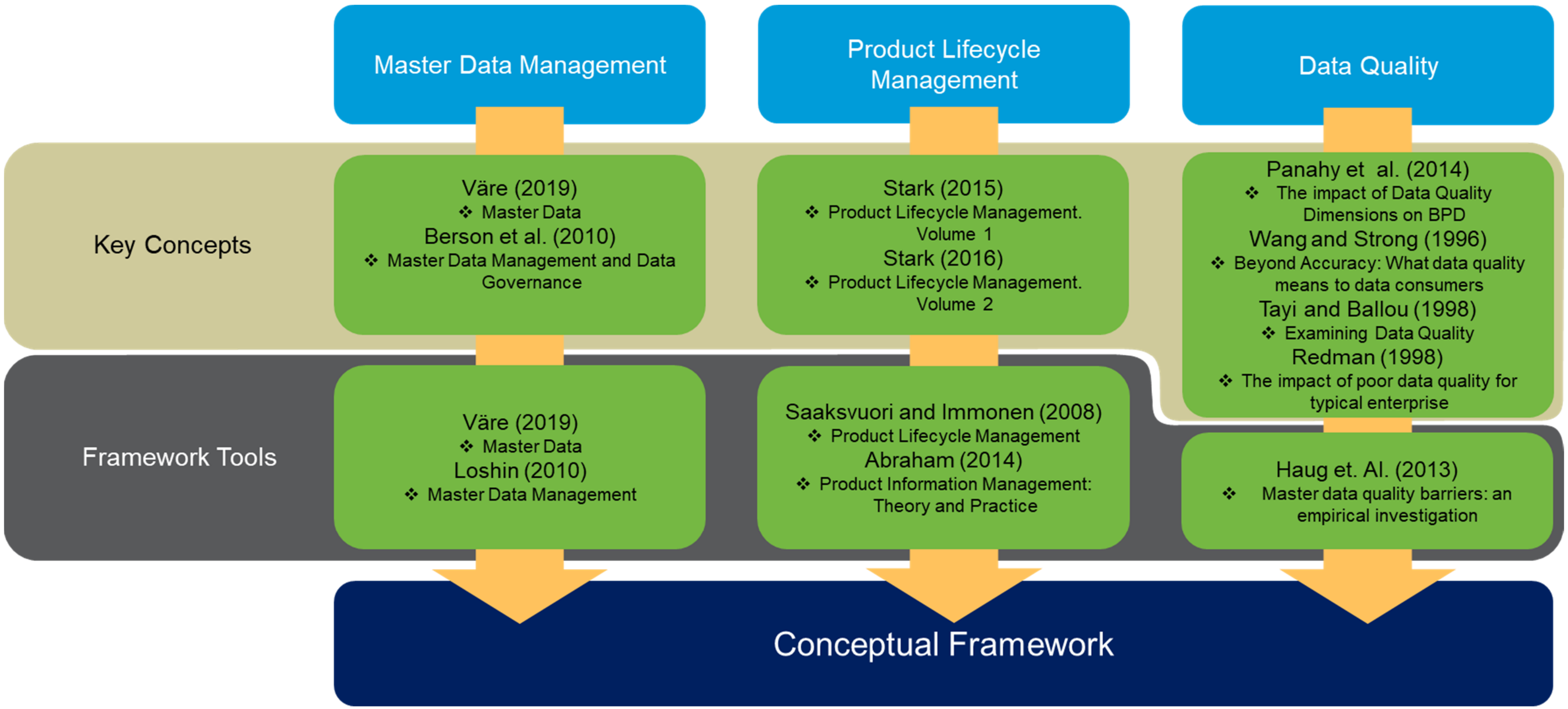

Figure 35. Conceptual Framework

As a conclusion, the proposed conceptual framework provides a solid ground to start building a proposal for data formation in items. The first topic master data and its management is described in an elementary level, i.e. what conditions should be taken into account when a company is starting its master data strategy. Even though the case company is much farther in terms of master data management, this chapter forms a support for other topics and provides necessary methods to manage master data. The second topic focuses on product lifecycle management and describes it also in elementary level. Knowledge in product lifecycle management is essential as all itemization in the case company is done in a PLM-capable environment. The third topic emphasizes the general issues found in data quality and how to overcome them.

Together all these three topics form a valid starting point in relation to issues found in the current state analysis to start developing a data formation guideline for a single product group which provides a future framework expansion for other products groups also. The conceptual framework introduced in this chapter is implemented into further use when developing the proposal in the next chapter.

5 Developing proposal of Design Item Policy to Enhance Proprietary Item Data Quality

This chapter is divided into four sections. The first chapter is dedicated to a brief overview of the work behind building the proposal. After that, the second chapter describes the findings from the second dataset and their link to previous chapters. The third chapter is dedicated to the product introduction for which the policy will be developed. The fourth chapter focuses on the actual development work and provides the proposed solution. Finally, the last chapter contains the summary of the developed policy proposal.

5.1 Overview

As mentioned in the business context in Chapter 1 the product portfolio is extensive with products ranging from small laboratory equipment to large-scale plant solutions and large singular pieces of equipment and the policy cannot be started to comply with all products at the same time. Instead, the objective is to generate a policy for a single product group to act as an example and a starting point in the progress towards better data quality which eventually reaches the entire portfolio. How the policy will be implemented towards user mass is discussed later in Chapter 7, next steps of implementation.

At first, to start building the initial proposal and to obtain a second set of data the findings from the Current State Analysis and theories gathered for the Conceptual Framework were presented to the product manager and the itemization team. In conjunction with the previous data (Data 1), the product itself was studied together with the product manager to gain knowledge of the product and its qualities. Secondly, the product group structure was studied to identify its attributes and how they reflect the PDM environment in use. Thirdly, a conceptual process was formed to identify the products' ingredients which was later applied to the selected product group to form a data policy.

5.2 Findings of Data Collection

Table 4 lists key focus areas implemented into Conceptual Framework and their relationships to the main pain points found in the Current State Analysis. Also, the main comments related to the topics are listed in the table.

Table 4. Key findings and their relations

	Key focus area from Current State Analysis	**Key element from Conceptual Framework**	**Description of the link between Current State Analysis and Conceptual Framework and comments (data 2).**
1	Large variance in item data quality	**Data Quality Dimensions:** • Representational	Representational dimensions are not met when there is no general consensus how an item should look like. Comment: Noticed by the PM, makes data comparison difficult.
2	No tangible rules how to insert data per product	**Data Quality Barriers:** • Lack of written data quality politics and procedures **PLM / PIM** • Product data	Related to #1. When there are no tangible guidelines, users create items as they see best and the end result is varying. Comment: Noticed by the members in the itemization team, users create data from old examples or as they see best. Guidelines would be appreciated.
3	No process to follow ensuring item meets all requirements	**Data Quality Dimensions:** • Intrinsic • Contextual	Data quality might be affected when all required checks are not mapped into a process. Comment: Might help new users to learn

The Conceptual Framework presented the topics but did not describe why they were chosen. Firstly, the Conceptual Framework focuses on master data as a general concept. Secondly, Product Lifecycle Management aids considerably when researching the product structure and how it should be broken into parts. Thirdly, the Data Quality is assessed through dimensions and barriers.

As the issue lies in inserted data itself, the data quality dimensions have some dimensions that are relatable to issues found in the Current State Analysis described in Chapter 3.

From the four categories described in the Conceptual Framework, three categories have relatable dimensions where issues do occur. One category, *Accessibility* and its dimensions can be dismissed as the users are working in the same environment and have role-based accesses already defined. All categorized dimensions are relatable to the issues found in the current state analysis as they are linked to each other categorically.

The dimensions under *Representational* category were chosen to when building the Conceptual Framework since all are dimensions that appear on data queries done in the current state analysis phase, where the query results display a consistent variation in how data is inserted into similar product items.

In relation to issues found in the current state analysis interviews and confirmed by data queries, the barrier *Lack of written data quality politics and procedures* was identified as a major cause in variance of resulted data. People working with itemization were interviewed and they stated that there are no tangible guidelines to rely on when working with design items unlike commercial items have.

In relation to Table 4, which collects the issues from the Current State Analysis and the key elements from the Conceptual Framework, the proposed solutions to each topic are presented on Table 5.

Table 5. Proposed solutions for key focus areas.

	Key focus area	**Proposed solution for the focus area**
1	Large variance in item data quality	Create tangible rules how data should be formatted.
2	No tangible rules how to insert data per product	Related to #1. Create tangible rules how item data should be formatted. Develop a process where the item data rules are created for a certain product.
3	No process to follow ensuring item meets all requirements	Develop a support process.

5.3 Design Item Policy Development for Pilot Product Group

The Current state analysis in Chapter 3 describes the current environment regarding design items. As mentioned, the current state allows similar products to be described in multiple different ways leading to saturation in description data. The main focus of development is to develop a set of syntaxes to enhance quality in description fields as the other relevant item attributes are sufficiently defined. It is also essential to emphasize data quality towards items that are considered as spare parts to avoid creating too much workload for items that contain limited or non-existent potential for spare parts and after-sales business which is discussed later in this chapter.

To achieve uniform item data, the foundations for it must be thought well. To support current systems and itemization, a process was developed to identify and group attributes for each product group. After the attributes have been grouped, the syntax generation has a logical base to rely on. Figure 36 describes the process to create define attributes for products in a general level and is based on the process to create a master data standard described in Conceptual Framework but is slightly modified with product management and PLM principles to suit the engineering and product management perspective. This process is then applied in use in this proposed policy to act as a pilot towards other products in the portfolio.

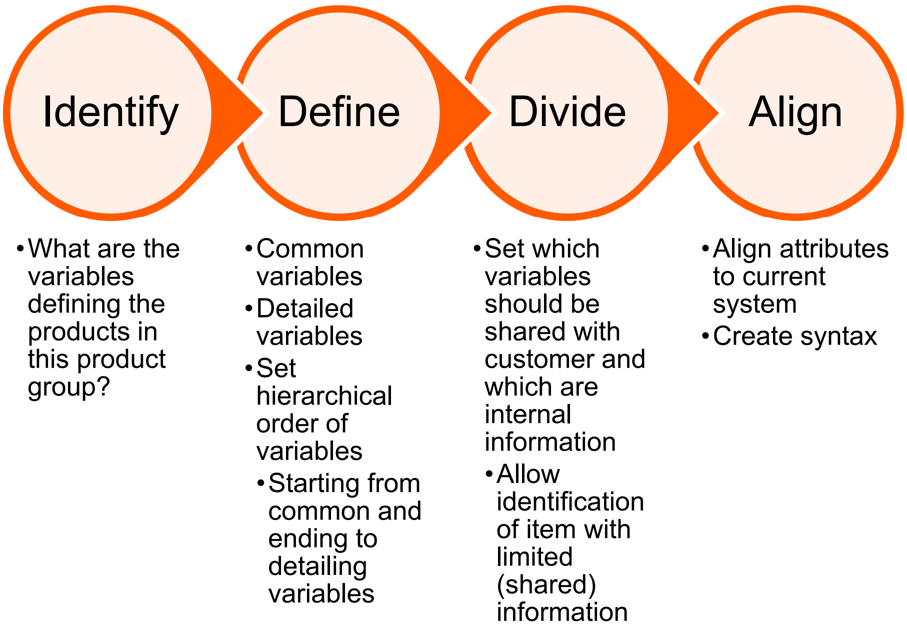

Figure 36. Product attribute identification and alignment process

Firstly, it is essential to identify all attributes of a certain product group to begin the process. Secondly, the identified variables are grouped to common variables describing the entire product group and detailed attributes which describe a certain product in a detailed manner. After the definition is complete, a division should be done of what data is allowed to be shared between customers and what is not. Even when the visibility is limited, the identification of the item should be plausible. Lastly, the attributes are aligned into the current system, which allows a syntax to be created.

Figure 37 illustrates the identified parts of filter cloths product group and proposed hierarchy of attributes. Not all information of the product is stored in description fields and only the information that is written into description fields is included. Manufacturer information and technical documentation such as datasheets and drawings are dismissed as that information is stored or linked in separate attributes or objects and the main focus of this study is to create uniform description data among items.

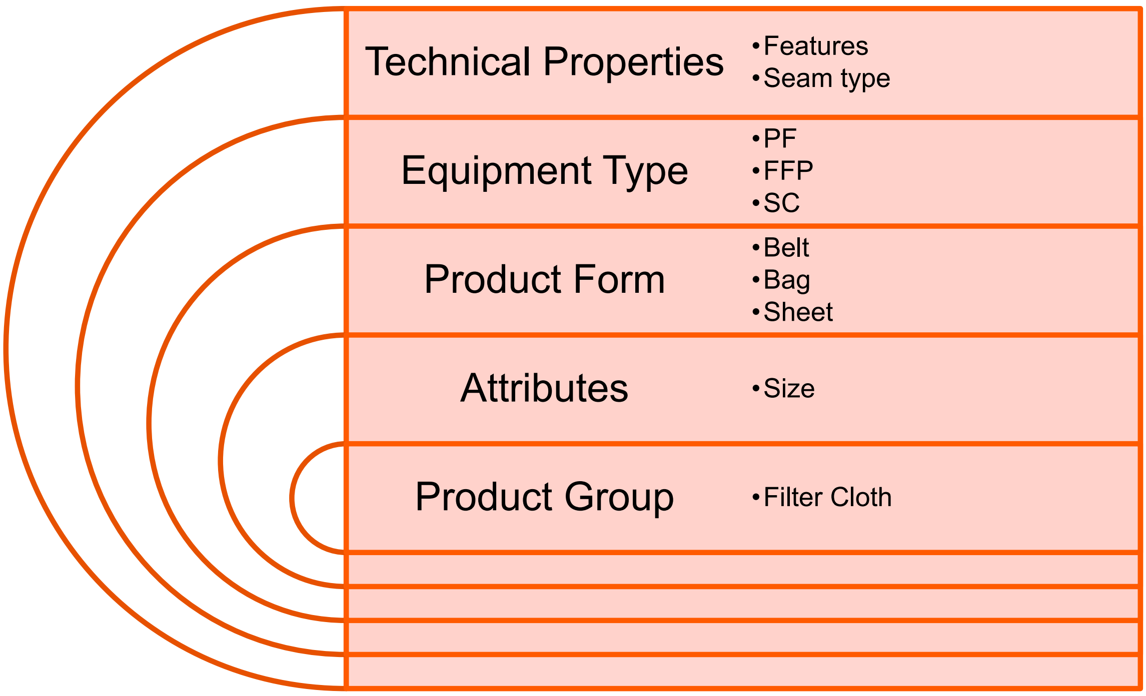

Figure 37. Identified attributes

In the center of the identified variables is the most common identifier between items in this group, the product group itself. In second level is the size of the item followed by form, related equipment type and technical properties are placed last. Figures 38 and 39 describe the proposed hierarchical order of the identified attributes.

Product group and size allow the identification of the item while restricting the confidential manufacturing and supplier information. The hierarchy is aligned to suit the current description attribute fields described in the Current State Analysis, Chapter 3, while maintaining the identification properties of the item for both internal users and customers.

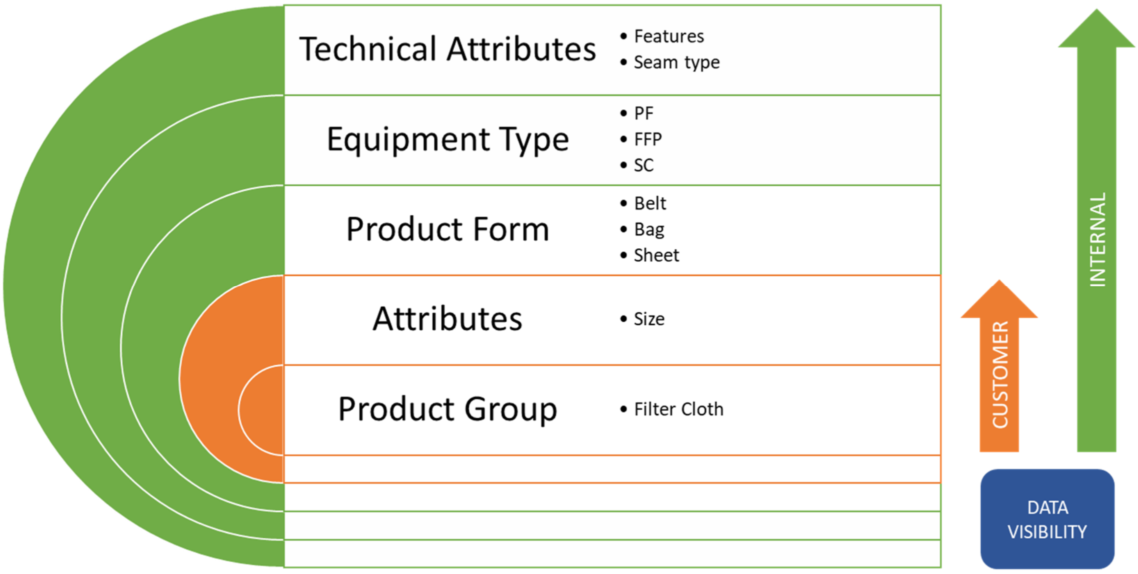

Figure 38. Identified attributes divided to internal and external visibility

Lastly, the identified attributes need to be aligned with the description fields as Figure 39 illustrates. The alignment between internal and external data is done within system limits.

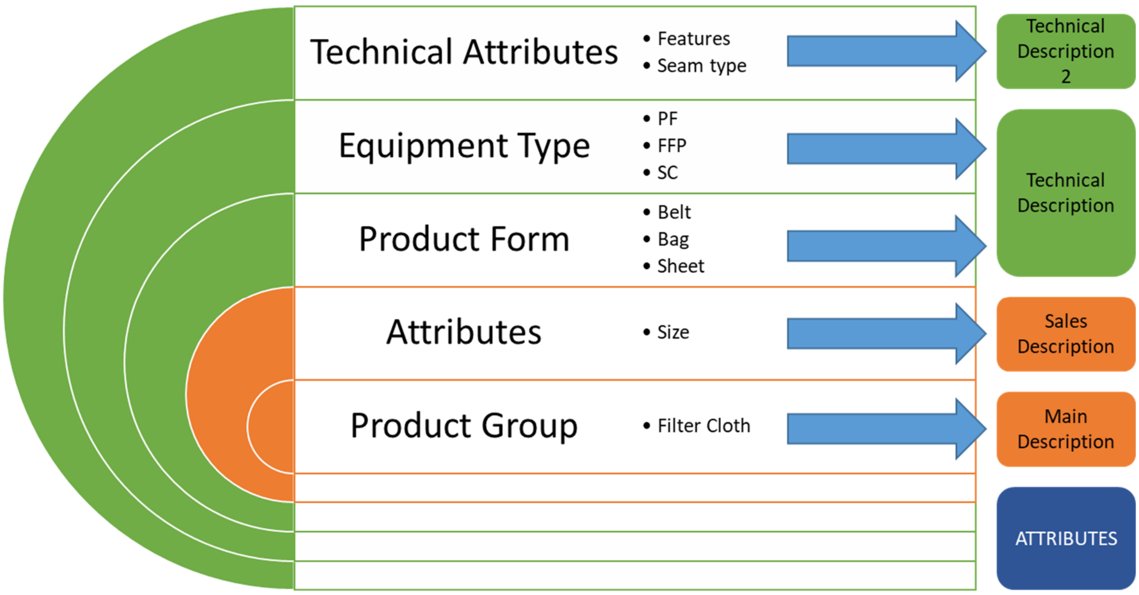

Figure 39. Identified attributes aligned to current attribute environment

After the alignment is done, a syntax for end users to follow can be created. Figure 40 illustrates an example use case of a syntax and its outcome.

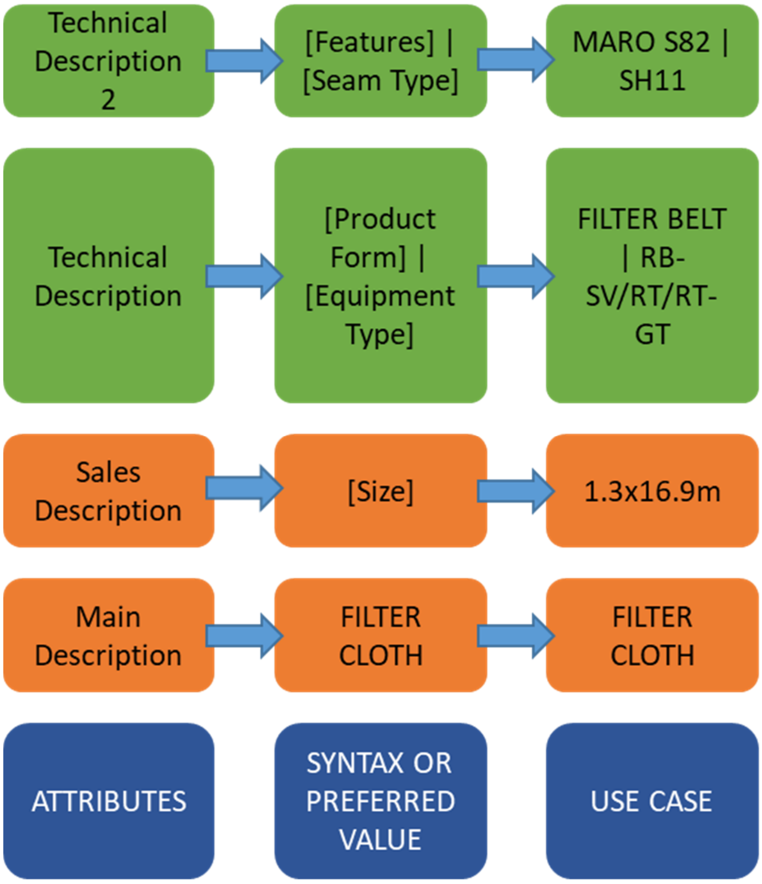

Figure 40. Generated syntax and example case

The main description is chosen to represent the entire product group. Other product groups may need to provide alternatives, depending on the product. The main description is chosen from a predefined list, therefore it must be called as a “preferred value” instead of a syntax. The Current state analysis presents data queries (Table 2) described in Chapter 3. The developed policy is implemented to items listed in Table 6, the same items listed in the Current State Analysis.

As a result, the data in the selected items is harmonized and the data stored in items is easier to compare and allows the identification of a certain item when seeking it from the search results.

Table 6. Harmonized items from Current State Analysis

#	Name	Description	Sales Description	Technical Description	Technical Description 2
1	H1837020	FILTER CLOTH	1500	BARREL NECK | FFP	N/A
2	NL32180	FILTER CLOTH	1.7x65m	FILTER BELT | PF	AINO K10 | SH2
3	NL32218	FILTER CLOTH	1.7x51m	FILTER BELT | PF	AINO T32 | SH1
4	L52372	FILTER CLOTH	D188mm	OTHER | TEST FILTER	AINO K16
5	L32530	FILTER CLOTH	1.05x33m	FILTER BELT | PF	AINO T30 | SH1
6	L609362	FILTER CLOTH	1.05x43.5m	FILTER BELT | PF	AINO T51 | SH2
7	L604029	FILTER CLOTH		OTHER | TEST FILTER	AITE S400 MFP0,3
8	L602344	FILTER CLOTH	1.05x3m	FILTER BELT | PF	ANNE T20 | SH2
9	L603227	FILTER CLOTH	0.2x18.25m	FILTER BELT | PF	ARTO S11 | WITHOUT SEAM
10	L606339	FILTER CLOTH	1.52x2.1m	FILTER SHEET | FFP	ASKO T54 | CS
11	L34720	FILTER CLOTH	D125mm	OTHER | TEST FILTER	MARO S30
12	L604276	FILTER CLOTH	3.21x45m	FILTER BELT | RB-SV/RT/RT-GT	MARO S96 | SH15
13	H39514	FILTER CLOTH	1000	FILTER SHEET | FP	N/A
14	L600965	FILTER CLOTH		FILTER SHEET | FP	N/A

5.4 Spare Part and After Sales Focus

In business generally, efficiency plays a major role in almost every work task. Working with itemization does not differ from it. As it would be nice to live in a perfect world where all items have been organized to follow a certain pattern, it is not efficient as some of these database records (items) provide no future value. Therefore, the focus should be shifted towards those items that have the prospect of generating revenue also in the future. Depending on the equipment, some contain more and some less of items that have value prospect in spare part business. Usually simple structural parts are not considered as spare parts and should last the entire lifecycle of an equipment unit. However, in the current environment all parts are required to be recorded in the PLM environment to allow data sharing between suppliers and manufacturers in the construction phase. Therefore, a recommendation for division between items that are considered spare parts and those which are not should be incorporated into the processes. To focus itemization efforts on spare parts prevents generation of waste via non-efficient work.

As the pilot product group consists entirely of items classified as spare parts the division in spare part attribute can be postponed to future development. However, the division between spare parts and items not considered as spare parts is essential as the future plan is to implement the proposed policy to other products as well, containing wider portfolio of items. Therefore, the handling process of proprietary (design) items should always follow a certain pattern when the guidelines for description attribute formation are available for a certain product group. A process proposal is described in Figure 41.

In the proposal the user starts with a situation where a new item is created or a request to enrich a legacy item is to be resolved. After the item has been identified, the user connects a specification such as manufacturing drawing or datasheet to the item. When connected, the user must identify is the item eligible as a spare part by setting the spare part attribute either Yes or No in item properties. The selection will choose which path the process will take to reach the end. If the item is delivered only once in a project, the user should ensure that the data is sufficient to allow manufacturing of that certain item. After verification, the user releases the item for manufacturing and the process cycle reaches the end. If the item takes another route and is eligible to be classified as a spare part, it must undergo more strict measures to ensure item data quality where the user runs through multiple checks to firstly ensure correct RDO, item behavior and type. Next, the user checks if the item is linked to the correct engineering class. Engineering classes are a synonym used for product groups in Enovia. This step has great importance as the description forming guidelines are based per product group and a wrong selection would expose the item for wrong guidelines. The last point to check is that the item has its descriptions formed correctly according to the guidelines per product group. When the description data is filled correctly, the user releases the item and reaches the end of the process. Figure 41 depicts the proposed handling process to ensure Design Item Data Quality.

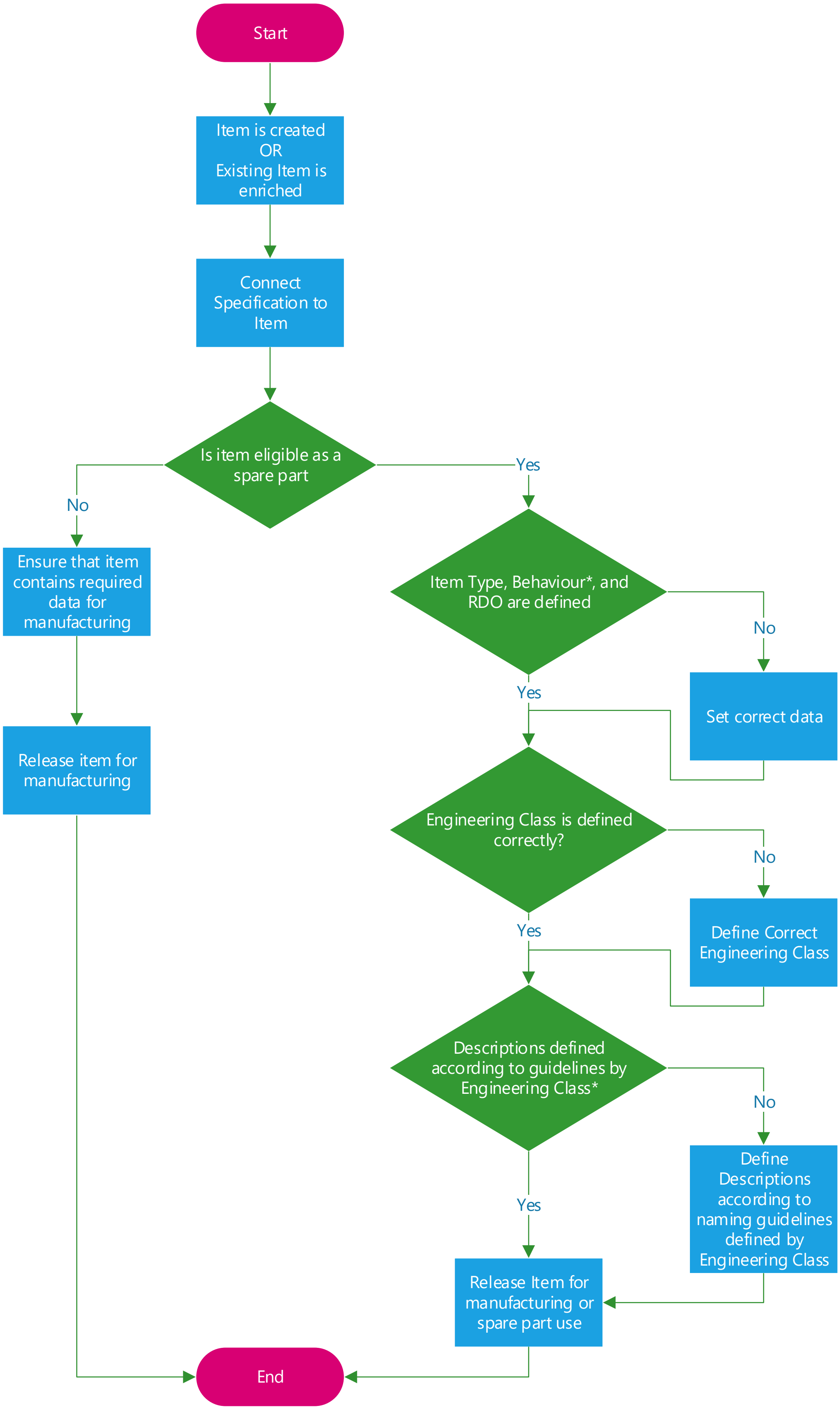

Figure 41. Proposed handling process to ensure Design Item Data Quality

5.5 Summary of Proposed Item Policy

Summarized, the proposal comes in two parts. The main focus was to generate a set of naming guidelines for a single product group. With the principles of the master data creation process presented in the Conceptual Framework are slightly modified by adding product management principles to suit the current PLM system and product environment.

As the data is transferred into a certain form future item creation takes the data quality dimension presented in the Conceptual Framework, into account. *Intrinsic* dimension, which relates to believability, accuracy and reputation are increased when there is one clear line of how items belonging to a certain group should look like and what they should include. As the division is done in product group level *Contextual* data quality dimension is included. Lastly *Representational* dimension is improved with the syntaxes created to form items into a certain form.

Additionally, data quality barriers as described and identified in the Conceptual Framework, were an important topic to overcome with the proposed solution. The Conceptual Framework raises especially one barrier in relation to this context, *Lack of written data quality politics and procedures.* Together with the process proposal, the second part of the proposal and product group-based item syntaxes users working with items by creating and modifying them have a process to follow and guidelines how to form item descriptions to achieve uniform data for the items. Next, in Chapter 6, the developed proposal is validated through feedback and the proposal is modified according to feedback.

6 Validating Proposed Global Item Policy Through Feedback

This chapter describes the validation of the initial developed policy through received feedback including the support process as described in Chapter 5. The first subchapter is an overview of the feedback process. The second subchapter describes received feedback. The third subchapter describes corrections made according to feedback and how the corrections made affect the result.

6.1 Overview

Feedback collection regarding the proposal was conducted with the product owner and itemization team. The main idea was to combine input from the owner, who sets the attributes and the employees who create actual items according to the created instructions. Firstly, the product owner was interviewed and the first proposal including all the steps leading to form simple syntaxes for a product item was presented. Secondly, the itemization team was interviewed, to seek how they would accept the idea of having stricter instructions for how to define items and whether they should be expanded for other products as well in the future.

6.2 Received Feedback

As described, the product owner was first in line in data collection. The main idea of recognizing the product attributes and setting them into different hierarchical layers was accepted well, especially the main idea behind it as it was based on literature on master data and its maintenance and creation. However, the initial alignment required some fine-tuning as the products had a known product name which is used in communication with customers and does not reveal technical details.

On the other hand, feedback from the itemization team was positive in the sense that the guidelines are updated and published for use. However, they emphasized the importance of having guidelines easily accessible and in easy to understand format. The Current State Analysis described an example of naming guidelines with syntaxes for item creation and something similar was required.

However, the main pain point is that in the early phase there is very limited amount of instructions available which may lead to complete dismissal of guidelines among the users. Therefore, the next major push is to get as many product owners as possible to create instructions for their products, which is discussed in Chapter 7.

6.3 Corrections Based on Feedback

When the product had a naming system, which was used in communication with external entities such as customers there is no need to hide the product name from externals. Initially the syntax was defined as [Technical Attributes] as the name defines also its technical qualities. However, according to feedback it was renamed simply as [Product Name] and moved to Sales Description field to make it visible in external reports. The reshaped syntax is shown in Figure 42.

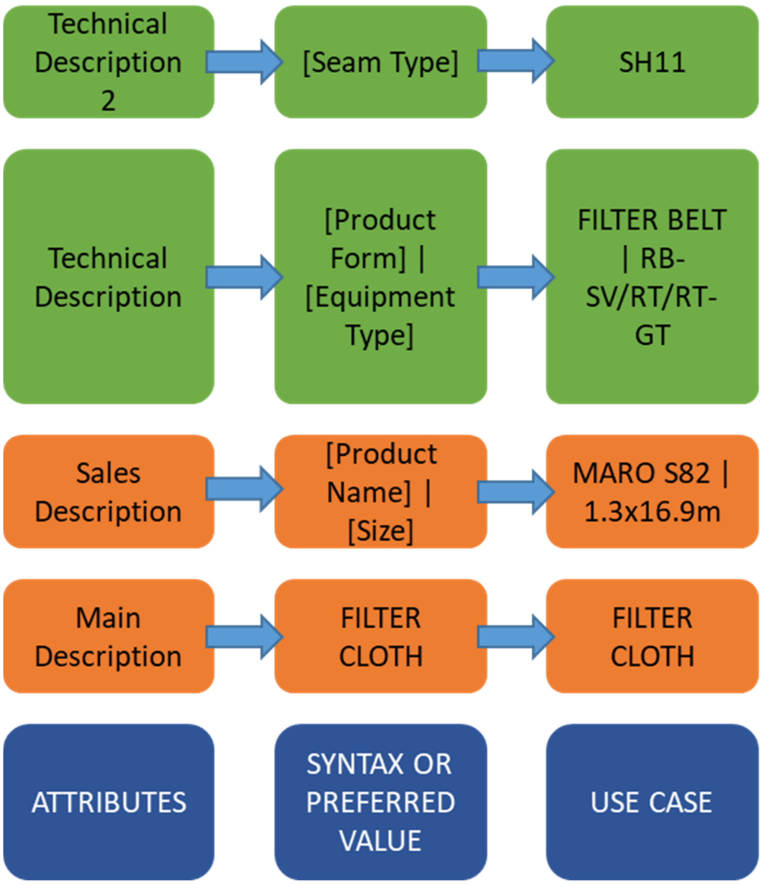

Figure 42. Corrected Syntax and Use Case

Table 5 displays how the data is transformed according to the fixed proposal and product name is visible in the sales description field.

Table 7. Item dataset harmonized according to corrected naming syntax

#	Name	Description	Sales Description	Technical Description	Technical Description 2
1	H1837020	FILTER CLOTH	1500	BARREL NECK | FFP	N/A
2	NL32180	FILTER CLOTH	AINO K10 | 1.7x65m	FILTER BELT | PF	SH2
3	NL32218	FILTER CLOTH	AINO T32 | 1.7x51m	FILTER BELT | PF	SH1
4	L52372	FILTER CLOTH	AINO K16 | D188mm	OTHER | TEST FILTER	N/A
5	L32530	FILTER CLOTH	AINO T30 | 1.05x33m	FILTER BELT | PF	SH1
6	L609362	FILTER CLOTH	AINO T51 | 1.05x43.5m	FILTER BELT | PF	SH2
7	L604029	FILTER CLOTH		OTHER | TEST FILTER	MFP0,3
8	L602344	FILTER CLOTH	ANNE T20 | 1.05x3m	FILTER BELT | PF	SH2
9	L603227	FILTER CLOTH	ARTO S11 | 0.2x18.25m	FILTER BELT | PF	WITHOUT SEAM
10	L606339	FILTER CLOTH	ASKO T54 | 1.52x2.1m	FILTER SHEET | FFP	CS
11	L34720	FILTER CLOTH	MARO S30 | D125mm	OTHER | TEST FILTER	N/A
12	L604276	FILTER CLOTH	MARO S96 | 3.21x45m	FILTER BELT | RB-SV/RT/RT-GT	SH15
13	H39514	FILTER CLOTH	1000	FILTER SHEET | FP	N/A
14	L600965	FILTER CLOTH		FILTER SHEET | FP	N/A

Table 7 displays the same set of items used in Current State Analysis and policy development chapters. Now the data in the set of items is formed according to the revisioned syntax. The product name that has been used in communication with customer and in different brochures is clearly in the front of the item data and visible now in customer reports. This way the item has its unique identifier (Item Number) followed by a generic description based on the product group (Main Description) and size of the product visible for external viewers. What is left hidden are the shape of the product, relevant machinery and seam type. The next chapter concludes this thesis and introduces the self-evaluation of the research and next steps in implementation of the proposed policy for design items.

7 Conclusions

This chapter concludes the Thesis and consists of three subchapters. Firstly, the executive summary related to this thesis is presented. Secondly, next steps for implementation are discussed and lastly the trustworthiness of the entire study is discussed.

7.1 Executive Summary

The objective of the study was to research issues in data quality in the context of proprietary items. Proprietary items have historically had little limitation of how the data should be displayed and what the minimum requirement is for data quality. And the responsibility of the data presentation was previously seen as a non-relevant issue, as the general thought was that the data owners would take ownership. Large variation in data quality creates waste in the later stages in the products' lifecycle by creating unnecessary workload, confusion and increased response times which could have been avoided if the data would have been in good shape. Good quality data, especially in an engineering context, significantly reduces the risk of supplying in-compatible or wrong items to the customer, whose location may not always be the most convenient possible. Therefore, savings are achieved thanks to risk reduction in manufacturing, logistics and in safety.

The initial research concentrated more on systematic issues than humane issues. This approach justified itself as there were no systematic rules of data creation, which rendered local differences in working processes insignificant. When the working environment is global and data is shared globally, there is no real advantage of researching or developing any local methods or guidelines, instead they should be visible for all users in every location.

Issues were found from current item data, where the fluctuation in data quality was clearly visible. It also revealed the difference between applied processes regarding item creation, modifying and release. In relation to the initial findings, the literature review provided some essential and relevant findings. The literature review was divided into three main topics, Master Data in general, Product Lifecycle Management (PLM) and Data Quality. Together all three topics provided a clear ground to generate a solution to tackle the issues found. Firstly, a process proposal to identify product attributes was created with the help of Master Data and PLM literature. Secondly, theories of Data Quality were compared with the initial research and the developed process. Especially Data

Quality literature provided some interesting views regarding the current issues. Data Quality can be viewed through dimensions, and some of the identified dimensions were not met. To tackle this, barriers were identified and the most relevant were taken into scrutiny when developing solution.

Proposal Development was done especially with Data Quality Barrier the "*Lack of written data quality politics and procedures*" in mind, which was identified as a root cause for variation in Item Data Quality. When the implementation of data formation guidelines is available, and relevant easy-to-use environment is created to support it, users creating or modifying item data should have a clear view of how to organize data per product group.

7.2 Next Steps in Implementation

The project started with developing a policy for a single product group. However, the product portfolio of the case company is very wide, and since all instructions cannot be the same for all, they need to be divided into groups to maintain the contextual correctness of data. Therefore, a service should be created where users are able to see item description syntaxes per product group and per responsible design organization attributes. When the service is developed, product managers can see the possible value creation by creating instructions into the service. As one large player has started the process, the natural way is to extend the creation of guideline syntaxes for other product groups under that certain RDO (Filters). When one large player has these instructions visible, it might create interest from others as well.

On the other hand, the proposed supportive process (Figure 41) should be implemented to the current official processes as a sub-process. However, as the supportive process relies heavily on the existence of the description guidelines, the creation of the guidelines must be higher in importance than the implementation of the process part.

7.3 Evaluation of Project Trustworthiness

This study is evaluated through four criteria: validity, reliability, logic and relevance. Each criterion has its dedicated section to introduce what the criteria represent and how they are reflected in this study.

According to Kananen (2013) validity defines the correct issues are subjected within the research. In detail, validity can be divided into sub-categories such as external and internal validity. External validity concerns studies done with quantitative methods as the aim of the study is to generalize the result into a larger group via scaling.

Internal validity can either be measured with contents, structural or by criteria according to Kananen (2013). Firstly, contents validity in research define if a measured subject is the correct one to measure in reference of the study subject. Secondly, structural validity measures the conceptual framework of the study and how well it has been derived from literature. Lastly, criteria validity means laying foundations of one's research into researches made by others.

As the solution proposal presented in this thesis relies on ideas and concepts found in literature the validity of the study is mainly measured by the effectiveness and functionality of the Conceptual Framework discussed in chapter 4. However, external validity as presented by Kananen (2013) is somewhat applicable also to this study as the measured data in chapter 3 presented a very small portion of the item data created and the query results can be generalized to represent entire item database.

The second criterion, reliability, in this context is how consistent the study results are every time the study is replicated. Together with validity they form the credibility of the thesis (Kananen 2013). The cwredibility of the thesis is valid as the Conceptual Framework and the data query results can be generalized to cope with proprietary items in the item database of the case company. Combined with reliability, the proposed process to identify and align product attributes to form syntaxes to guide in item creation can be implemented into use for other product groups as well inside the case company.

Thirdly, the relevance of the study can be measured by the significance of the outcome for the case company. As discussed, the significance is minor at most in the beginning of the project and the work is done silently in the background with limited visible results. However, the significance grows when the development curve reaches momentum and the foundations created in this study become more relevant.

Lastly, the logic in this study is evaluated holistically from the foundation to the conclusion. In this study a business problem was identified, which was varying data quality in engineering item data. With the Current State Analysis the proposition was confirmed as true. From there with the help of the Conceptual Framework, discussed in chapter 4, a conclusion was created to fix the initial problem.

7.4 Closing Words

Master Data is a very versatile topic to discuss and develop. Even in a single branch of master data in a company, such as engineering master data there is a massive number of things to consider before and after the master data thinking has been implemented into use. During the planning of implementation, the environment must be well thought of to avoid endless patching work in the future. It must be defined who will use the system, how it will be used and what the functionalities required from it are. A well-thought out ecosystem acts as a good foundation for master data. However, even if the system turns out to be good, the support functions and processes must be also in a good shape to support creating and maintaining the actual data. Without good guidance through processes and guidelines, users eventually will create data with varying outcome.

In a world where service business is gaining more and more importance, the winner may not be the one who initially supplied the equipment, but rather the one who had it documented best and was able to service customers better and quicker. By creating guidelines how to form data in single items and propose a supportive process to maintain the item data may not remove the issues for the whole installed base structure, but instead offers a good start and gains efficiency in situations where the exact item code is known and the need for investigation for technical data is removed, thus increasing efficiency.

References

Abraham, Jorij. *Product Information Management: Theory and Practice.* Management for Professionals. 1st ed. Springer, 2014.

Ballou, Donald, Madnick, Stuart, Wang, Richard. *Assuring information quality*. Journal of Management Information Systems, Vol. 20, No. 4, pp. 9-11, 2004.

Berson, Alex, Dubow, Lawrence, Plagman, Bernard, Raskas, Paul. *Master Data Management and Data Governance*. McGraw-Hill, 2010.

Concha, Fernando. *Solid-Liquid Separation in the Mining Industry.* Springer, 2014.

Friedman, Ted, Feinberg, Donald, Beyer, Mark, Gassman, Bill, Bitterer, Andreas, Newman, David, Radcliffe, John, White, Andrew, Paquet, Raymond, DiCenzo, Carolyn, Logan, Debra, Blechar, Mike, Knox, Rita, Bell, Toby, Shegda, Karen. *Hype Cycle for Data Management*, Gartner Research, Gartner ID G00140057, 2006.

Haug, Anders, Stentoft Arlbjørn, Jan, Zachariassen, Frederik, Schlichter, Jakob. *Master data quality barriers: an empirical investigation*. Industrial Management & Data Systems, March, pp.234-249, 2013.

Hüner, Kai, Martin, Ofner, Boris, Otto. *Towards a Maturity Model for Corporate Data Quality Management*. SAC '09: Proceedings of the 2009 ACM symposium on Applied Computing, March, pp 231–238, 2009.

Kananen, Jorma. *Design Research (Applied Action Research) as Thesis Research: A Practical Guide for Thesis Research*. Publications of JAMK University of Applied Sciences, 2013.

Levitin, Anany, Redman, Thomas. *Data as a Resource: Properties, Implications, and Prescriptions.* Sloan Management Review. pp. 89-101, 1998.

Loshin, David. *Master Data Management.* Morgan Kaufmann, 2010.

Boris, Otto, Lee, Yang, Caballero, Ismael. *Information and data quality in networked business.* Electronic Markets, pp. 79-81, 2011.

Panahy, Payam, Sidi, Fatimah, Affendey, Lilly, Jabar, Marzanah. *The impact of data quality dimensions on business process improvement.* Information and Communication Technologies (WICT), pp. 70-73, 2014.

Redman, Thomas. *The Impact of Poor Data Quality on the Typical Enterprise.* Communications of the ACM, February, pp.79-82, 1998.

Saaksvuori, A., & Immonen, A. Product Lifecycle Management. 3rd ed. Springer, 2008.

Stark, John. *Product Lifecycle Management. Volume 1, 21st Century Paradigm for Product Realisation.* 3rd. ed. Springer, 2015.

Stark, John. *Product Lifecycle Management (Volume 2) The Devil Is in the Details.* Springer, 2016.

Tayi, Giri, Ballou, Donald, *Examining Data Quality*, Association for Computing Machinery. Communications of the ACM, February, pp.54-57, 1998.

Väre, Taru. *Master Data*, Alma Talent, 2019.

Wang, Richard, Storey, Veda, Firth, Christopher, *A framework for analysis of data quality research*, IEEE Transactions on Knowledge and Data Engineering, Vol. 7 No. 4, pp. 623-640, 1995.

Item Data for Current State Analysis

Item Number	Main Description	Sales Description Free Text	Technical Description 1	Technical Description 2
L58544	FILTER CLOTH AINO T30 1.05x18m SH2	AINO T30 1.05x18m SH2	[redacted]	[redacted]
L43503	FILTER CLOTH AINO K10 1,05x17m SH1	AINO K10 1,05x17m SH1	[redacted]	[redacted]
F013190	FILTER BAG elem 7 VPF550	elem 7 VPF550	[redacted]	[redacted]
L26003	FILTER CLOTH		[redacted]	[redacted]
L44793	FILTER CLOTH OUTOTEC ERTO S10 1.93x28.5m	OUTOTEC ERTO S10 1.93x28.5m	[redacted]	[redacted]
PA26960	FILTER CLOTH		[redacted]	[redacted]
L59849	FILTER CLOTH FP1216, T40	FP1216, T40	[redacted]	[redacted]
L34464	FILTER CLOTH AINO T50 1.025x84m SH2	AINO T50 1.025x84m SH2	[redacted]	[redacted]
L58100	FILTER CLOTH AINO T31 1.7x144m SH3	AINO T31 1.7x144m SH3	[redacted]	[redacted]
L50865	FILTER CLOTH AINO K12 1.7x149m SH3	AINO K12 1.7x149m SH3	[redacted]	[redacted]
L48841	FILTER CLOTH AINO T31 1.7x97m SH1	AINO T31 1.7x97m SH1	[redacted]	[redacted]
56223	CLOTH		[redacted]	[redacted]
PA900062	FILTER CLOTH		[redacted]	[redacted]
L32530	FILTER CLOTH AINO T30 1.05x33m SH1	AINO T30 1.05x33m SH1	[redacted]	[redacted]
L40776	FILTER CLOTH AINO T31 1.7x138m SH3	AINO T31 1.7x138m SH3	[redacted]	[redacted]
N048047470	FILTER CLOTH		[redacted]	[redacted]
L44282	FILTER CLOTH AINO T31 1.05x22m	AINO T31 1.05x22m	[redacted]	[redacted]
L39904	FILTER CLOTH AINO K11 D190MM,TEST FILTER	AINO K11 D190MM,TEST FILTER	[redacted]	[redacted]
L54029	FILTER CLOTH AINO K12 1.18x49m SH2	AINO K12 1.18x49m SH2	[redacted]	[redacted]
PA52693	FILTER CLOTH		[redacted]	[redacted]
PA53641	FILTER CLOTH		[redacted]	[redacted]
L33077	FILTER CLOTH AINO K13 1.05x59m SH3	AINO K13 1.05x59m SH3	[redacted]	[redacted]
L49174	FILTER CLOTH AINO T70 1.05x30.5m SH1	AINO T70 1.05x30.5m SH1	[redacted]	[redacted]
NL32216	FILTER CLOTH		[redacted]	[redacted]
PA59601	FILTER CLOTH 2.43x30.7M	2.43x30.7M	[redacted]	[redacted]
F012290-SH2	MAINTENANCE CLOTH		[redacted]	[redacted]
L34720	FILTER CLOTH MARO S30 D125MM	MARO S30 D125MM	[redacted]	[redacted]

Item Number	Main Description	Sales Description Free Text	Technical Description 1	Technical Description 2
L59806	FILTER CLOTH MARO S30 1.95x41.8M SH15	MARO S30 1.95x41.8M SH15	[redacted]	[redacted]
L54403	FILTER CLOTH AINO T31 1.05x57m SH1	AINO T31 1.05x57m SH1	[redacted]	[redacted]
PA61040	FILTER CLOTH		[redacted]	[redacted]
NL32218	FILTER CLOTH		[redacted]	[redacted]
L27774	BARREL NECK CLOTH		[redacted]	[redacted]
F621754	FILTER CLOTH		[redacted]	[redacted]
PA52523	FILTER CLOTH		[redacted]	[redacted]
F614363	FILTER CLOTH HEAD- ENDPLATE FP2016 KT40	HEAD- ENDPLATE FP2016 KT40	[redacted]	[redacted]
L37831	FILTER CLOTH AINO K10 0.86x31.8m SH1	AINO K10 0.86x31.8m SH1	[redacted]	[redacted]
L32464	FILTER CLOTH AINO K10 1.05x38m SH1	AINO K10 1.05x38m SH1	[redacted]	[redacted]
L35528	CLOTH AINO T30 1.05x0.2m SH1/SH3	AINO T30 1.05x0.2m SH1/SH3	[redacted]	[redacted]
L32605	FILTER CLOTH ANNE K30 1.05x60m SH2	ANNE K30 1.05x60m SH2	[redacted]	[redacted]
N90256	FILTER CLOTH		[redacted]	[redacted]
L39264	FILTER CLOTH AINO K10 1.05x3m SH2	AINO K10 1.05x3m SH2	[redacted]	[redacted]
NL32525	FILTER CLOTH		[redacted]	[redacted]
L32537	FILTER CLOTH AINO T30 1.05x48m SH1	AINO T30 1.05x48m SH1	[redacted]	[redacted]
L52730	FILTER CLOTH AINO K12 56.5x1.18m SH2	AINO K12 56.5x1.18m SH2	[redacted]	[redacted]
H1537208	BARREL NECK CLOTH		[redacted]	[redacted]
PA60044	FILTER CLOTH PB 1237 B 1500x25800 mm	PB 1237 B 1500x25800 mm	[redacted]	[redacted]
PA900588	FILTER CLOTH PB 35 A PP 2876 PP	PB 35 A PP 2876 PP	[redacted]	[redacted]
L41748	FILTER CLOTH MARO S86 2.25x29M SH15	MARO S86 2.25x29M SH15	[redacted]	[redacted]
L56000	FILTER CLOTH AINO T71 1.7x84.5m SH3	AINO T71 1.7x84.5m SH3	[redacted]	[redacted]
L52350	FILTER CLOTH AINO T31 1.21x73m SH3	AINO T31 1.21x73m SH3	[redacted]	[redacted]
L37517	FILTER CLOTH		[redacted]	[redacted]
NL32181	FILTER CLOTH		[redacted]	[redacted]
PA51319	FILTER CLOTH		[redacted]	[redacted]

Item Number	Main Description	Sales Description Free Text	Technical Description 1	Technical Description 2
L52676	FILTER CLOTH Outotec ARTO T20 1300x21600	Outotec ARTO T20 1300x21600	[redacted]	
PA52613	FILTER CLOTH			
L59533	FILTER CLOTH AINO T81 1.05x26m SH1	AINO T81 1.05x26m SH1		
PA58744	FILTER CLOTH 3,21x41,6M SH15	3,21x41,6M SH15		
PA20737-11750	FILTER CLOTH			
PA901487	FILTER CLOTH			
NL32180	FILTER CLOTH			
L42466	FILTER CLOTH AINO T30 1.05x40m SH2	AINO T30 1.05x40m SH2		
L52372	FILTER CLOTH AINO K16 D188mm	AINO K16 D188mm		
L51603	FILTER CLOTH MARO T91 3.35x23M SH15	MARO T91 3.35x23M SH15		
H39514	OVERHANG CLOTH			
PA53637	FILTER CLOTH			
L600952	FILTER CLOTH AINO T71 1.7x57m SH3	AINO T71 1.7x57m SH3		
H1930353	BARREL NECK CLOTH 1500, MEMBRANE PLATE M	1500, MEMBRANE PLATE M		
2007	CLOTH			
PA901400	FILTER CLOTH			
L39903	FILTER CLOTH AINO K11 0.45x0.45m	AINO K11 0.45x0.45m		
H2205714	OVERHANG CLOTH			
56853	CLOTH			
L48505	FILTER CLOTH AINO T33 1.7x62 m SH1	AINO T33 1.7x62 m SH1		
L32505	FILTER CLOTH AINO K13 1.05x27.5m SH1	AINO K13 1.05x27.5m SH1		
L38519	FILTER CLOTH AINO K10 1.26x101.1m SH1	AINO K10 1.26x101.1m SH1		
PA55706	CLOTH DRIVE UNIT			
F614657-6	FILTER CLOTH Outotec MITO S62 2.5x3.25M	Outotec MITO S62 2.5x3.25M		
L58164	FILTER CLOTH ARTO S11 SH14 1.5x17.6m	ARTO S11 SH14 1.5x17.6m		
L601200	FILTER CLOTH AINO T31 1.05x44.5m SH1	AINO T31 1.05x44.5m SH1		
H1878743	OVERHANG CLOTH 1500 JF 4140	1500 JF 4140		

Item Number	Main Description	Sales Description Free Text	Technical Description 1	Technical Description 2
L18684	CLOTH		[redacted]	
6515	CLOTH			
F619014P126/5	CLOTH			
L39642	FILTER CLOTH AINO T71 1.7x138m SH3	AINO T71 1.7x138m SH3		
L35650	FILTER CLOTH			
L35651	FILTER CLOTH			
H1837020	BARREL NECK CLOTH			
PA61062	FILTER CLOTH			
F003587-2	FILTER CLOTH			
H1930197	BARREL NECK CLOTH 1500 N, MEM-BRANE PLATE	1500 N, MEMBRANE PLATE		
L41652	FILTER CLOTH Outotec FPC201 CS CLOTH FOR	Outotec FPC201 CS CLOTH FOR		
PA63820	CLOTH			
L17092	FILTER CLOTH			
PA901118	FILTER CLOTH			
L59722	FILTER CLOTH AINO T51 1.7x62m SH1	AINO T51 1.7x62m SH1		
PA61061	FILTER CLOTH			
L35522	CLOTH AINO T31 1.7x0.2m SH2/SH3	AINO T31 1.7x0.2m SH2/SH3		
PA56055	FILTER CLOTH			
PA58566	CLOTH DRIVE UNIT			
F610229-IN1	FILTER CLOTH			
H2533172	OVERHANG CLOTH			
L52224	FILTER CLOTH MARO S60 3.21x31.1M SH15	MARO S60 3.21x31.1M SH15		
H1844257	FILTER CLOTH			
L39266	FILTER CLOTH AINO K10 1.05x23m SH2	AINO K10 1.05x23m SH2		
PA52639	FILTER CLOTH			
H1877695	FILTER CLOTH			
PA52486	FILTER CLOTH			
H45361	BARREL NECK CLOTH			
NL32210	FILTER CLOTH			
L47908	FILTER CLOTH AINO T31 1.7x85.5m SH1	AINO T31 1.7x85.5m SH1		

Item Number	Main Description	Sales Description Free Text	Technical Description 1	Technical Description 2
PA53639	FILTER CLOTH PB 50 B PP 0.2x4.3M	PB 50 B PP 0.2x4.3M	[redacted]	
H772822	FILTER CLOTH			
L35267	FILTER CLOTH Outotec ARTO T20 CLOTH FOR	Outotec ARTO T20 CLOTH FOR		
L43243	FILTER CLOTH AINO K11 1.68x82m SH2	AINO K11 1.68x82m SH2		
L44302	FILTER CLOTH AINO T50 1.05x57m SH1	AINO T50 1.05x57m SH1		
PA70525/10	FILTER CLOTH			
F621741	FILTER CLOTH			
NL32570	FILTER CLOTH			
L59625	FILTER CLOTH AINO T50 1.05x59m SH2	AINO T50 1.05x59m SH2		
L26432	FILTER CLOTH			
PA50657	FILTER CLOTH			
H1801695	OVERHANG CLOTH 1200 KT25	1200 KT25		
PA61538	FILTER CLOTH 1340x20800 MM	1340x20800 MM		
NF614657-2	FILTER CLOTH			
L18707	CLOTH			
L67174	FILTER CLOTH ARTO S11 1.5x24.3M SH15	ARTO S11 1.5x24.3M SH15		
PA52628	FILTER CLOTH			
L19133	FILTER CLOTH			
3495	CLOTH			
L51382	FILTER CLOTH			
NF614657-4	FILTER CLOTH			
PA52717	FILTER CLOTH			
F644748/M1098	FILTER CLOTH AINO K13 1.05x(3+33+23m)	AINO K13 1.05x(3+33+23m)		
NF614657-3	FILTER CLOTH			
PA27207	FILTER CLOTH			
L53460	FILTER CLOTH AINO T51 1.7x128m SH3	AINO T51 1.7x128m SH3		
H1837376	OVERHANG CLOTH			
H2545267	OVERHANG CLOTH 1200 JF 4350	1200 JF 4350		
L53774	FILTER CLOTH AINO K16 0.45x0.45m	AINO K16 0.45x0.45m		
PA60604	CLOTH DRIVE UNIT 2,2kW	2,2kW		
L27107	FILTER CLOTH			

Item Number	Main Description	Sales Description Free Text	Technical Description 1	Technical Description 2
F609385	OVERHANG CLOTH		[redacted]	
L03630	CLOTH			
H1287101	BARREL NECK CLOTH			
PA58331	FILTER CLOTH			
F003700	FILTER CLOTH			
L50021	FILTER CLOTH OUTOTEC FPC201 D188MM	OUTOTEC FPC201 D188MM		
7008	CLOTH			
PA27082	FILTER CLOTH			
L00189	CLOTH 1.7x57 UPPER AUX. CLOTH	1.7x57 UPPER AUX. CLOTH		
H2089712	OVERHANG CLOTH 1200 JF4102 / PP PROPEX 1	1200 JF4102 / PP PROPEX 1		
PA56906	CLOTH DRIVE UNIT			
H2130078	OVERHANG CLOTH			
L54893	FILTER CLOTH AINO K14 1.26x60.5m	AINO K14 1.26x60.5m		
F003753	OVERHANG CLOTH CD50 P3011TQ	CD50 P3011TQ		
L30292	FILTER CLOTH			
PA53822	FILTER CLOTH			
PA53507	FILTER CLOTH			
L37960	FILTER CLOTH MARE S50 1.5x19.5M SH15	MARE S50 1.5x19.5M SH15		
L40752	FILTER CLOTH AINO K10 1.05x25m SH2	AINO K10 1.05x25m SH2		
PA27085	FILTER CLOTH			
PA61044	FILTER CLOTH			
L34926	FILTER CLOTH ANNE T40 1.05x60.5m SH1	ANNE T40 1.05x60.5m SH1		
L50490	FILTER CLOTH AINO K14 1.7x75m SH1	AINO K14 1.7x75m SH1		
L55461	FILTER CLOTH AINO T71 1.05x60.5 SH1	AINO T71 1.05x60.5 SH1		
L33733	FILTER CLOTH AINO K10 0.86x57.7m SH2	AINO K10 0.86x57.7m SH2		
F661003	COVER			
L49750	MAINTENANCE CLOTH AINO T31 0.5x158m SH2	AINO T31 0.5x158m SH2		
L43848	FILTER CLOTH ARTO T20 1.4x18 M SH11	ARTO T20 1.4x18 M SH11		
L34876	FILTER CLOTH AINO T30 D85mm	AINO T30 D85mm		

Item Number	Main Description	Sales Description Free Text	Technical Description 1	Technical Description 2
NL09816	FILTER CLOTH		[redacted]	[redacted]
PA56327	FILTER CLOTH		[redacted]	[redacted]
L32466	FILTER CLOTH AINO K10 1.05x51m	AINO K10 1.05x51m	[redacted]	[redacted]
H1084326	OVERHANG CLOTH		[redacted]	[redacted]
NH1814086	FILTER CLOTH		[redacted]	[redacted]
L58866	FILTER CLOTH TFC101 Tubular filter cloth	TFC101 Tubular filter cloth	[redacted]	[redacted]
L51443	FILTER CLOTH AINO T33 1.7x136 m SH1	AINO T33 1.7x136 m SH1	[redacted]	[redacted]
PA900822	FILTER CLOTH		[redacted]	[redacted]
H2543924	OVERHANG CLOTH 1200 CHAMBER PLATE	1200 CHAMBER PLATE	[redacted]	[redacted]
L45578	FILTER CLOTH AINO T70 1.05x13m SH1	AINO T70 1.05x13m SH1	[redacted]	[redacted]
NL32457	FILTER CLOTH		[redacted]	[redacted]
NL32458	FILTER CLOTH		[redacted]	[redacted]
L40110	FILTER CLOTH MARO S92X 2.45x44,5M SH12	MARO S92X 2.45x44,5M SH12	[redacted]	[redacted]
F003585-2	FILTER CLOTH		[redacted]	[redacted]
L52734	FILTER CLOTH AINO K12 1.7x95m SH1	AINO K12 1.7x95m SH1	[redacted]	[redacted]
L39018	FILTER CLOTH MARE S81 1.95x24.8M SH12	MARE S81 1.95x24.8M SH12	[redacted]	[redacted]
PA20726	FILTER CLOTH		[redacted]	[redacted]
PA900312	FILTER CLOTH		[redacted]	[redacted]
PA52765	FILTER CLOTH 1,5x18,5M SH15	1,5x18,5M SH15	[redacted]	[redacted]
L57963	FILTER CLOTH AINO T40 1.7x80 m SH2	AINO T40 1.7x80 m SH2	[redacted]	[redacted]
L32468	FILTER CLOTH AINO K10 1.05x57m SH2	AINO K10 1.05x57m SH2	[redacted]	[redacted]
L33666	FILTER CLOTH ANNE K30 1.05x37m SH1	ANNE K30 1.05x37m SH1	[redacted]	[redacted]
H1790138	FILTER CLOTH		[redacted]	[redacted]
H1135011	OVERHANG CLOTH 630, END PLATE PP2436	630, END PLATE PP2436	[redacted]	[redacted]
L32606	FILTER CLOTH ANNE K30 1.05x69m SH1	ANNE K30 1.05x69m SH1	[redacted]	[redacted]
PA61036	FILTER CLOTH		[redacted]	[redacted]
L35658	FILTER CLOTH		[redacted]	[redacted]
PA61533	FILTER CLOTH		[redacted]	[redacted]
NL32603	FILTER CLOTH		[redacted]	[redacted]

Item Number	Main Description	Sales Description Free Text	Technical Description 1	Technical Description 2
H1530526	OVERHANG CLOTH 1200, HEAD/END PLATE, CD4	1200, HEAD/END PLATE, CD4	[redacted]	
L43525	FILTER CLOTH Outotec ARTO S11 3330x37000	Outotec ARTO S11 3330x37000		
3496	CLOTH			
F013186	FILTER BAG elem 2 VPF550	elem 2 VPF550		
L33216	FILTER CLOTH AINO T30 1.05x37.5m SH1	AINO T30 1.05x37.5m SH1		
L39684	FILTER BELT Outotec AINO T30 1.025x65.5	Outotec AINO T30 1.025x65.5		
L01877	CLOTH			
L43140	FILTER CLOTH 1,7m x 148m PF test cloth	1,7m x 148m PF test cloth		
NL32199	FILTER CLOTH			
L44157	FILTER CLOTH AINO T31 1.7x110m SH1	AINO T31 1.7x110m SH1		
L55858	FILTER CLOTH AINO T30 1.05x48.5m SH1	AINO T30 1.05x48.5m SH1		
H1470343	OVERHANG CLOTH 630 2816 PP	630 2816 PP		
H1721091	OVERHANG CLOTH 1200, CHAMBER PLATE, CD40	1200, CHAMBER PLATE, CD40		
H1875640	OVERHANG CLOTH HALF 1500 JF 4160 PP	HALF 1500 JF 4160 PP		
L32511	FILTER CLOTH AINO K13 1.05x59.4m SH1	AINO K13 1.05x59.4m SH1		
L52908	FILTER CLOTH AINO T50 0.45x1.195m SH1	AINO T50 0.45x1.195m SH1		
L55683	FILTER CLOTH AINO K16 1.05x57m SH2	AINO K16 1.05x57m SH2		
PA62631	FILTER CLOTH			
L40128	FILTER CLOTH AINO T33 1.7x138 m SH2	AINO T33 1.7x138 m SH2		
L49876	FILTER CLOTH AINO T31 1.05x25m SH3	AINO T31 1.05x25m SH3		
PA26974	FILTER CLOTH			
L41647	FILTER CLOTH Outotec FPC102 MS CLOTH	Outotec FPC102 MS CLOTH		
H2103968	FILTER CLOTH			