Storage for metal raw material information

Bachelor's Thesis for ABB Oy WA

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Degree Thesis

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Sammandrag:

Vid produktion av el-installationsprodukter behövs det flera olika metalldelar som leder strömmen, som sedan uppnår en viss funktion. Ifall det blir brist på metalldelar, kommer det också att sätta stopp på produktionen av installationsprodukter. Detta examensarbetes mål är att förbättra hanteringen av metallråvaruinformation genom att skapa en förvaringsplats, som är lätt tillgänglig, och har ett intuitivt användargränssnitt. Förvaringsplatsen skapas för cirka 30 till 40 personer på ABB Oy Wiring Accessories. Lättare tillgång till råvaruinformationen möjliggör en snabbare process om ett material behöver ersättas, lösning av orsaken till ett problem i en produkt som skett under kvalitetskontrolleringen, eller vid planering av en ny komponent där råvarans dimensioner samt toleranser beror på maskinen som komponenten tillverkas med. En litteraturöversikt av materialegenskaper, informationshantering, och informationssäkerhet gjordes, samt kvalitativ studie i form av intervjuer med personal från ABB Oy WA, och från Busch-Jaeger Elektro GmbH. Målet med intervjuerna var att bygga en grundläggande uppfattning för vilken råmaterialinformation ska inkluderas i det nya systemet. Nya råvaruinformationslagret skapades, med information om råvaror som anseddes vara relevanta för företagets användning. Som informationsförvaringsplats valdes SharePoint, eftersom det finns flera metoder att hantera informationen, samt integrera en lista med flera olika program. Listan från SharePoint integrerades till Power BI, där en rapport med flera val för filtrering var skapad. Power BI rapporten skapades av en anställd med tidigare erfarenhet med programmering av Power BI rapporter. Rapporten är var de anställda kommer huvudsakligen att använda för att hitta metallråvaruinformationen. Resultaten från informationssöknings testen, där deltagarna begärdes att hitta information på råvaran av en metalldel med gamla metoderna och sedan från den nya förvaringsplatsen, visade en 20% framgångsfrekvens för det gamla, och 100% framgångsfrekvens för det nya metoderna. Slutsatserna var att det nya metallråvaruinformation förvaringsplatsen har nått examensarbetets mål, ifall den på lyckat sätt integreras på arbetsplatsen, samt uteslutna råvaruinformationen och förbättringarna till filtreringsfunktionerna är tillagda.

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Abstract:

In the production of wiring accessories, multiple metal components are used in the product to conduct electricity to achieve a certain function. Poor availability of compatible raw materials leads to reduced production of essential metal components. The goal for the thesis is to improve the management and available information about the raw materials, by creating a new metal raw material information storage that is easily accessible with an intuitive user interface. The new storage will be created for approximately 30 to 40 employees at ABB Oy Wiring Accessories-department. The access to such information allows for a faster process if a material needs to be replaced, solving a problem that has occurred to the product during the quality test phase, or during the design phase of a new modification to a component, when dimensions of the raw material need to be considered depending on the machinery that produces the component. A literature review of material properties, information management, and information security was done, along with a qualitative study in the form of interviews with personnel from different departments in the company, and from Busch-Jaeger Elektro GmbH. The objective of the interviews was to build a foundational level of understanding on what raw material information was needed for the new system. The information was deducted and modified to fit company needs and the new raw material information storage was created. The platform was chosen to be SharePoint, where information can be easily added and there are multiple ways to manipulate the information. The SharePoint list was integrated to Power BI to create a report where the information will mainly be presented to the employees. The Power BI report was created by an employee with previous experience with creating reports with the software and was instructed on the design choices for the report layout. The results from testing and comparing the old methods of metal raw material retrieval to the new showed that the participants performed better with the new system, with a success rate of 100% to find the requested information, compared to 20% success rate with the old methods. A successful information retrieval was defined by finding the information without the need for help. It was concluded that the new raw material information storage achieved the goal of the thesis, if it is successfully integrated in the company, and the rest of the excluded raw material information along with improvements for filter options are included.

Keywords:	Raw material storage, Metals, Manufacturing processes, Procurement
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Abbreviations

ABB	ASEA Brown Boveri
ANSI	American National Standards Insitute
ASEA	Allmänna Svenska Elektriska Aktiebolaget
BJE	Busch-Jaeger Elektro GmbH
DBMS	Database Management System
DIN	Deutsches Institut für Normung
GPa	Giga Pascal
HSEQ	Health, Security, Environment and Quality
IA	Information Architecture
IACS	International Annealed Copper Standard
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
ITU	International Telecommunication Union
M	Minute(s)
MPa	Mega Pascal
MRP	Material Requirement Profile
NIST	National Institute of Standards and Technology
PRP	Process Requirement Profile
R&D	Research and Development
RM	Raaka-aine Metalli
S	Second(s)
SFS	Suomen Standardisoimisliitto
UTS	Ultimate Tensile Strength
WA	Wiring Accessories
WSC	World Standards Cooperation

1 INTRODUCTION

This bachelor's thesis was commissioned by, and made for, ABB Oy, Wiring Accessories. The scope is to create a new user-friendly storage for the metal raw materials information, used in the metal components in the company's wiring accessory products. This chapter will introduce the problem, the study programme relevancy, and the objectives for the thesis work.

1.1 About the commissioning company

The company formed in 1987 when Swedish ASEA and Swiss Brown, Boveri & Cie merged to become ASEA Brown Boveri, or ABB. The company employs about 105,000 people in over 100 countries. The business areas of the company are electronic devices, drives and motors, process automation, and robotics. (ABB, 2022)

The ABB Wiring Accessories business unit manufactures and markets electrical installation accessories for the Nordic, and central European countries.

1.2 Defining the problem

Metal components are a crucial part for electrical installation accessories, as it is through them that the electricity travels to perform a certain function. The metal components are made from different raw materials, depending on what the component was designed to do. Following an incident that resulted in damaged metal raw materials, the insufficient information available on the specifications of the raw materials, and only a few people knowing where to find the information, led to complications to acquire new raw materials for metal component production at ABB Oy WA.

This thesis work will focus on finding out the essential material information and creating an intuitive and user-friendly storage for metal raw material information which includes all that information easily accessible for everyone in the company. The storage will be created in the form of a SharePoint list, and presented in a Power BI report, which is created together with an employee with previous experience with programming Power BI

reports. The programmer will be provided with instructions on the design of the layout for the information retrieval report. The report will be used by approximately 30 to 40 employees in the ABB Oy Wiring Accessories department.

The goal of creating the new information storage is to minimize the required time to find a possible replacement material if new complications were to emerge regarding the flow of raw material supply. The accessibility to such information is also useful for designing processes when the raw material dimensions are essential to know depending on the machinery used for the manufacturing process of the new designed product. Furthermore, finding the material specifications leads to faster diagnosing of a faulty product during the quality assurance process.

1.3 Objectives

The aim of the thesis is to create an accessible storage for the information about the metal raw materials used in the metal components at ABB Oy WA-department, with a user-friendly interface. To reach the goal, the following objectives were set:

1. Assess the current situation for raw material information storing
2. Interview different company departments about what information they find relevant about the raw materials
3. Decide on what information to include in the information storage
4. Create a new user-friendly and intuitive metal raw material retrieval interface
5. Test and score the new system and compare it to the old methods of finding the information

1.4 Study programme relevance to the thesis work

Knowledge about materials and their properties is an important part of this thesis work, where the essential information needs to be identified and added to build a database for general company use. In *Arcada Process- och Materialteknik* study programme there are courses like *Material Physics, Material Selection, Manufacturing Processes, and Mechanics of Materials*, which all teach relevant information to handle a thesis work related

to managing information on materials. A topic of data management is of high relevancy in a company environment, as updated and reliable data leads to the company being able to make decisions quicker with a smaller chance of errors.

2 LITERATURE REVIEW

2.1 Material properties

Different materials have different properties, and the properties determine how the materials react and behave in certain conditions. The properties determine how the product can be manufactured, what tools are needed to work with the material, what dimensions are possible to make with it, is the material durable enough for what the product is assigned to do. (Singh & Dwivedi, 2009, p. 1)

2.1.1 Ultimate tensile strength

A materials tensile strength is measured by performing a tensile test on a test specimen made from the material. The tensile test specimen is loaded with a force, and through software, a line graph with a relation between stress and strain is drawn, where different material characteristics can be determined. By performing a tensile test, one can also determine other properties of the material, i.e., the elastic modulus, elongation, yield point, and yield strength (*see Figure 1*). (Iowa State University Center for Nondestructive Evaluation, 2021)

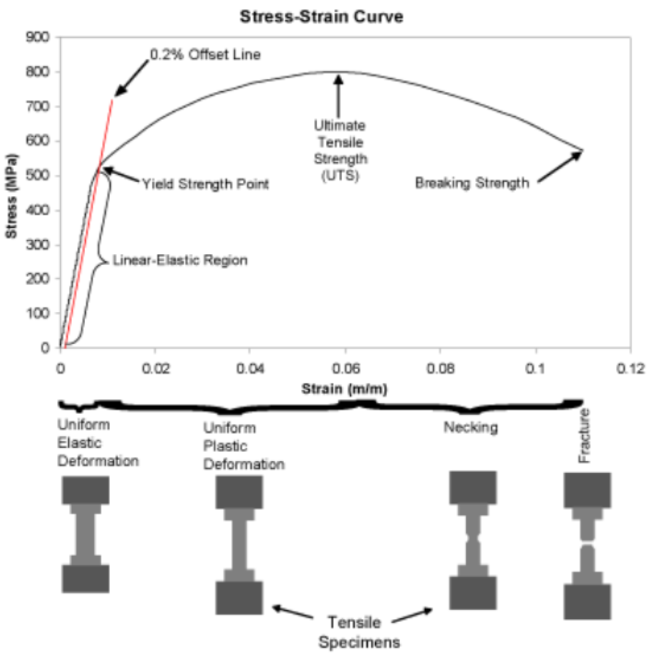

Figure 1: A stress-strain curve, showing where certain material properties are found during a tensile test. (Iowa State University Center for Nondestructive Evaluation, 2021)

A materials UTS shows how much force or stress the material can withstand before breaking. The commonly used unit for UTS is MPa (N/mm^2). The UTS tends to be right after the linear-elastic region when the material is brittle, and for ductile materials, it usually resides in the plastic deformation part of the curve.

2.1.2 Yield strength

Yield strength, or sometimes referred to as yield point, is the point at which a material is under so much stress that it will be plastically deformed. Plastic deformation is when the material cannot return to its original state once the force is removed. For brittle materials the plastic deformation can be non-existent or very minimal, due to the material breaking very quickly after it has reached the end of linear elasticity (*see Figure 2*).

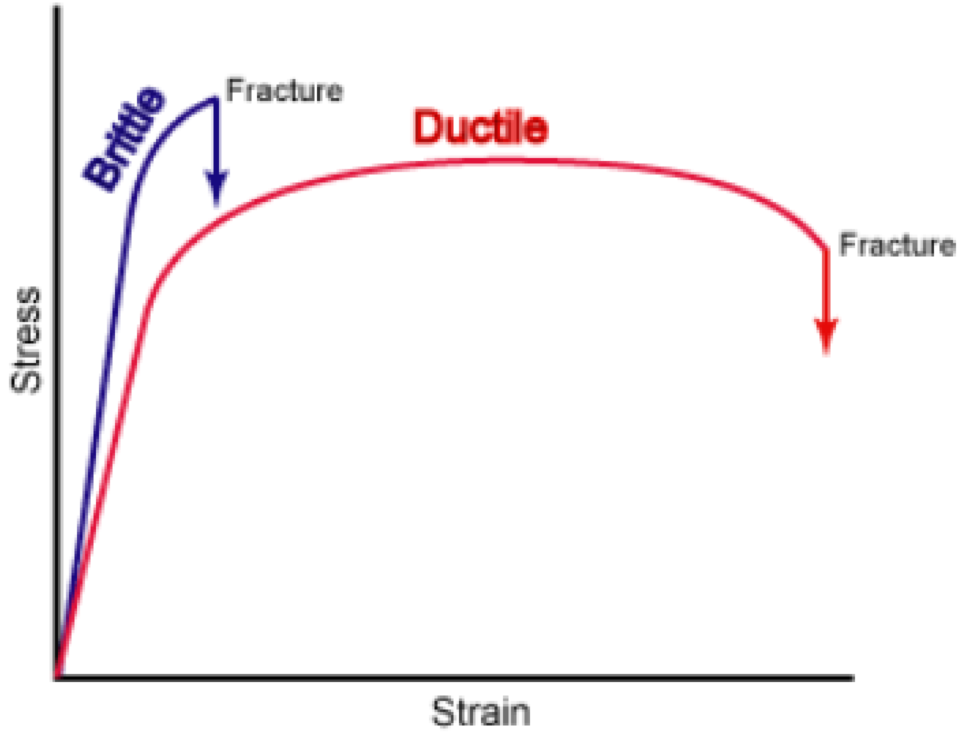

Figure 2: A stress-strain curve, showing the difference in behaviour during a tensile test, between a brittle and ductile material. (Iowa State University Center for Nondestructive Evaluation, 2021)

Because of the gradual transition from elastic to plastic in most materials, the yield point is often determined by the method of offset yield strength. It is done by drawing a line, parallel to the linear-elastic region, offset by 0.2% on the x-axis. The yield point is where

the offset line and the curve meet, which can be seen in *Figure 1* where the red line is the 0.2% offset line. (Iowa State University Center for Nondestructive Evaluation, 2021)

2.1.3 Strain

When a material is being loaded with a force, a stress is being applied to it, and the material deforms. If a tensile force is applied to a copper rod, the rod will deform. By dividing the amount of deformation, in the direction of the applied force, with the copper rods original length, we get a unitless number known as strain. An example of this is seen in *Figure 3*. (Iowa State University Center for Nondestructive Evaluation, 2021)

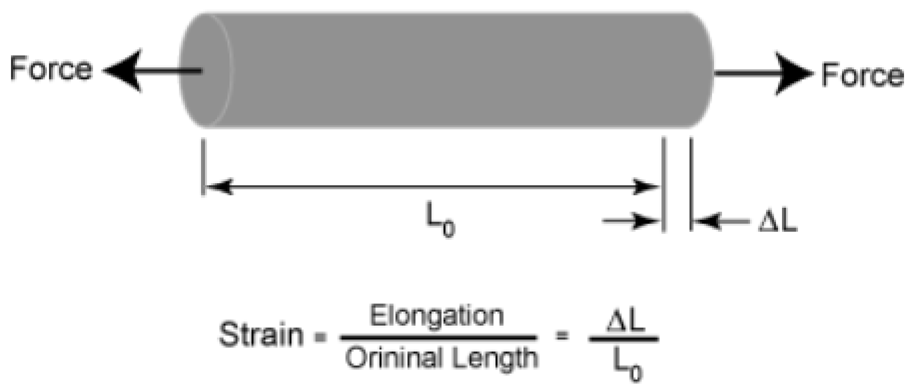

Figure 3: Example of calculating the strain. (Iowa State University Center for Nondestructive Evaluation, 2021)

2.1.4 Young's modulus

The linear region seen in the beginning of the stress-strain curve in *Figure 2,* can be defined with Hooke's Law:

$E = \frac{\sigma}{\varepsilon}$ (Iowa State University Center for Nondestructive Evaluation, 2021)

E is the modulus of elasticity (MPa)
σ is the stress in the test specimen under a certain force load (MPa)
ε is the strain measured in the test specimen at the measured stress (% elongation)

Modulus of elasticity, also known as Young’s modulus, is a measure of a material stiffness, when the material is stretched with tensile force. Because strain is a unitless value, the modulus has the same unit as stress, MPa, usually given as GPa to differentiate between stress and modulus. (Iowa State University Center for Nondestructive Evaluation, 2021)

2.1.5 Hardness

Hardness measures the materials ability to resist deformation. In metals, this deformation is plastic deformation of the surface. Hardness is considered a composite property rather than a basic one, due to there being many factors such as, yield strength, modulus, and tensile strength, that the hardness relies on.

There are many different types of tests to measure hardness, but the most used ones are Rockwell, Brinell, Vickers, and Knoop hardness tests.
All four of them use an indenter, and from the resulting indentation a value from each tests own scaling system is given.

In the Rockwell test a machine is used to apply a specific load with either a steel ball with differing diameters, or a cone shaped indenter with a 120° angle, 0.2 mm radius, diamond tip. The choice of indenter depends on what scale is used, which in turn depends on what material is being tested. The machine applies a load, and releases it, then the machine takes a depth reading and the hardness number can be read from the scale. If a material is specified to have a hardness of 65 HRC, it means that the material has a hardness reading of 65 on the C-scale. (Iowa State University Center for Nondestructive Evaluation, 2021)

Brinell is the oldest test method in common use today, mostly on metal forgings and castings. It is measured by making an indentation on the materials surface with a specified load, then dividing the load, in kilograms, by the surface area, in mm^2, of the indentation. In the US, a 3000 kg force and a 10 mm diameter ball are commonly used for iron and steel castings. For aluminium the load is reduced to 1500 kg. With copper and brass it is further lowered to 500 kg with a 5/10 mm ball. When a material is specified to have a hardness of 35 HB 5/500/30, it means that the hardness was measured to be of the Brinell

hardness 35 with a 5 mm ball under a 500 kg load for 30 seconds. (Iowa State University Center for Nondestructive Evaluation, 2021)

Vickers test method is a modified version of the Brinell method, where the indentation is made with a pyramid shaped indenter. The indent is much smaller, which requires the measurement to be taken under microscope. Measurements are taken from the diagonals of the indent that is left by the pyramidic square shape, and the Vickers Hardness Number (VHN) can be read from a table or chart. The loads that are applied to create the indentation range from 10 g to 1000 g.

The Knoop test method differs from the Vickers method by the shape of the indenter, where in the Knoop method the pyramid is of a rhombic shape with a diagonal ratio of 7.114:1, rather than a square. When a materials hardness is expressed as either 2000 HV 75, or 2000 HK 75 for Knoop's hardness, it reads that the Vickers or Knoop's hardness number is 2000 under a 75g load. (Iowa State University Center for Nondestructive Evaluation, 2021)

2.1.6 Electrical resistivity and conductivity

Electrical resistivity is the constant which expresses a materials ability to resist conductivity. The resistivity of a material is not to be confused with resistance of a material with certain geometrical dimensions, i.e., Copper has its own intrinsic resistivity, while a copper wire will have a different resistance depending on the length and thickness of the wire. Resistivity has the unit ohm-meter ($\Omega * m$).
Electrical resistivity can be expressed as:

$$\rho = R\frac{A}{l}$$

(Lowrie, 2007, p. 254)

R is the electrical resistance of the specimen (ohm)
A is the specimen's cross-sectional area (mm^2)
l is the specimen's length (mm)

The typical conductivity in metals is called electronic conduction. In copper, the free electrons travel at an average speed of $1.6 * 10^5\ ms^{-1}$, but when an electric field is applied, they travel much slower at $4 * 10^{-5}\ ms^{-1}$ in the direction of the applied electric field. The mean free time between electron collisions determines the electrical resistivity of the material, the more frequent the collisions happen, the higher the resistivity. (Lowrie, 2007, p. 254)

The conductivity of a material can be expressed as the inverse of the resistivity: $\sigma = \frac{1}{\rho}$

σ is the electrical conductivity ($\Omega^{-1} * m^{-1}$).

ρ is the resistivity ($\Omega * m$)

The unit of conductivity is likewise the inverse of ohm-meter ($\Omega^{-1} * m^{-1}$). (Lowrie, 2007, p. 254)

2.1.7 Thermal conductivity

Thermal conductivity is the materials ability to conduct heat. When higher energy molecules collide with lower energy molecules, the energy is transferred to the less energetic ones. Higher temperatures mean that the molecular movement is higher, equating to higher molecular energy. This means that conductive heat moves in the direction of lower temperatures withing the solid object or stationary fluid.

Thermal conductivity can be expressed as:

$$\lambda = \frac{Q * L}{A * \Delta T}$$

Q is the transmitted quantity of heat (J)

L is the length of the specimen in the direction where heat travels (mm)

A is the cross-sectional area of the specimen (mm^2)

ΔT is the heat gradient of the specimen in steady state conditions (°K)

(Iowa State University Center for Nondestructive Evaluation, 2021)

2.1.8 International Annealed Copper Standard (IACS)

IACS was adopted by the Electrotechnical Commission in 1914. The standard defines 100% IACS, or coppers conductivity to be $58.2\frac{MS}{m}$(Mega Siemens per meter). Despite the specific conductivity being defined as 100%, modern processing methods can produce copper with 103% IACS. The conductivity of silver is 108% IACS. (Materion Brush Inc., 2017)

2.2 Metals used in electrical wiring accessories

Materials are classified into three different categories according to the ease of which they conduct an electric current: Conductors, semi-conductors, and insulators. Metals, such as copper, silver gold, aluminium, iron, and nickel, belong to the category of conductors. A common trait for metals is that they have less than a half from 8 possible electrons in the atoms outer orbit, which makes the metals good at conducting electricity.
(Kakani & Kakani, 2004)

2.2.1 Copper

Copper has historically been used to make beads presumed ten thousand years old in northern Iraq, making bells in China, and after discovery of its alloy together with tin, bronze had been used to make cutlery, coins, and tools.
Nowadays copper is widely used for electrical wiring and motors, due to its ability to conduct electricity and heat and easy workability. (Royal Society of Chemistry, 2022)

2.2.2 Tin

The main use of tin historically was to alloy it with copper to make bronze. Adding 5% tin into the alloy lowered the melting temperature of the metal, and increased its hardness, which made it optimal for creating tools and weapons.
Modern day usage of tin are alloys like soft solder, bronze, and phosphor bronze. Most commonly it is used as a coating for other metals to prevent corrosion, and to give a high polished surface finish. Tin cans are made of steel coated with a tin layer. (Royal Society of Chemistry, 2022)

2.2.3 Silver

Silver has historically been used for jewellery, and silverware, due to its characteristically shiny appearance, as well as the materials capability to resist corrosion and oxidation. (Ferré, 2022)

Silver has the IACS value of 105%, meaning that it conducts electricity 5% more efficiently than copper, specified by the IACS standard. (Blue Sea Systems, 2002) This makes silver a great choice for electronics like circuit boards, or electrical contacts in light switches. To achieve the best possible electrical conductivity, the silver needs to be 99.99% pure. (University of Calgary, 2016)

2.2.4 Gold

Gold is commonly known to be used in jewellery. The gold used in jewellery can be pure gold, or an alloy of gold. Pure gold is notated as 24 karats, and if the gold is alloyed it can be notated as low as 10 karats, meaning that it has a gold content of 41.7%. (World Gold Council, 2022)

Gold has a IACS conductivity of 70%, meaning that it is 70% as conductive as copper. (Blue Sea Systems, 2002) Despite the lower electrical conductivity compared to copper and silver, and the higher price of gold, it is still often used because of its excellent corrosion and oxidation resistance. The resistive capabilities also exceed that of silver, as silver will start to oxidize at the smallest trace of sulphide in the atmosphere. (Goodman, 2002)

In closed connectors, the localised heating caused by voltage and contact pressure can lead to surface oxidation in the metallic connector pin. This is not the case if gold was used, as it would resist the oxidation.

Because gold is so soft, it is preferably not applied to tasks where wear occurs. Gold is the preferred material to use where there is low voltage, low current, and low contact forces. (Goodman, 2002)

With the above stated preferred conditions, the softness, and resistive properties of gold, it can be formed into the most intricate geometries, for example, gold wirings for computer chips to create circuits. (Royal Society of Chemistry, 2022)

2.2.5 Brass

Brass is an alloy of copper and zinc, where the copper concentration ranges from 55% to 95% by weight, and zinc from 5% to 45%. Brass is anti-corrosive, which make it good for applications in areas that are moist. It is a good electrical conductor and malleable, which is why it is used in electric cables because it can be drawn into wires without breaking. (Sabhadiya, 2022)

2.2.6 Steel

Steel, or carbon steel, is an iron alloy containing 0.02% up to 2.1% carbon. Alloy steels are also iron alloys, but they contain other alloying elements like manganese and chromium. In alloy steels the carbon content can reach 2.5%. When carbon steels reach carbon contents exceeding 2.1%, they are usually classified as cast irons. Stainless steel is a type of alloy steel, with other alloying elements, usually a chromium content of 10.5-18% for martensitic stainless steels, and 10.5-30% in ferritic stainless steels. (Cobb, 2012, p. 216 & 219)

With the wide range of different steel alloys that are available, it is fair to say that steel is a diverse alloy, meaning that the steel used for springs will be very different from the steel that might be used for structures, like bridges.

2.3 Manufacturing processes of metal articles

2.3.1 Material selection

When a product is designed, there is a lot to think about as to what material or materials the product will be created from. Depending on the task the product is made for, the material might need to have certain properties so that it can perform the task without any

type of mechanical failure, degradation, or safety hazard. Sometimes the material can perform every task as intended, but there can also be a more cost-effective material that could be more suitable for the product. (Ashby, 2005, p. 42)

2.3.2 Metal forming

Metal forming is the process of which the desired shape and size are obtained by plastic deformation under applied forces. Processes like rolling, forging, and drawing are waste-less and highly economical, give high dimensional accuracy, and are easily formable for complex shapes and good surface finishes. (Singh & Dwivedi, 2009, p. 63)

2.3.3 Hot and Cold working

Hot working processes are hot forging, hot rolling, hot spinning, hot drawing, hot pierc-ing, and pipe welding. Hot working a metal is done at a temperature above crystallization but below the metals melting point. The process leaves a poor surface finish due to oxi-dation, but the physical properties, like ductility, resistance to impact are improved, and the material strength is improved. Due to the material scaling, achieving close tolerances is difficult. The process is not suitable for some metals due to their brittleness at high temperatures. (Singh & Dwivedi, 2009, pp. 64-65)

Cold working processes are cold rolling, cold extrusion, and press work i.e., drawing, squeezing, bending, and shearing. The cold working process is done under the materials recrystallization temperature. The process leaves a good surface finish because no surface oxidation is occurring due to the metal being worked in cold temperatures. Because of the good surface finish, greater dimensional accuracy is achieved. A cold worked metal will have an increase in ultimate tensile strength, yield point, and hardness. Cold metals need more force to be worked, meaning that the process is preferably done to produce smaller components. (Singh & Dwivedi, 2009, pp. 65-66)

2.3.4 Press work

Press working is a process of forming where material is cut without making chips. A press consists of a frame that supports a stationary bed, a ram, power source and a mechanism moving the ram at right angles towards the bed. They are also equipped with dies and punches for operations such as forming, punching, and shearing. (Singh & Dwivedi, 2009, p. 91)

2.3.5 Shaping processes

Common shaping processes that are done to metal ingots are casting, forging, cold rolling, metal spinning, and wire drawing. Some processes can finish a product to its usable form by reshaping the metal, like cold rolling, metal spinning and wire drawing. For processes like casting, it requires the ingot to be molten before the liquid metal is cast into a mould to take its final shape. (Singh & Dwivedi, 2009, p. 197)

2.3.6 Galvanizing

Galvanizing is a process mainly used for coating low melting metals like zinc, tin, cadmium, aluminium, or lead, onto metals like iron, steel, and copper. Galvanizing, or hot dip galvanizing, is done by having a metal article cleaned, then dipped into a bath of molten metal, after which the article is finished properly. The process is usually done when coating metals like iron or low carbon steel with zinc, which improves the metals corrosion resistance. The zinc hot dipping process starts with cleaning the metal component with dilute sulphuric acid to remove any scale, rust, and impurities. It is then dipped into a bath of zinc maintained at 400°C. The surface of the bath is covered with a molten flux layer of zinc ammonium chloride to prevent oxidization. The duration of immersion depends on the size of the metal component being coated. Galvanizing is also done to make tin coats, or tinplating. (Singh & Dwivedi, 2009, pp. 245-246)

2.3.7 Electroplating

The electroplating process is a type of galvanisation coating process where one metal is coated with another metal through an electric charge. The metal part which is to be coated is connected to the negative charge of a power source, which makes it the cathode. The metal that will be coated onto the cathode is connected to the positive charge of the power source, which makes it the anode. Both the cathode and anode are placed in an electrolytic solution, with a base depending on which metal will act as the coating. When the current is applied, the electrons from the anode move along the wiring to the cathode, and the positively charged ions that are oxidized from the anode will be attracted to the cathode, which forms the desired coating. The higher the current, the faster the plating progress is, and the longer the process takes, the thicker the coating will become. (Mittal, et al., 2021) An example of electroplating is shown in *Figure 4*.

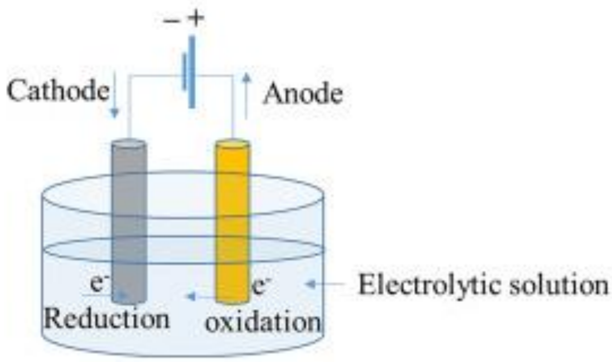

Figure 4: Visual explanation of electroplating. (Mittal, et al., 2021, pp. 119-137)

2.4 Information management

The chapter on information management will focus on the importance of a system for data management and what it brings to a company that strives to upkeep a common place for storing information relevant to the company. The different tools for data management will also be split into different sub-chapters where the main functions will be presented.

2.4.1 Information storage in general

The dependency and need for reliable access to information has increased the need for businesses to have data centres to store and manage information. A data centre is where

businesses store, manage, and perform other computations on the stored information. By virtualizing the information, it eases the management and optimization of resources. (Gnanasundaram & Shrivastava, 2012)

Data can be either unstructured or structured. Structured data is usually organized in rows and columns, while unstructured data comes in the form of e-mails, notes, or digital format files like .txt, and .pdf, and cannot be stored in rows and columns. Having structured data makes it easier for applications to retrieve and process the data. Database management systems (DBMS) are usually used to store structured data. See *Figure 5* for examples of unstructured and structured data. (Gnanasundaram & Shrivastava, 2012)

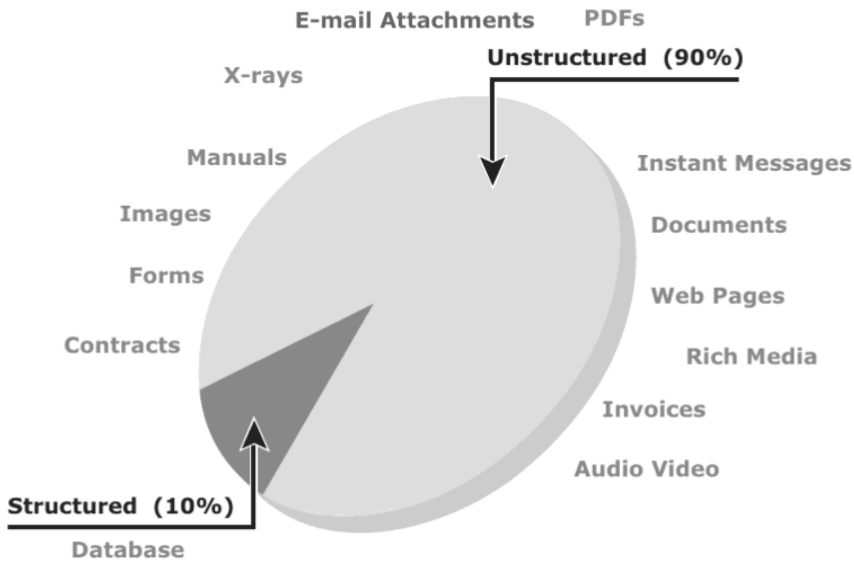

Figure 5: Structured and unstructured data pie chart (Gnanasundaram & Shrivastava, 2012)

2.4.2 Data security

Data security is important to maintain in an organization, with delicate information such as budget, financial reports, business strategies, research, trade secrets and information on their staff. When an unauthorized person gains access to insufficiently secured information, the security has been breached. A security breach can cause serious reputational and financial harm to businesses, involving costly lawsuits and even loss of business. (Ndungu & Kandel, 2015)

For a proper foundation of information security, a company needs to establish a security policy, which describes the employee's responsibilities for protecting company information and company communications. A security policy can be created with the help of a framework, such as a standard for general framework for information security policies. (Ndungu & Kandel, 2015)

A company can further strengthen the information security by controlling and granting certain people access, or to deny them access. Access control protects the company from unauthorized access to intricate information. A person that has been authorized may be granted access to information that is protected by firewall, where in contrast an unauthorized person is denied access. A firewall is a system that controls the unauthorized access to a private network and can be installed in hardware and software. It is a solution for safe data transfer without the need for decryption and re-encryption. (Ndungu & Kandel, 2015)

Encryption is the mathematical function of turning original plaintext into an encrypted unreadable cyphertext. Encryption is used to protect sensitive information from being hacked. When data is encrypted, a decryption key or password is related to the one encrypting the data, which allows only the one with a key or password to decrypt the data back into readable form. (Chen, 2022)

2.4.2.1 The Advanced Encryption Standard (AES) standard

AES is a standard that specifies an algorithm used to protect electronic data. The algorithm is a symmetric block cipher that can encrypt and decrypt information, meaning that it can convert plaintext into ciphertext, and vice-versa. The standard was published by the National Institute of Standards and Technology (NIST). (U.S. Government Publishing Office, 2001)

2.4.3 User interface

A Graphical User Interface is the design of software, applications, websites, and other products based on user experience and interaction. With the design of user interface, the

objective is to create a simple, efficient, and user-friendly interaction, while balancing the usability and appearance of the interface. (Fu, 2012)

A good user interface increases the user's productivity and help them perform tasks more efficiently. Furthermore, a well-designed user interface keeps the user interested, which makes the user keep using the system. By implementing good graphical design to a website, improves the accessibility and transfer of information for the user. (Fu, 2012)

When it comes to a website's appearance, content, and actions, it is referred to as information architecture (IA). IA is used for organizing content in different online resources, to support the usability and findability of the content. It is meant to provide users knowledge of their virtual environment, and find what they are searching for, with the design purpose reaching the balance between the businesses and user's needs. A successful case of IA is properly organized content, and a quick orientation to the website. (Rykanova, 2015)

Usability of a website consists of many different factors, such as intuitive design, ease of learning, memorability, efficiency of use, and error frequency. A website with an intuitive design is where the navigation principles and structure can easily be understood. The memorability refers to the ease of effectively performing the same task on the site in a future visit. Unnecessary information and an interface that is hard to interact with and understand increases the time spent on the site, resulting in the user losing interest in the website. (Rykanova, 2015)

2.4.4 Information management software

2.4.4.1 SAP

SAP software offers companies a centralized data management platform. Centralizing the data lets different departments easily access information of other business functions and leads to less errors in data. (SAP, 2022)

2.4.4.2 Microsoft Excel

Microsoft Excel spreadsheets are used to organize data in a grid of cells and offers various ways to present that data. Excel can perform many different calculations, be it the users own inserted formulas, or functions readily available in the software. (Microsoft, 2022)
Excel is used in ABB Oy WA for quality control templates, where measured values can be inserted, and the template calculates the standard deviation. Personnel also use excel files where they have their own calculations and formulas set up for different work tasks that require them, furthermore the software is used for keeping logs on e.g., quality control.

2.4.4.3 Microsoft SharePoint

SharePoint is a platform where a company can share information among employees. The information can be shared between certain teams and team members, or for the whole department, or with the whole company, by simply accessing the site via browser. All information added to a SharePoint page is saved in a cloud storage. SharePoint can be integrated with other Microsoft software, so one can work with the information stored in SharePoint and i.e., create charts or other visuals with Power BI, or make an automated flow of data with MS Flow. (Microsoft, 2022)
When a file is uploaded to SharePoint, the file is encrypted and sent to Azure storage, Microsoft's cloud-based storage platform. When the file is sent to Azure, a decryption key is created for the customer, which is identified by Azure when the file is downloaded. All uploaded data is encrypted with an AES 256-bit key. (Microsoft, 2022)

2.4.4.4 Microsoft Power BI

Power BI is a data visualization and analytics software, where organizations can analyse data in a customizable visual presentation. It can be used i.e., to show sales reports, and the interface can be interactable and include different filters that help the user to read the data that is relevant to them. (Microsoft, 2022) The software has been used in ABB Oy WA to create presentations for quarterly earnings meetings, such as economic figures.

2.5 Standards

Standards are an important factor to ensure quality in a process or a product, by having a common guideline of actions and quality benchmarks that ensure a good outcome. Standardization is achieved by approval of generally accepted guidelines, for example a process leading for the approval and purchase of new machinery in a factory or ensuring that a material has been tested and complies with the requirements set to a certain material property before it can be approved for sale. (Grant, 2021)

Standards can be made for many different environments like companywide, or just for specific department. Standards can also be set and published by standards organizations, which apply on international level, which makes them international standards. The three largest international standards organizations are International Electrotechnical Commission (IEC), International Organization for Standardization (ISO), International Telecommunication Union (ITU), which all collaborate as the World Standards Cooperation (WSC). (World Standards Cooperation, 2022)

The international standards organizations consist of members from different national standards bodies, for example, ISO consists of 167 members all from different countries. These members take part in developing ISO standards, with the level of influence depending on what membership category they have. Examples of member bodies in ISO are ANSI from the United States, DIN from Germany, and SFS from Finland. These three are full members of ISO, meaning that they can influence the development and strategy of ISO standards by voting at ISO meetings. Furthermore, they adapt and sell ISO standards nationally, as well as translated into their country’s language. (International Organization for Standardization, 2022)

3 METHOD

In the method chapter of this thesis the steps to create a functioning database of material data will be researched. The chapter will be divided into sections for different stages of the database building process.

The first section discusses the method of figuring out what the current situation of finding the relevant data looks like. Afterwards, the discussion leads to deciding what material data is relevant to keep in the information storage, along with decisions on what platform the information storage will be made. The relevant data is determined by multiple interviews with co-workers and interviews with material suppliers.

3.1 Assessing and planning for the new database

3.1.1 The current state of material data acquisition

To improve the availability of raw material information, the current situation and method of acquiring relevant material data needs to be assessed. The old and the new method can be evaluated afterwards, to have a way of telling if the new system has been an improvement.

Assessment will be done through a qualitative research method of interviewing the people whom the use of material data is most relevant to. This includes the workers from the procurement, Research & Development (R&D), Health, Security, Environment & Quality (HSEQ), and engineering departments at ABB Oy Wiring Accessories.

From what was gathered from an interview with the person managing material information, the way to find raw material data was through SAP. To properly use SAP the user needs to have certain rights assigned to them for using certain transaction codes. This alone creates a layer of difficulty for some people to acquire the data when needed. Through product structure data, one can find the drawings of products, which have included the material name in the form of for example, *CuZn37 F54; 0.9mm*, which tells that it is made of brass with the temper F54, which is the temper value given by the

supplier, and the 0.9 mm is the thickness of the material. When searching further in the product structure page, the material code for the material given by ABB Oy WA can be found. The codes follow the naming logic of RM which stands for “Raaka-aine Metalli” (Raw material Metal), followed by initials of the material in Finnish. Listed below in the table are the codes used by ABB for the metal raw materials:

Table 1:The logic behind naming the raw material codes.

Raw Material Code	Material name in Finnish	Material description in English
RMA	Alumiini	Aluminium
RMH	Hopea	Silver
RMK	Kupari	Copper
RMKT	Kupari Tinattu	Tin plated copper
RMM	Messinki	Brass
RMMT	Messinki Tinattu	Tin plated brass
RMP	Pinnoitus	Surface treatment
RMT	Teräs	Steel
RMTJ	Teräs Jousi	Spring steel
RMTK	Teräs Kylmävalssattu	Cold rolled steel
RMTR	Teräs Ruostumaton	Stainless steel
RMTS	Teräs kuumaSinkitty	Hot-dip galvanized steel

The raw materials can have different geometries, like some might have a different thickness and temper, which is why the codes are also further differentiated by numbering them, for example, RMMT01 and RMMT02 are both tin plated brass strips, but they have different thicknesses and widths.

The raw material information that was found on SAP is not all the information the company has on raw materials. To find more, one would have to use a list created in SharePoint, where the material certifications can be found. However, depending on the supplier that has handed over the certificates, there is a big variation in the amount of information that they provide.

3.1.2 Interviewing different departments about the company material data needs

Personnel from the different company departments were interviewed multiple times throughout the project because the database will ultimately be used by them, which makes their feedback the most important source for improving the system. After each interview, changes were made, regarding what information should be added into the new system, how the new system would look like and what functions it should include. After the changes, there would be another interview to ask questions about the changes.

The purpose of the first interview was to set a foundation for what information the personnel would like to find from the new system. The need for more technical information about the raw material geometry, like the width, thickness, and the tolerance of these measurements were of common interest to the R&D, HSEQ, and engineering departments. Some metal components are made of multiple different sub-components, a suggestion to have these separately and clearly presented was brought up. HSEQ suggested that information about hazardous materials that the material might include should be included, as well as the emissions from the manufacturing and shipping of the raw material and the product itself, as well as the manufacturing country.

An interview with personnel from Busch-Jaeger Elektro GmbH (BJE) was suggested, to ask them about how they go on about raw material management, and what properties and other information they prioritize to store. When ABB acquired Ensto Busch-Jaeger Oy in 2009, Busch-Jaeger Elektro kept their branding while Ensto became the ABB Oy WA-department. BJE is part of the same corporate group and produces products similar to the ones at the WA-department.

3.1.3 Interview with Busch-Jaeger Elektro GmbH

In the BJE interview, a lot was shown regarding to how their systems were put up for raw material data management. They mainly use SAP for their raw material information, where they have their own codes for material groups, sorting them by geometry, material, and surface treatment. That is an approach that could be worth trying to do at WA, where

the materials could be given SAP transactions where a page for the different properties of the materials are listed.

Besides their SAP material management, two different templates were shown, one was called the material requirement profile (MRP) (See Appendix 1) and the other one processing requirement profile (PRP) (See Appendix 2). These profiles are sent by them to their raw material distributors to fill. The information that needs to be filled in the MRP, are different material properties, surface treatment information, questions about what processes the material can be used for, if it is manufactured in accordance with industrial and environmental safety regulations, and different attachments like technical data sheets and inspection certificates.

The PRP has questions about the materials geometry, if the surface has been degreased, same questions about processability that were asked in the MRP, asking if welding the material is permitted, if it has been flat-rolled, deburred, and if the delivery was done in accordance with BJE's own delivery standards.

3.1.4 Creating the base concept for the new system

After gathering the first bit information from the interviews, the next step was to create the first mock-up of all the information to be included in the new system. With the use of Microsoft Excel a list was created with the material properties that were thought to be useful to include, judging from the material property knowledge presented in the literature review, and what was included in the BJE MRP-template, as well as the material certificates found in the SharePoint list. Additionally, the SAP transaction codes, and the RM codes were added, so that personnel can use either of the codes to identify the material they are looking for.

From the suggested information to be added in the interview, it was decided that for the scope of the thesis, that information such as hazardous materials as well as the production emissions are to be left out for the time being. The raw material dimensions with tolerances were included.

The Excel lists were filled with all the information that could be found in the company systems, from SAP and the SharePoint list. Ten separate Excel files were created, one for each different supplier, with the idea that they would be sent to the suppliers to fill out any missing data. This way one supplier will not have a list filled of other suppliers' products and materials.

3.1.5 Follow-up interview about the included information

An interview was set up with the company departments, where updates were presented on what information were decided on including in the system, and to question if the most important information for the departments were included. The procurement department thought the most important information for them was the supplier product names and codes. Both R&D and HSEQ departments thought most of the mechanical properties, raw material dimensions and tolerances, and standards are a must have, as well as the supplier product codes.

R&D suggested adding a column for the hazardous materials, which will be added in the future. Properties such as, electrical conductivity, specific electric resistance, thermal conductivity, elastic modulus, and elastic limit, were considered by HSEQ to be of less importance, and they can be tested in the laboratory if they are needed. For that reason, and because the information on those properties was also mostly not found for the materials, the columns with those properties were removed. The information that was decided on to keep in the new storage can be seen in *Appendix 4*.

3.2 Creating the new raw material information system

To make the raw material information more available to anyone who will need it, the new system needs to be added to a platform that everyone can easily access. Because the company is beginning to transfer into using SharePoint for sharing information across the company, it was decided that the information would be added there. It is simple to create a list in SharePoint and to add more information into the list. Rights to edit the list can also be added to people with more knowledge about the materials, and rights for viewing

purposes only can be given to the rest of the personnel. Adding attachments like material certificates, technical data sheets, and standard documents are a possibility in SharePoint.

Because of the different Microsoft integrations that are possible via SharePoint, one can make automated flows to extract the information from the into a material card, which can be used to send specifications of a raw material to use in a component to a supplier.

The filtering functions on SharePoint do not quite meet the expectations of what would be needed for the system. It offers no real accurate number filtration where one can choose to show a range of different tensile strengths, or a range of thicknesses for the material. The solution was to create a report on Power BI of the SharePoint list, which allows for better customization regarding filtering, and the report can also be more easily shared to different platforms for others to use. The Power BI report was created by an employee with previous experience in programming Power BI reports, and they were provided with instruction on the design for the report layout.

In addition, another list was created where all the components and sub-components that are produced from the raw materials in the list are related to the raw material SAP codes. This allows there to be a relation made between the 2 lists in Power BI, by relating them by the SAP codes included in both lists. This way the user can filter by components and sub-components, to find any raw material information related to the component.

4 RESULTS

The results and relation of the research done for the literature review will be presented in the following chapters. The new system will be presented, demonstrating the different functions that are available. Test results from the different personnel using the old system to find raw material information will be presented, to justify the creation of the new system.

4.1 The resulting new raw material information storage

The new system for material information includes information relevant to manufacturing of metal components for electronic equipment. The main information storage in SharePoint, where the information can be manipulated with different programs that are integrated with the platform. This allows the information to be presented in the form of a filterable Power BI report. The raw material information can be filtered through text field, by sliders where a range of measurements can be filtered, or by filtering selection boxes which include the metal components, standards, alloy, and metal names, as well as raw material geometry. The layout of the report is as seen in *Figure 6*.

Figure 6: The layout of the new raw material information storage.

4.1.1 The filtering capabilities

To assure the user finds the information they are looking for it is important to have filtration options for multiple possible keywords or codes. The user can know the SAP code for a component or raw material, but not the company given component code or RM code. The table seen in *Figure 6* shows the materials and their properties, and other material information that were gathered. When filtered, it shows only the materials that match the filter option.

Filtering with a type of metal allows the user to compare the different alloys used in the company. It is useful when material replacements are considered, letting the user compare the properties if another one is similar and suitable to use. The material standards let the user find similar materials outside the company raw material system if comparable materials are not used in the company.

Having the supplier product codes and names let the user easily draw reference to the material, when contacting a supplier about a certain material. That way, the supplier can instantly find the material from their systems, for more efficient communication.

4.1.2 Updating the information in the new system

Because of the integration capabilities in SharePoint, new information can be added in bulk. The list can be generated into an Excel sheet to keep the same formation and columns as the SharePoint list, where the user can fill in missing information, or add new information in the cells under the right columns. The new addition in the Excel sheet can then be generated back into SharePoint, and into the Power BI report. This function is useful for purposes like sending a sheet to a supplier to fill in the requested information.

Information can also be added in SharePoint, by adding a new item to the list. If the added information is for the already existing columns, no further changed are needed for the Power BI report, as the relations are already created for every item in the columns. If another column for new material information, it requires changes in the report.

4.2 Raw material information retrieval tests with personnel

4.2.1 Tests with the means of the old system

The testing was done with 5 people, 2 from the procurement, 2 from the R&D and 1 from the HSEQ department. They were asked to find the width and the width tolerance of the raw material of a metal component. Each person was allowed to use any method they found suitable for finding the information and were also asked to instantly tell if they would ask for help from someone else.

The primary criterion for the test was if the person needed to ask someone for help to find the information. This can greatly impact the time to find the information needed depending on who it is asked from, if the person that is asked themself knows the information or where it is found, or if the person asked is available at the time of asking.

Table 2: Reasons for asking for help during the test

Occurrences of asking for help during the test				
Person 1	Person 2	Person 3	Person 4	Person 5
Was helped to find the raw material name.	Location of the raw material information.	Location of the raw material information.	Location of the raw material information.	
Location of the raw material information.	Guided to find the RM code for the raw material.			
Guided to find the RM code for the raw material.				

Person 1 was from the procurement department. They used the first 69 seconds (s) finding the raw material name but was unable to find it without help. They said specifically that they would ask help from someone in the HSEQ department. Person 1 asked where the information was located and was guided to the SharePoint list where it could be found.

After 143 seconds of searching for the information in the SharePoint list, they asked for help. They were asked to find the RM code of the material, which would then help them find it in the list. After 90 seconds the raw material information was found. Person 1 asked for help a total of 3 times and spent a total of 302 s, or 5 minutes (m) and 2 s looking for the information.

Person 2 found the raw material name in the metal components drawing after 53 seconds. They asked where the raw material information could be found, after which they were guided to the SharePoint list. After searching for the raw material in the SharePoint list, they asked help again, and were guided to find out the RM code of the material. The material was found after 240 seconds, and the requested information was found 47 seconds after. Person 2 asked for help a total of 2 times and spent a total of 340 s, or 5 m 40 s looking for the information.

Person 3 found the RM code of the raw material in 51 s. They spent 166 s looking for the requested raw material information until they asked for help. They were guided to the SharePoint list, where they were able to find the information after 64 s. Person 3 asked for help 1 time and spent a total of 281 s, or 4 m 41 s looking for the information.

Person 4 found the RM code of the raw material in 74 s. After 94 s of looking for the requested information, they asked for help. They were guided to the SharePoint list, where they took 110 s to find the raw material information. Person 4 asked for help 1 time and spent a total of 278 s, or 4 m 48 s looking for the information.

Person 5 was the only person who found the requested information without help. It took them 54 s to find the raw material name, 80 s to find the RM code, and 192 s to find the raw material information. Person 5 spent a total of 326 s, or 5 m 26 s looking for the information.

Help was asked on average:

$$\frac{3+2+1+1+0}{5} = 1.4\ times$$

The average time spent finding the information, without calculating the potential additional time from waiting for help, was:

$$\frac{302s + 340s + 281s + 278s + 326s}{5} = 305.4\ s\ (5\ m\ 5.4\ s)$$

1 out of 5 people were able to find the information on their own. By the means of the old system, there is a $\frac{1}{5} = 0.2 = 20\%$ success rate at finding the required raw material information. Out of the 5 people tested, only person 5 had prior knowledge of the SharePoint list.

4.2.2 Presenting the new system

Following the testing of raw material information retrieval by the means of the old system, the new system was presented to the test participants. They were requested to find the same raw material information used in the metal components from the new system presented in Figure 6.

Person 1 found the information after 14 s, by using the filtration for RM code.

Person 2 found the information after 58 s. They approached the test as if no prior knowledge of the RM code was still known and filtrated by the component code and found the RM code from the list connecting raw materials to the components and subcomponents.

With person 3, 4, and 5 there was difficulties with the viewing rights of the Power BI report, so the testing had to be done by the means of video sharing. Each person was asked what their path through filtration to the raw material information would be, and their instructions were followed through video sharing.

Person 3 found the information in 25 s. They filtered by choosing the sub-component, and then by RM code when it was found to be connected to the sub-component.

Person 4 found the information in 30 s. The information was found by filtering the subcomponent and then by RM code that was related to the sub-component.

Person 5 also filtered through the same sub-component to RM code route, and found the information in 21 s.

The average time spent finding the requested raw material information was:

$$\frac{14 + 58 + 25 + 30 + 21}{5} = 29.6\ s$$

The information was found without asking for help. Using the new system to find the requested raw material information has a $\frac{5}{5} = 1 = 100\%$ success rate.

4.2.2.1 Flaws found in the new system

A few problems came up when testing the new system. One problem was that some of the participants did not have access to the Power BI report, which can be solved by granting permissions to every company role that the raw material information is relevant to. The text box filtration was not functioning, likely due to missing relations to a column in the list. It was suggested that both text box filters would be put together into one text box, that can filter by multiple columns and their values.

A filter box containing the components, not only sub-components, should be added. The user might not know the sub-component names that are in the component, which makes filtering by component an important function to include.

4.3 The old and new information retrieval methods

The flow charts of the old and new information retrieval methods are presented in *Figure 7* and *Figure 8* respectively. The most common points where help was asked during the testing of the old methods were at the deviation from "Inspect the product structure tree" to "Find the RM code…", where the participants were advised to find the RM code of the raw material. Right after, guidance was needed to find the SharePoint list with the information about the raw materials.

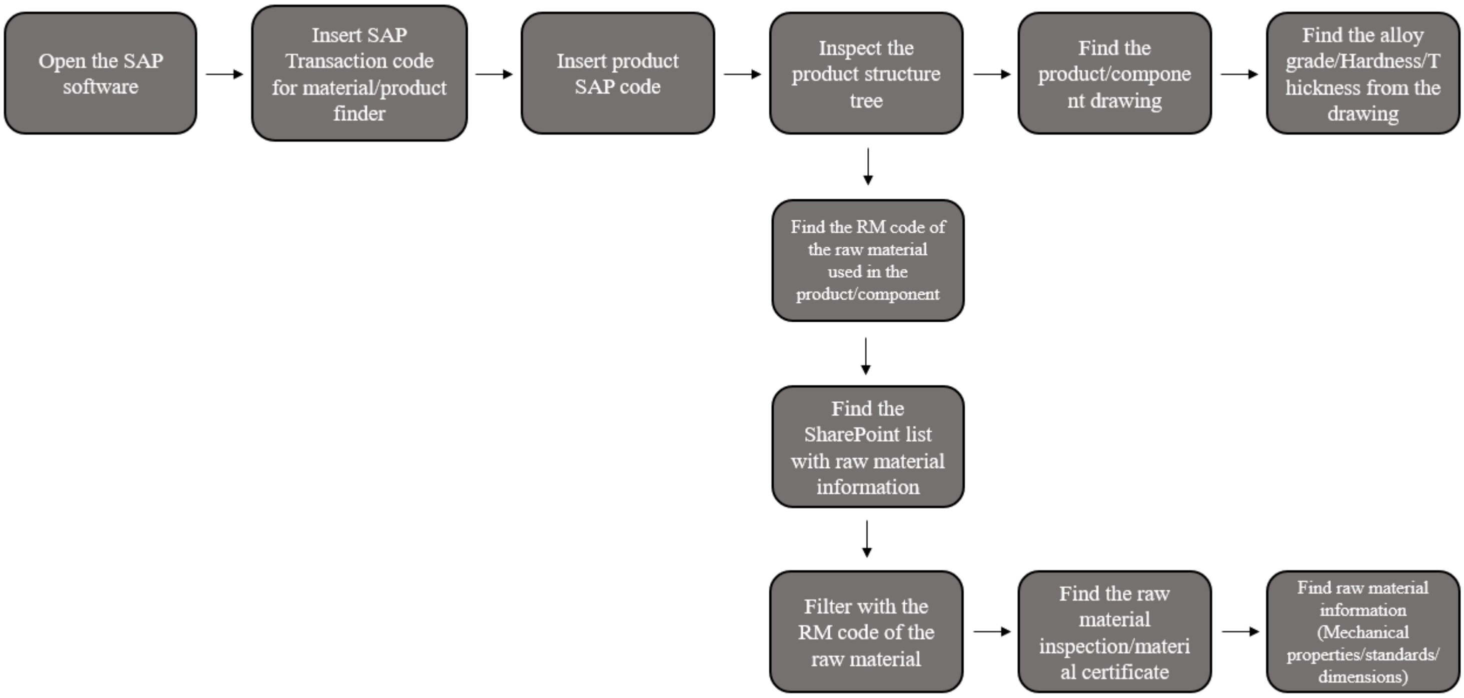

Figure 7: A flowchart of the old information retrieval method

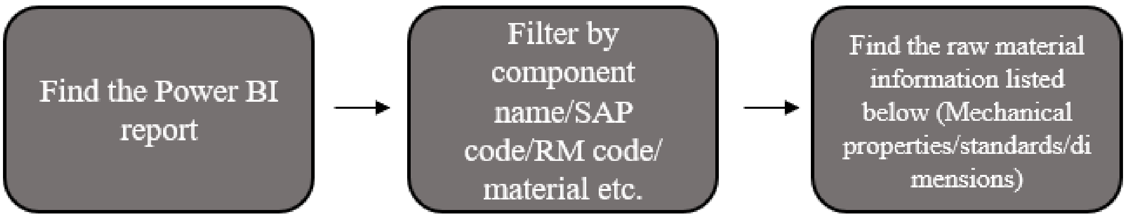

Figure 8: A flowchart of the new information retrieval method

4.4 Compliance with ABB Oy WA data security policies

The information found in the new system is classified as confidential information according to the ABB Oy information classification instructions. This includes stored and processed information at ABB that is considered sensitive, such as agreements, contracts with suppliers or personal data. The information can be shared internally unless there is valid need for sharing it externally. This information must be encrypted and labelled as “confidential”.

To get access to IT assets the user needs to be authorized. If the user needs access to a system, or create an account for a service, they need to be authorized. This ensures that only authorized people are allowed to view the information found in the new raw material

information system. Once an employee’s contract has ended, all IT assets are to be returned to the company. The platforms for the new raw material information system (SharePoint and Power BI) both encrypt the information that is stored in them.

5 DISCUSSION

The final product for the thesis, while being a good base to build further for storing all the company raw material information, is still requiring further development. As mentioned in the results chapter, there were a few apparent flaws in the system that will have to be reworked. The dimension for raw material length, along with the filter slider will be removed, as it was deemed as unnecessary information. It was intended for rod like geometries, that there were only 1 of in the system as of right now. Instead, the geometry of the material can be seen in the geometry column as “rod” and the length of it can instead be called the material width, which there is already a column for.

The search bar filter needs to be improved so that it filters multiple columns, and a new filter selection for components needs to be added. Adding dates for when an item in the list was last updated should also be added.

The information used in this version of the system is the raw material information for products from only one of the suppliers. The reason was because there was limited available time to finish the project, thus including every supplier with unknown scheduling times was not feasible. The supplier that was chosen is the one with the most metal products that are purchased by ABB Oy WA, and the raw material information for their products was more broadly available. The rest of the suppliers products will be added into the system in the future.

In the testing of the old system, 80% of the participants did not know about the existence of the SharePoint list where the material certificate including the raw material properties were located. This is a point that will be considered when trying to implement the new system into the workplace. Because it is in the form of a Power BI report it can be easily attached to other social workplace platforms like teams, so that more people are aware that there is a place where all the raw material information is stored and easily found.

While testing the new system, the link to the participants was directly provided to them, but if nobody is aware of it in the first place, they will ask help from someone, which again could prove to be a problem if the person asked also is unaware, unavailable, or for some other reason does not provide the information.

Another possible inaccuracy in the testing of the new system was that the instruction, to approach the question like the RM code was still not known, was not given to every participant. It is expected that it would have increased the average time to find the requested information by a few seconds.

6 CONCLUSION

The aim for the thesis was to create a platform that hosts all the metal raw material information used in the metal components in ABB Oy WA-department. Five objectives were set to reach the goal: (1) Assess the current situation of storing metal raw material information, (2) Interview personnel from different departments on what raw material information they deem useful for their work task, (3) Decide what raw material information to include in the new information storage, based on the interviews and research on material properties, (4) Find a suitable platform for the raw material information, (5) Test and compare the new system to the old methods of raw material information retrieval.

The first objective was reached through interviewing the person managing material information. It was found that the current methods for finding metal raw material information was from SAP, with more information being stored in a SharePoint list that includes products that are purchased from all WA suppliers.

The second objective was reached through interviews with personnel from the procurement, R&D, HSEQ, and engineering departments. The most requested information was the raw material dimensions and tolerances, and material hardness. Information such as hazardous substances and environmental impacts of the raw material manufacturing were deemed to be outside of the scope of the thesis. The interview with BJE provided a lot of knowledge on the type of information that is important to know about the raw materials (Appendix 1 & 2).

The third objective was reached with the conclusions from the second objective, together with an interview with the company departments and the final raw material information to be included in the new system were chosen. The raw material properties, dimensions, and standards presented in the first draft of inclusion of material information were modified to fit the company needs.

The fourth objective was reached, by deciding with context from the first objective that the information needs to be located and presented in one place, to minimize the need multiple different platforms to find relevant raw material information. The simplistic method of adding new information, and the capabilities to manipulate the information, as well as the information security, led to the decision of using SharePoint as the platform to store the company metal raw material information. The presenting, filtering, and easy report integration capabilities of Power BI, led to the decision to use it as the main platform for presenting the information.

Through raw material information retrieval tests with the personnel, the fifth objective was achieved. The test participants were requested to find the width and tolerance of the width of a raw material used in a metal component. By the means of the old methods of finding the information, only 20% were able to find the information without help. The other participants were able to find the information when help was given. The average time, without calculating the potential added time to get the help from someone with the right knowledge, was 5 minutes and 5.4 seconds. Help was asked on average 1.4 times. With the new information storage, the average time to find the requested raw material information was 29.6 seconds. Help was not asked a single time. The aim of creating a better system for raw material information was achieved, based on the succession rate of 100% to find the information without help, and the time to find the information being on average 4 minutes 35.8 seconds less time consuming with the new system.

Reflection on the results of the tests brought forward points about the test instructions being inconsistent, leading to a possible reduced total time of finding the information in the new information storage. The possibility of the existence of the raw material information storage not being well known also brings scepticism to the conclusion of the storage being more efficient in practice, as it would bring the same problems of having to ask another person for the information.

In conclusion, the new platform for raw material information is still in initial development. There are flaws that need to be assessed like the search box filtration, the removal of the length dimension and filtration, addition of metal component filtration, and the missing raw material information for the other suppliers. The biggest reason for

inconclusiveness on the efficiency of the raw material information platform comes from the methods to bring awareness of the platform to the personnel. Assuming the integration of the system to the company is successful and everyone is aware of its existence, it can be concluded that the new raw material information platform has achieved the goal of the thesis.

7 SAMMANDRAG

Introduktion

Detta examensarbete utfördes på uppdrag av ABB Oy Wiring Accessories. ABB grundade 1987 då svenska ASEA och schweiziska Brown, Boveri & Cie sammanslogs. ABB anställer 105,000 personer i över 100 länder. Företagets affärsområden är elektroniska apparater, frekvensomriktare samt elmotorer, process automation, och robotik. ABB Oy WA tillverkar och marknadsför el-installationsprodukter till de nordiska länderna, samt centrala Europa.

Detta examensarbetes mål var att förbättra hanteringen av metallråvaruinformationen på WA-avdelningen, genom att skapa en förvaringsplats för metallråvaruinformationen som används i metallkomponenterna i installationsprodukterna, som också är lätt tillgänglig med ett intuitivt användargränssnitt. Bakgrunden till detta arbete var komplikationer i ersättning av vissa råmaterial, som förekom på grund av force majeure som orsakade felaktiga metallråvaror. Lättare tillgänglighet samt centraliserad metallråvaruinformation leder till effektivare verksamhet gällande ersättning av råvaran, problemlösning ifall en produkt hittats felaktig under kvalitetskontrollering, eller när en ny komponent ska planeras och dimensionerna av råvaran bör vara i rätt dimensioner samt toleranser för maskinen som delen tillverkas med.

Den nya förvaringsplatsen kommer att finnas på SharePoint som en lista, och listans innehåll presenteras i form av en Power BI rapport. Rapporten skapas tillsammans med en anställd med tidigare erfarenhet av rapportprogrammering i Power BI. Rapporten skapas för cirka 30 till 40 personers användning på ABB Oy Wiring Accessories-avdelningen.

Fem olika delmål sattes för att nå examensarbetets mål:

1. Lista ut nuvarande situationen av metall råvaruinformationsförvaring
2. Intervjua personal från de olika företagsavdelningarna, för att få en uppfattning om vilken metallråvaruinformation det finns behov av

3. Avgör vilken information som ska inkluderas i den nya information förvaringsplatsen
4. Skapa det nya metallråvaruinformationsförvaringsplatsen, som är lätt tillgänglig, samt har ett intuitivt användargränssnitt
5. Testa och poängsätt den nya förvaringsplatsen, och jämför den med de gamla metoderna av råvaruinformationssökning

Litteraturöversikt

I litteraturöversikten presenteras relevant teori för detta examensarbete. Teori om viktigheten av att veta materialets egenskaper vid tillverkning av en produkt kommer fram i första delen av översikten, samt teori om de egenskaper som kommer fram i metod delen av denna studie. Materialets egenskaper bestämmer hur materialet reagerar och beter sig under givna förhållanden. Egenskaper som framkommer i examensarbetet är draghållfastighet, elasticitetsgräns, deformation, elasticitetsmodul, hårdhet, elektrisk ledningsförmåga samt resistivitet, och värmeledningsförmåga.

Allmän information om metaller som används i tillverkning av el-installationsprodukter är inkluderade i översikten. Eftersom det är frågan om elprodukter, används det metaller som är bra på att leda el. Metaller som används i el-installationsprodukter är bland annat koppar, silver i elektriska kontakt, guld i datachips el kretsar, tenn som används oftast som beläggning på andra metaller för att skydda metallen från korrosion, mässing, och stål som används mest för ramen av produkten.

Bakgrundsinformation om olika tillverkningsprocesser som utförs på metallråvarorna för att ge insikt till läsaren om el-installationsprodukternas metallkomponenters tillverkning. Materialval är en viktig del av tillverkningsprocessen av en produkt, eftersom det beror på materialets egenskaper ifall den kan utföra dess uppgift utan mekaniska fel, degradering, eller hälsorisker. Tillverkningsprocesser som metallformning, varm- och kallbearbetning, och pressarbete är presenterade under varsin underrubrik. Litteraturöversikten går också in på de ytbehandlingar som utförs på metallkomponenterna. Galvanisering är en process där ytan av en metall är belagd med en lager av en annan metall, oftast zink eller tenn som beläggning. När man varm galvaniserar, doppas metall komponenten i till

exempel smulten zink, vilket lämnar en zinkbeläggning, vars tjocklek beror på hur länge komponenten har hållits i zink badet. Elektroplätering är en slags galvaniserings process, där beläggningen är tillsatt genom elektrolys. Katoden är kopplad i den negativa laddningen, och anoden i den positiva laddningen av en strömkälla, sedan placeras de i en elektrolytisk lösning. Katoden är den metallen som beläggningen kommer att täcka, och anoden är beläggningsmaterialet. När strömmen appliceras övergår oxiderade jonerna från anoden att fästa sig på katoden.

Informationshantering och datasäkerhets kapitlen är högst relevanta i detta examensarbete. Litteraturen behandlar hur centraliserad informationslagring förbättrar hanteringen och optimering av resurser, vilket kommer att reflekteras i metodiks delen av examensarbetet. Eftersom information kommer att lagras och hanteras i det nya metallråvaruinformationslagret, gäller det att följa information säkerhetsinstruktioner, vilket tas fram i datasäkerhets delen av översikten. Datasäkerhet är ytterst viktigt i ett företag, där det sparas information om budget, finansiella rapporter, affärsstrategier, forskningar, och information om personalen. Ett säkerhetsbrott kan leda till skada på företagets rykte samt ekonomi, där det kan inblandas dyra rättegångar. För att grundlägga ett företags informationssäkerhet, behöver företaget utveckla en gemensam säkerhetspolitik, där de anställdas skyldigheter för att uppehålla bra informationssäkerhet är beskrivna. Tillgångskontrollering är också bra att uppehålla på ett företag, så att någon som inte är auktoriserad kan slippa in till dokument eller information som är låsta bakom brandvägg.

I kapitlet om användargränssnitt lyfts det fram olika fördelar för ett intuitivt samt simpel layout för en nätsida. Ett bra användargränssnitt ökar användarens produktivitet och hjälper dem att utföra uppgifter mer effektivt. Onödig information, samt ett gränssnitt som är svår att förstå, ökar tiden som användaren spenderar på nätsidan. Detta leder till att användaren tappar intresset och lämnar sidan.

En översikt på olika programvaror som används i arbetet var tillagd, så att läsaren kan få en insikt på vilka funktioner som behövts i olika skeden av arbetet. Ett kapitel om standarder är inkluderat, där standardernas roll inom produkttillverkning, samt var standarder kommer från.

Metod

I metod delen presenteras de olika stegen som togs för att skapa det nya informationslagret. Det kommer att stegvis från informationssökningens nuvarande situation, vilken information är relevant att hålla i det nya informationslagret, och beslut på vilken plattform informationen kommer att sparas på.

För att bygga en grundläggande uppfattning om hur nuvarande metoderna av metallråvaruinformationen lagras samt söks, gjordes det kvalitativa studier i form av intervjuer med personal från de olika företagsavdelningarna. Från intervjun med personen som hanterar råvaruinformationen, kom det fram att informationen hanteras i både SAP och en SharePoint lista. All information hittas inte från ett ställe, utan det finns viss information på SAP, som ritningar till komponenter var det står råvarans kvalitet till exempel *CuZn37 F54;0.9mm*. I SharePoint listan kan det finnas mera information i dokument till exempel ett materialcertifikat.

I ytterligare intervjuer frågades det av personalen vilken råvaruinformation var viktigast att inkludera i det nya systemet. R&D, HSEQ, samt ingenjörsavdelningens personal uttryckte sitt behov av teknisk information som materialgeometri och dimensioner som råvarans bredd, tjocklek och dessa dimensioners toleranser. Delkomponenter i metallkomponenterna kan vara tillverkade av olika råvaror, vilket begärdes att göras klart i det nya systemet. En intervju med BJE föreslogs, med målet att få reda hur de sköter hanteringen av metallråvaruinformationen. BJE är ABB Oy WA's systerbolag, och de har liknande produkter som på WA-avdelningen.

I intervjun med BJE's personal, visades det 2 dokument som kallades *material requirement profile* (Materialkravprofil) (MRP), och *process requirement profile* (Processkravprofil) (PRP). Med informationen från dessa dokument, informationsönskemål från tidigare personals intervjuer, samt materialegenskaperna från litteratursöversiktet, gjordes det första konceptet i form av en Excel-lista om vilket information som kommer att finnas i det nya råvaruinformationsförvaringsplatsen. Konceptet visades åt de olika företagsavdelningarna, var efter information som ansetts mindre nyttigt togs bort. Efter de sista redigeringarna till Excel-listan var informationen färdig att användas i det nya systemet.

Informationen laddades upp i SharePoint, var informationen kan lätt bli hanterad på grund av flera olika integrationer till Microsofts andra programvara. Listan integrerades till Power BI, eftersom det finns flera olika filtrerings möjligheter som inte finns på SharePoint. SharePoint används som huvudinformationförvaringsplats eftersom det går lätt att lägga till mera information, endera en rad i taget, eller med hjälp av Excel integrering, vilket möjliggör att hämta flera rader med råvaruinformation på en gång. Power BI rapporten kan bifogas lätt i flera olika socialplattformer som används i företaget, vilket gör det lättare att ge synlighet åt råvaruinformationsförvaringsplatsen så att den blir använd. Power BI rapporten har filtrerings funktioner för råvarans SAP koder, RM koder, delkomponenternas namn, dimensioner, standarder, samt råvarans namn.

Resultat

I resultat delen presenteras det nya informationsförvaringsplatsen, dess filtrerings funktioner, samt testresultat där deltagarna begärdes att hitta viss information om råvaran i en komponent med gamla sökmetoderna, sedan med det nya systemet.

Råvaruinformationen presenteras i en Power BI rapport som hämtar informationen från en SharePoint lista. Informationen går att filtreras med textfält med råvarans samt delkomponentens SAP koder, samt genom att välja vad som filtreras bland råmaterial, delkomponenter, material standarder, legeringsklass, geometri, samt metallens namn. Beroende på vilket filter som inställts visar rapporten alla egenskaper och information som det finns om råvaran som fyller filtreringens kriterier. Information kan tilläggas i det nya systemet genom att lägga till en rad i SharePoint listan som är relaterad till Power BI rapporten, och den kommer att synas i Power BI eftersom relationerna är gjorda från kolumner som redan finns på SharePoint. Ifall en ny kolumn läggs till i SharePoint ifall ny information om råvarorna behövs, måste det skapas en ny relation till Power BI rapporten så att den visar den informationen. Nya material kan läggas till i stora mängder med att integrera från en Excel-lista, ifall den innehåller samma kolumner som listan på SharePoint.

Resultaten från testen med personalen visade att bara 1 av 5 deltagare hittade den begärda informationen utan att fråga efter hjälp med de gamla sökmetoderna, och det tog dem i genomsnitt 5 m 5.4 s att hitta informationen, med potentiella tiden det räcker att fråga hjälp borträknat. Med det nya systemet hittade alla deltagare den begärda informationen utan hjälp, och det tog i genomsnitt 29.6 s.

Problem som dykte upp under testen var att vissa deltagaren inte slapp och se Power BI rapporten, och textfält filtreringen fungerade inte. Förslag att förbättra systemet var att lägga till filtrering för komponenter, inte bara delkomponenter.

Gällande information säkerhetspolitiken på ABB Oy WA, fyller det nya systemet alla krav för att hålla informationen säker från säkerhetsbrott. Listan är märkt som konfidentiell, och information som läggs till i SharePoint samt Power BI är krypterad.

Diskussion och slutsats

I diskussionen kommer det fram olika förbättringar som kunde göras till det nya systemet. Dimensioner för råvarans längd samt filtreringen som hörs till den kunde tas bort och i stället läggas till i bredd dimensionen, och geometrin kan i stället specificeras i geometri fältet som ”stång” vilket oftast är geometrin då längd dimensionen används. Textfält filtreringen måste rättas till så att den fungerar, samt kunde det ändras så att det går att söka genom flera kolumner med sökord i stället för bara en. På grund av begränsad tid till förfogande, användes bara råvaruinformation från 1 leverantör. Resten av leverantörernas råvaruinformation måste läggas till i framtiden. 80% av deltagarna i testen visste inte om SharePoint listan där informationen tidigare hittades. För att undvika liknande att hända med det nya systemet, måste medvetenheten om dess existens ökas.

Första delmålet nåddes med intervjun där det kom fram att SAP samt en SharePoint används för det nuvarande informationssöknings metoderna. Andra delmålet nåddes med intervjun med de olika företagsavdelningarna och med BJE personal. Tredje delmålet nåddes med informationen från de två första delmålen, och en till intervju med ABB Oy WA’s personal. Fjärde delmålet nåddes genom att föra all information till en förvaringsplats, vilket hjälper användaren att hitta all relevant information snabbare. Lätt tilläggning av information, integreringsmöjligheter, informationssäkerhet, och tillgänglighet ledde

till beslutet att använda SharePoint som informationsförvaringsplats. Power BI valdes som huvudplattform för att presentera informationen åt personalen, på grund av flera olika sätt att filtrera, samt bifoga rapporten. Rapporten skapades av en anställd med tidigare erfarenhet med rapportprogrammering i Power BI. Designinstruktioner gavs till programmeraren så att rapporten presenterar all information på ett intuitivt sätt. Det nya systemet jämfördes med de gamla informationsökningsmetoderna, och resultaten visar att det nya systemet presterade bättre, med en 100% framgångsfrekvens jämfört med 20% framgångsfrekvens för det gamla metoderna. Slutsatserna var att det nya metallråvaruinformationsförvaringsplatsen har nått examensarbetets mål, ifall den på lyckat sätt integreras på arbetsplatsen, samt uteslutna råvaruinformationen och förbättringarna till filtreringsfunktionerna är tillagda.

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9 APPENDICES

9.1 Appendix 1: The MRP provided by BJE

Table 3: Appendix 1 with raw material information in the BJE MRP

Material standard	Material code	Thickness	Tolerance	Material type	Tensile strength	Yield stress
0.2% elastic limit	Elastic modulus	Dynamic stress limit	Notched impact strength	Breaking elongation	Bending radiuses	Hardness
Thermal conductivity	Coefficient of thermal expansion	Specific elec-tric resistance	Surface character	Surface treat-ment	Colour	Coating type and thickness
Material processing suitability (reshaping, weld-ing galvanizing)				Material industrial & environmental reliability in accordance to REACH & ROHS guidelines, and ABB banned substances.		
Documents from supplier (Technical data sheet, Safety data sheet, Inspection certificate)						

9.2 Appendix 2: PRP provided by BJE

Table 4: Appendix 2 including the information in the BJE PRP

<table>
<tr><td colspan="3">The geometry and dimensions of the material (Strip, Round stock, Flat stock, Rectangular, misc., and the width and tolerance of the material)</td></tr>
<tr><td>Is the surface degreased?</td><td colspan="2">Material processing suitability (reshaping, welding galvanizing)</td></tr>
<tr><td>Weldability, flat rolled, deburred, rounded off, cut edges?</td><td>Delivery in accordance with BJE’s delivery standard?</td><td>Material samples</td></tr>
</table>

9.3 Appendix 3: First version of the needed raw material information

Table 5: Appendix 3. The raw material information included in the first mock-up

ABB mat. code (SAP) – the code of the material in SAP	**ABB old mat. no**. – The RM code given to the material	**Description**	**Raw mat. distributor material name** – the name for the material used by the raw material supplier	**Supplier product name/code** – the name of the component or material used in the component by the component supplier	
Metal/Alloy name	**Alloy grade**	**Geometry**	**Length [mm]**	**Width [mm]**	**Thickness [mm]**
Diameter [mm]	**Electrical conductivity**	**Specific electric resistance**	**Thermal conductivity**	**Hardness**	**Elastic modulus [GPa]**
Tensile strength [MPa]	**Yield stress [MPa]**	**Elastic limit [MPa]**	**Breaking strain %**	**Surface treatment method**	**Coating**
Coating thickness [µm]	**Material standard**	**Shipping standard**	**Manufacturing standard**	**Coil dimensions**	

9.4 Appendix 4: The final included raw material information for the new system

Table 6: Appendix 4. The final included raw material information for the raw material information storage

ABB mat. code (SAP)	**ABB old mat. no.**	**Description**	**Raw mat. distributor material name**	**Supplier product name/code**	**Metal/Alloy name**
Alloy grade	**Geometry**		**Length [mm]**	**Width [mm]**	**Thickness [mm]**
Diameter [mm]	**Hardness**	**Tensile strength [MPa]**	**Yield stress [MPa]**	**Breaking strain %**	**Surface treatment method**
Coating	**Coating thickness [µm]**	**Material standard**	**Shipping standard**		**Coil dimensions**