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Measuring and developing a process for better quality: Scrapping process

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The main goal of this thesis was to create development ideas for a company in electrical and automation equipment industry regarding their scrapping process. In this study the term scrap refers to components that are faulty due to mishandling of a worker, or some other reason, that the component cannot be complained about to the supplier. This study was mainly conducted in the summer of 2015. By developing this process into a more functional entity there is an opportunity for the company to save costs related to scrap. The research method used in this study was participant observation and informal interviews.

The first theoretical part of this thesis is about quality, and why it is an important factor, how it can be interpreted in various ways, what the simple means and actions are to prevent additional costs and how all this is related to process thinking. The second part of theory is about processes, why and how they need to be described, measured and developed. All this highlights the importance of continuous improvement and how that is related to good quality.

The conclusion is that the process does not have any indicators and without them continuous improvement is impossible. By developing the tools, mainly ERP system SAP used in the scrapping process and removing unnecessary phases the process can be improved. There are several changes that need to be done to SAP transaction ZGWQ_ZNAP that is used for scrapping and with these changes data can be obtained from SAP that can be used to measure the process effectiveness and find problem areas that need improvement. The development ideas are being taken into use step by step. The first action is to take reason codes for scrapping into use so that it will be easier to identify why the item has been removed from stock. The next step is to conduct a study about implementing transaction ZNAP into all production lines and work stations and continue from here as the company sees best, based on the study.

Keywords	scrap, quality, error conditions, quality deviations, process, process description, process development, indicators, measuring

Tekijä Otsikko Sivumäärä Aika	Salla Kasper Prosessin mittaaminen ja kehittäminen laadun parantamiseksi: Romutusprosessi 45 sivua + 3 liitettä 11.10.2015
Tutkinto	Insinööri (AMK)
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Insinöörityön päätavoitteena oli luoda kehitysideoita sähkö- ja automaatioteknologia-alan yritykselle sen romutusprosessin parantamiseksi. Tässä tutkimuksessa romulla tarkoitettiin yrityksen työntekijöiden rikkomia tai muulla tavalla viallisia komponentteja, joita ei voida reklamoida toimittajalle. Kehittämällä romutusprosessia toimivammaksi kokonaisuudeksi yrityksen on mahdollista vähentää romutuskuluja. Tutkimusmenetelmänä käytettiin osallistuvaa havainnointia ja epävirallisia haastatteluja.

Hyvä laatu on tärkeä tekijä, ja se tarkoittaa, että tuotteessa ei ole vikoja eikä puutteita ja se vastaa sidosryhmien odotuksia. Tuotannon rooli laadun tekemisessä on varmistaa, että tuote on koottu oikein ja kuranteista komponenteista. Pidemmällä tähtäimellä hyvä laatu tarkoittaa yrityksen selviämistä ja töiden jatkuvuutta. Prosessien jatkuva kehittäminen on tärkeää, jotta yritys pysyy kilpailukykyisenä nopeasti muuttuvina aikoina. Prosessin jatkuva kehittäminen ja parantaminen on mahdollista ainoastaan, jos prosessi on mitattavissa. Ilman prosessimittareita prosessia ei voi ohjata, ja jos prosessia ei voi ohjata, ei sitä voi johtaa ja hallita. Yrityksen prosessit kertovat myös paljon siitä, kuinka hyvin yritys ymmärtää omia toimintojaan ja niiden tehokkuutta.

Johtopäätöksenä oli, että romutusprosessilla ei ole mitään mittareita ja ilman niitä jatkuva parantaminen on mahdotonta. Kehittämällä työkaluja, pääasiassa toiminnanohjausjärjestelmä SAP:a, joita käytetään romutusprosessissa, ja poistamalla turhia työvaiheita prosessia voidaan parantaa. Useita muutoksia tulee tehdä SAP:n transaktioon ZGWQ_ZNAP, jota käytetään romutukseen. Näiden muutosten avulla voidaan saada tarvittavaa dataa SAP:sta ja sen avulla voidaan mitata prosessin toimivuutta ja romutuksesta syntyviä kustannuksia sekä löytää parannusta kaipaavia kehityskohteita. Kehitysideat otetaan käyttöön vaihe vaiheelta. Ensimmäinen askel on ottaa käyttöön syykoodit romutukselle, jotta on helpompaa tunnistaa, miksi tavara on poistettu SAP:n varastosaldolta. Seuraava suoritettava vaihe on tehdä selvitys siitä, kuinka ZNAP-transaktio voidaan implementoida jokaiselle tuotantolinjalle ja työpisteelle, sekä jatkaa toimenpiteitä niin kun yritys parhaaksi näkee selvityksen perusteella.

Avainsanat	romu, laatu, virhetilanteet, laatupoikkeamat, prosessi, prosessin kuvaus, prosessin kehittäminen, mittarit, mittaaminen

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Abbreviations

ERP	Enterprise resource planning. Business management software.
SAP	ERP system
LAC	Low Power AC
PDCA	Plan-Do-Check-Act – cycle. Management method for continuous improvement
ZNAP	Short version of transaction ZGWQ_ZNAP

1 Introduction

1.1 Background and goals of the study

In this thesis I examine the scrapping process in ABB Oy, Drives LAC – business unit. For a company to be able to keep up with constantly changing world it needs to invest in continuous improvement of processes and operations. When continuously improved a company should be able to preserve good quality of products and through that maintain or even increase its market share. Quality of the products is a key factor in customer satisfaction.

The first part of this study concentrates on why quality is an important factor in business and in manufacturing, and how quality can be interpreted in various ways. This study also presents different means and actions to prevent additional costs through making simple changes in the process. The theoretical part is also about processes and process thinking. What needs to be considered when mapping out processes and highlighting the importance of continuous improvement and its link to good quality.

The second part of the thesis is a case study that was done in the summer of 2015. The case study concentrated on LAC's scrapping process that needed to be developed so that ABB was able to measure it and based on the information that the indicators gave improve work quality and minimize the related error costs. Also the process should be more straightforward in the sense how many people are involved and how many work tasks need to be carried out, making the process as simple as possible.

1.2 ABB Group

ABB is a global leader in power and automation technologies, creating solutions to improve efficiency, productivity and quality of customers' operations and at the same time minimizing environmental impact. ABB Group is based in Zürich, Switzerland. The company employs about 140 000 people in total, in 100 different countries.

ABB's business is comprised of five divisions that are organized in relation to the customers and industries they serve. All five divisions function globally. The product offering

of Power Products division includes circuit breakers, switchgear, capacitors, instrument transformers, power distribution and traction transformers and also a complete range of medium voltage products. ABB is the world's largest transformer supplier. (About ABB, 2015)

The Power Systems offer turnkey solutions for traditional and renewable energy-based power generation plants, transmission grids and distribution networks. These solutions play a key role in the optimization of electricity generation and the evolution of more flexible, reliable and smarter grids. (About ABB, 2015)

Low Voltage Products division offers solutions and products suitable for several electrical applications from industrial building to residential home automation, including low voltage circuit breakers, switches, control products, wiring accessories, enclosures and cable systems designed to ensure safety and reliability. (About ABB, 2015)

Process Automation offers products, systems and services designed to optimize the productivity of industrial processes. The solutions include turnkey engineering, control systems, measurement products, life cycle services, outsourced maintenance and industry specific products, e.g. electric propulsions for ships, mine hoists and turbochargers. (About ABB, 2015)

Discrete Automation and Motion division offers a wide range of motors, generators, drives, mechanical power transmissions, robotics, PLCs, wind converters, solar inverters, voltage regulators, rectifiers, UPS systems, excitation systems, traction converters and fast DC chargers. Also in this division ABB is the world's largest supplier of industrial electric motors and drives. (About ABB, 2015)

1.3 ABB Oy, Drives

The ABB Oy, Drives business unit is globally in charge of the sales and marketing of the drives together with research and development. ABB Oy, Drives provides a wide range of DC- and AC-drives. These are used among different industries and applications. By adjusting a motor's rotation speed with a drive, the energy consumption of the motor can be reduced by 50%. In 2012 ABB's drives saved approximately 355 terawatt-hours,

which can be compared to the annual electricity consumption of 85 million EU households. (ABB Lyhyesti, 2015)

ABB Oy, Drives is located in Pitäjänmäki, Helsinki and it is a part of the global ABB Group. ABB Globally employs approximately 145 000 people and 5 400 of them are in Finland and the Drives department in Pitäjänmäki employs 1000 people. ABB operates in more than 30 locations in Finland, the biggest plant concentrators are located in Helsinki, Vaasa and Porvoo. ABB Oy, Drives is a part of Discrete Automation and Motion division. (ABB Lyhyesti, 2015)

The business principles of ABB Oy, Drives are respect, responsibility and determination. The goal is to create value to customers by providing products, services and expertise for controlling electric motors to save energy and to improve customers' machineries and processes over lifecycle and beyond. (ABB Intranet, 2013)

2 Quality

Quality has a different meaning to different people. In manufacturing it usually means that the product in question is free from defects, deficiencies and significant variations. When a product is of good quality it meets the standards the stakeholders set and is possibly better than a competitor's similar product.

Juran points out two meanings of the word "quality" that are of critical importance when managing quality:

"Quality" means those features of a product which meet customer needs and thereby provide customer satisfaction. In this sense, the meaning of quality is related to income. The purpose of such higher quality is to provide greater customer satisfaction and, one hopes, to increase income. However providing more and/or better quality features usually requires an investment and hence usually involves increases in costs. Higher quality in this sense usually "costs more". (Juran 1998, 2.1)

"Quality" means freedom from deficiencies – freedom from errors that require doing work over again (rework) or that result in field failures, customer dissatisfaction and customer claims. In this sense, the meaning of quality is related to costs, and higher quality usually "costs less". (Juran 1998, 2.2)

Organizations are created to achieve a goal, mission or objective but they will only do so if they satisfy the needs, requirements and expectations of their stakeholders. Their customers, as one of the stakeholders, will be satisfied only if they provide a product and services that meet their needs, requirements and expectations. Their other stakeholders (shareholders, employees, supplier and society) will only be satisfied if the products and services provided to customers are produced and supplied in a manner that satisfies their needs, requirements and expectations – in other words, makes profit, does no unintentional harm, and is conceived and produced with due regard to prevailing legislation. (Hoyle 2007, 2)

Hoyle (2007, 14) on the other hand points out that in the end quality is free. Hoyle states we should divide costs related to quality into two different categories. There are quality costs that are unavoidable and there are also additional costs. Unavoidable costs are such as labour, materials, facilities, machines and transports. These additional costs

Hoyle discussed about are the costs covering the prevention, detection and removal of errors. Important question that Hoyle points out is whether customers should have to pay for the errors made by others.

The role of manufacturing and assembly in producing quality is to ensure that the product is manufactured correctly. The linkage between design and process engineering is obvious; manufacturing can not do its job without good product design and good process technology. In production, however no defects should be acceptable. If and when they occur, every effort must be made to identify their cause and eliminate them. Inspecting defective items is costly and wasteful. (Evans & Lindsey 2011, 54)

Worn manufacturing tools result in defective parts and improperly calibrated inspection gauges give misleading information. These and other tool problems lead to poor quality and inefficiency. The result is excessive scrap, waste, and higher costs. (Evans & Lindsey 2011, 54)

Human beings tend to make mistakes inadvertently. Typical mistakes in production are omitted processing, processing errors, setup errors, missing parts, wrong parts, and adjustment errors. Such errors can arise from the following factors:

- Forgetfulness due to lack of concentration
- Misunderstanding because of lack of familiarity with process or procedures
- Poor identification associated with lack of proper attention
- Lack of experience
- Absentmindedness
- Delays in judgment when a process is automated
- Equipment malfunction.

Blaming workers not only discourages them and lowers morale, but also does not solve the problem. (Evans & Lindsey 2011, 339)

2.1 Quality deviations

Deviations can be categorized according to whether the deviation has an effect on the reliability and approval of operations and results, and what the risks and their direct and indirect effects caused by the deviations are. Deviations can be categorized as significant if a company does not fulfill the applied ISO-standards requirements, its own management systems requirements or other requirements so that the confidence in its validity or quality of work is compromised. Deviation is classified as observation where the company's practice may lead to a significant offset and thus risk quality. (Suomen standardisoimisliitto SFS-EN ISO 9000 2005)

2.1.1 Internal quality deviations

Good quality is created when manufacturing the product and quality can't be added afterwards. Procedures and practices form a quality management system. The quality management system practically covers all the company operations. Companies often have their quality policy in accordance with the ISO standard and the content is defined by the ISO standards: this usually means how the senior management has defined the way to deal with quality in the organization. (Siitonen 2011, 1-7)

The applied quality management system encourages organizations to analyze customer requirements and to identify those processes which provide a product that the customer approves, as well as to control these processes. The quality management system can provide means for continuous improvement and therefore is likely to increase customer and stakeholder satisfaction. It provides the organization and its customers confidence that the organization is able to provide products that consistently meet the requirements. (Suomen standardisoimisliitto SFS-EN ISO 9000 2005)

Quality control refers to the detection of quality deviations in products and to withdrawing products that exceed the allowed amount of deviations from the production. Ensuring quality aims to prevent errors. Quality responsibility belongs to every department. In order to achieve quality objectives, it is important that the entire organization commits to producing quality. (Flower 1990). A preventive action is a measure which intends to eliminate any reason for deviation or other potential undesirable situation. There might be several possible reasons for deviation. A preventive action is done to prevent the event,

while corrective action is done to prevent the recurrence of the deviation. (Suomen standardisoimisliitto SFS-EN ISO 9000 2005)

A corrective action is an activity whose purpose is to eliminate the cause of the observed deviation or another undesirable situation. Repair is an action that eliminates the detected deviation and it can be done during corrective actions, for example in the form of re-processing. (Flower, 1990)

A corrective action refers to a change in the working method. When error in the product is observed, one must think if the error is due to poor practice of action, and if necessary, correct it, so that similar errors can be avoided in the future. Steps in the corrective action are:

- defining the problem
- responsibilities of future processing
- evaluation of importance
- search for possible causes
- making an analysis (finding the actual cause)
- exploring prevention of error recurrence
- finding a solution
- instigating change (change instructions, training).

(Suomen standardisoimisliitto SFS-EN ISO 9000 2005)

Disposing nonconforming products and preventing their distribution can be related to the corrective action. Corrective actions in the target organization are taken for example when a deviated part is noticed and replaced before the manufacturing of the drive is finished. If the supplier has supplied the faulty piece a complaint is made, and if the quality deviation is the organization’s own fault, the component will be scrapped.

Reprocessing or rework is an operation that is performed on a deviating product to bring it into conformity. (Suomen standardisoimisliitto SFS-EN ISO 9000 2005). In ABB we refer to this as rework and it is often performed for example for option kits that need to be updated. A changing requirement category means that the deviating product's requirement category is changed so that it fulfills the requirements that differ from the original requirements. (Suomen standardisoimisliitto SFS-EN ISO 9000 2005)

Reconditioning is a measure that is done on a deviating product to obtain approval for the intended use. Unlike reprocessing, reconditioning can affect a product's parts or change them. (Flower, 1990). The process of identifying and selecting quality problems for correction should be as quick and efficient as possible. Unfortunately, many quality improvement efforts never get beyond this point because available resources are consumed in an effort to quantify quality problems. (Hinckley 2001, 25)

Our tendency is to conceal mistakes. Yet when this happens, the root cause of the problem will never be identified and corrected. One of the keys to getting to the root cause of problems is to involve everyone; key insights are often obtained from the comments and suggestions of others. One powerful but simple technique that makes mistakes obvious, and identifies problems that deserve attention, is to display current defects where everyone in the factory will see them. (Hinckley 2001, 25-26)

2.1.2 Internal quality deviations and customer

The quality of a product is usually defined by its technical features and that is why traditional organizations focus their attention almost exclusively on the quality of the goods. A product's quality is often imagined as the technical features of a service or a product, or at least it is considered to be one of the important features of the perceived quality. Good quality, however, means faultlessness of a product, low quality costs, and as a result cost-effectiveness. It has a positive effect on the company's margin and profitability. There is always a risk that when quality is defined narrowly and the quality program is also too narrow. In reality customers usually perceive quality on a much larger scale and quality experience is often based on quite other aspects than technical. Good quality fulfills customers' requirements and expectations, and increases customer satisfaction. Satisfied customers are usually loyal to the company and communicate positively to other potential customers. As a result a Quality Company's position in the market becomes stronger. In turn good quality and satisfied customers can give company more

freedom in pricing and quality can be sold with a better margin. (Lecklin 2006, 16-30; Grönroos 2000, 49-66)

On a long run quality means the company's survival and continuity of employment. Customer-oriented activity is important for the company, as the customer is the final assessor of quality. The customer is not always right, but the customer funds the company's operations, so the products and the processes behind them must be able to meet the customer's needs in changing circumstances. The company has to determine quality in the same way as the customer experiences it. Management must be committed to the development of quality. Quality companies take the development of quality seriously. In these companies senior management is personally committed to quality work. Quality is not delegated to a quality manager or a separate quality department, but the company's management is prominently involved in serving as an example and spending their own time and money on the development of quality. (Lecklin 2006, 16-30)

The company's competitive advantage is said to depend on the goods offered and the quality of service. Too often, the quality of the technical aspects is considered the biggest factor in quality. There are basically two different dimensions to customers' experiences of the service, according to Grönroos (2002). The dimensions are the technical or outcome dimension and the operational or process dimension. What customers gain from the interaction with the company is clearly important to them. Often the quality of interaction is considered internally to be the quality of the whole delivered product. However, that is not the whole truth. Technical quality of service production process' results is only one dimension of quality. The strategy of technical quality is successful if the company succeeds in achieving a technical solution, which competitors can't reach. Nowadays it is rarer and usually different companies can achieve roughly the same technical quality. Furthermore achieving a technical advantage is difficult because in many industries competitors can bring similar solutions to the market fairly quickly. The technical quality dimension does not include all the quality customer experiences. Also the way that the technical quality and process end result are delivered has an effect on the customer. (Grönroos 2000, 49-66)

The personnel must be developed, because the personnel makes the quality. Great production equipment and methods do not guarantee a high level of quality, if the employees are not trained and motivated to work for the better of the work community. Everyone

contributes to the quality the customer experiences. Since quality is created and produced within a given time, a large number of employees are involved in producing quality. If someone fails in customer contacts or background tasks, quality will suffer. When it comes to companies that manufacture goods and provide services as part of their offering, we can talk about perceived overall quality. Quality is good when the perceived quality will meet customer expectations or the expected quality. Factors of overall quality include validity, which is related to technical quality. Workmanship is associated with outcome and therefore is a dimension of technical quality. Reputation and credibility are closely related to the perceived quality image. Attitude, behavior, flexibility, and reliability are clearly related to the process and represent functional quality. Despite the benefits of quality improvement, many companies that have implemented quality programs feel that the programs are not worth the money and time the implementation takes. Usually the problem is the attitude towards quality improvement. If it is considered only a program, and if limited time is sacrificed for implementation and training, and the entire organization from top to bottom consider it only a tactical matter, the risk of failure is high. As a separate program, quality improvement processes are doomed in the long run. The main problem is the approach. Quality improvement should not be considered a program or campaign but an ongoing process. One of the main objectives is to develop “quality behavior” among the staff. Every member of the organization is required to continually appreciate the importance of quality and comprehend the means of improving quality. Management should maintain it at all times. (Lecklin 2006, 30-43, Grönroos 200, 67-95)

Speed and flexibility are needed because in business the ability to react quickly means readiness for change and preparedness. Only change is permanent is often used as a slogan. Acceleration of product development, production and delivery processes generally impacts positively competitiveness and also reduces the number of errors. The customer wants to pay for added value, not for the storage of goods, transport or transferring of paper from one person to another. The company’s image is extremely important in most services and affects the quality experience in many ways. If the customer has a positive image of the service provided, small errors will probably be forgiven. If errors occur often, the image will suffer. If the image is negative, any error will affect relatively more. (Lecklin 2006, 18-30, Grönroos 2000, 62-64)

Companies need to head for the future, because successful companies have a clear vision of the future and an ability to build an action plan supporting it. Also management must be based on facts. The management system and decision-making must be based

on actual and reliable information. Information systems collect real-time data, and the company has the tools and processes to assess and use the information. For monitoring customer satisfaction and process functionality clear targets, indicators, and a monitoring system for them are set. Causes for deviations are clarified and the company is able to prepare for change. Everyone needs to follow quality guidelines in the whole organization. Since quality is produced by a large number of people and activities, the reaching of quality must be monitored and ensured at the point where one invests in quality. The organization must manage quality assurance itself. Quality, and quality improvement and assurance processes are strategic issues that require constant attention from senior management. (Lecklin 2006, 30-43, Grönroos 2000, 96-114)

Successful companies usually have a good ability to cooperate. This is apparent both within the company and in relations with external stakeholders. External marketing has to be created in line with quality management. The quality perceived by the customer depends on the quality expectations and actual experience. That is why improving quality experience can be made idle for example with a campaign which promises too much for the customer. This creates expectations that cannot be fulfilled. Therefore external marketing and market communications, in particular, must be linked with quality management. In addition to a quality company's business principles include a good "corporate citizenship" target. This implies a high level of business morality, health and safety perspectives, prevention of creating environmental damage and wasting natural resources. (Lecklin 2006, 37-54, Grönroos 2000, 96-114)

In product and process design stage efforts are needed. Errors and problems are anticipated and removed before production and customer deliveries start. Error costs are smaller the earlier in the process they will be detected. Errors that go all the way to the customer are harmful for the company's image. Quality is what customers experience. Management cannot decide on quality, but quality has to be based on customers' needs and desires. Quality management does not exclude performance management, and vice versa. In successful companies these management components are integrated. In addition to actual performance targets one sets the goals in the direction of customers, owners, employees, society and partners. Quality work includes continuous improvement. After a large-scale reform or development project we cannot rest and take a break, but continue to work immediately. The basics for quality development are feedback systems, audits, evaluation of methods and tools, as well as following the outside world. Things can always be done better. Quality cannot be separated from the production and delivery

process either, production output is only a part of the customer perceived quality. Customers who are actively involved in the production and delivery process, will experience it. That is why the process and process interaction situations are part of overall quality. (Lecklin 2006, 55-61, Grönroos 2000, 96-114)

2.2 Quality deviation costs

Quality costs are all the costs that would disappear if everything was done right the first time. Quality costs will tell one how much work in the company or its processes is not value adding unproductive work or other stranded costs. Quality cost accounting is not an end in itself. Quality cost accounting is a procedure closer to business change management rather than accounting and finance. Quality costs can be used to identify the most viable target for improvement, even though there can be found varying opinions in the matter; according to Edward Denning it is unnecessary to clarify quality costs, because only an insignificant part of the quality costs can be determined. Another well-known American quality pioneer Joseph Juran represents a completely opposite view. According to him the top management will not respond to anything, if its own language, money is not used. Due to quality cost accounting many companies have identified and corrected errors and the company's performance has improved. (Järvinen, Lemetti, Virtanen, Lillrank & Malmi 2001, 11-20)

Grade	**Cost type of poor quality**	**Definition**
1	Traditional costs	Clearly caused by errors in production
2	Hidden costs	Unidentified by accounting and finance
3	Lost profit	Customer dissatisfaction
4	Costs caused for customer	Caused by the delivered product
5	Socioeconomic costs	Caused for society

Table 1. Breakdown of poor quality costs (Modified from Järvinen, Lemetti, Virtanen, Lillrank & Malmi 2001, 21)

Quality costs are seen as consisting of costs associated with poor quality or its prevention. Quality costs are formed in all areas of the company's operations, in actual business processes as well as in their support processes. The intention of quality cost accountings is not to cut costs but to point out the most profitable targets for improvement. (Järvinen, Lemetti, Virtanen, Lillrank & Malmi 2001, 11-20)

Internal error costs are those costs which are caused by errors that are found before the delivery of the product to the customer. These may include for example debugging and repair, scrapping, rework, as well as the cost of a waiting period caused by errors. Also re-checks are considered internal error costs when the inspection is carried out after error correction. In addition to the foregone manufacturing costs, poor quality costs are also lost margins when operating at full capacity, assuming that all products can be sold. Income losses due to stoppages caused by equipment breakage should also be taken into account. (Järvinen, Lemetti, Virtanen, Lillrank & Malmi 2001, 34-44)

Internal error costs can be divided into the following:

- faulty (rejected)
- reworks (repaired)
- testing of repaired products
- restructuring production
- profit margin of rejected products

(Järvinen, Lemetti, Virtanen, Lillrank & Malmi 2001, 23)

It is generally recognized that the error costs will increase the later the error is discovered. When discussing error costs the most important costs to be remembered are due to poor quality:

- immediate work with overtime compensation
- indirect labor, including for example salaries for staff and supervisors

- immediate material, i.e. raw materials and accessories used.

(Järvinen, Lemetti, Virtanen, Lillrank & Malmi 2001, 42)

Prevention is the cheapest way to eliminate errors. Most of the quality costs, for example scrapping, loss, guarantees, liquidated damages recorded by economic and operational systems generally do not include indirect unproductive costs associated with quality costs. Consequently, the results and decreases to the actual error costs from the improvement measures may not appear in reports. This will reduce the experienced management benefits of quality improvement and also the quality cost accounting utilization as a potential performance indicator. There are three main sources for information related to the calculation of quality costs: information systems, follow-ups and reviews. Although the information system does not give all the direct quality costs, it provides valuable information for quality cost accounting. Information enables us to calculate the average and unit costs of labour and materials, which can then be used in analysis. Along the way, it has been observed that companies have invested time and money on direct labour and materials analysis in their systems. In terms of indirect costs companies have been generally vaguer, although in some cases indirect costs can account for several times the direct labour costs. Part of the reason for this is that it is difficult to align indirect costs in traditional systems. (Järvinen, Lemetti, Virtanen, Lillrank & Malmi 2003, 100-106)

The costs of failing to control quality are the costs of producing material that does not meet specifications. They can be broken down into the following:

- Internal failure costs are the costs of correcting problems that occur while the goods are still in the production facility. Such costs are scrap, rework, and spoilage. These costs would disappear if no defects existed in the product before the shipment. (Arnold, Chapman & Clive 2014, 52)

- External failure costs are the costs of correcting problems after goods or services have been delivered to the customer. They include warranty costs, field servicing of customer goods, and all the other costs associated with trying to satisfy the customer complaints. External failure costs can be the most costly of all if the customer loses interest in a company's product. These costs would also disappear if there were no defects. (Arnold, Chapman & Clive 2014, 52)

The costs of controlling quality can be broken down into the following:

- Prevention costs are the costs of avoiding trouble by doing the job right in the first place. They include training, statistical process control, machine maintenance, design improvements, and quality planning costs.

- Appraisal costs are the costs associated with checking and auditing quality in the organization. They include product inspection, quality audits, testing, and calibration.

(Arnold, Chapman & Clive 2014, 52)

3 Process

3.1 Definition of process

A process is a set of interrelated, repetitive actions which require resources, so that the process will go forward. Each process should have an owner who is responsible for process operations, results and development. The processes are part of the company's operating system, and their task is to describe the company's business logic. An action process is a set of logically related actions and needed resources that will provide results. (Laamanen 2002, 19)

A process can be thought in terms of being something repetitive and permanent which can be modeled, as well as developed. A process always has a beginning and an end, and the most important customers, products, feeds and suppliers. The personnel are the company's most important asset, and they control processes by working in them. Laamanen (2002) states that important functions in organizing operations according to processes are:

- process evaluation
- registering the roles
- starting measurement
- creation of teams and networks
- knowledge analysis
- analyzing tools
- process audits.

(Laamanen 2002, 96)

A business process refers to a set of interrelated tasks, which together generate business results. The process has an internal or external customer for whom the process creates added value. The process can also be defined as a chain of functions, which allows the company to change the received inputs as income to the customer. A process, as opposed to a project, is a recurring set of tasks that can be defined and measured. A process can be controlled in a way that the results or deliverables meet the set quality standards. (Lecklin 2006, 123-124)

The production process starts with impulse, when energy, raw materials and other required inputs are imported. It occurs as an activity (process) and it has an output. In addition to the process output there may occur emissions and waste as by-products. (Tuurala 2010)

3.2 Process types and process owners

3.2.1 Process types

In the process thinking there are six different types of processes that are defined, which are as follows: core processes, support processes, key processes, main processes, part processes and sub processes, and the step or task. Next we will address what each process type holds.

Core processes are serving the external customer. They are based on the company's dynamic capabilities. With the help of core processes the company can find and refine their abilities and expertise into products, which creates added value to the customer. Typical core processes are R&D, production and customer service. Core processes should be defined as broadly as possible in view of the interfaces with the supplier and customers, as well as other processes within the company. Core processes are essential for business and directly related to the external customer service. They are the processes in which the input current is formed. They begin and end with the customer. They begin with customer expectations and end with customer satisfaction. The core processes already start with the customer and end only with the customer, regardless of where the owner limits are changed. (Lecklin 2006, 130; Laamanen & Tuominen 2012, 21)

Key processes are related to the organization's success factors. They are all of the company's most important processes and at the same time the priority areas for development. Key processes can be core, support or their sub processes. Main processes are essential and extensive in an overall picture. Main processes are often core processes. (Lecklin 2006, 130)

Part and subprocesses are on the lower level in the hierarchy of processes. Step or task is an activity belonging to the lowest level of the process. Work step is an entity usually carried out in whole. In process description a step or task does not have a process chart but is attached with work instructions. (Lecklin 2006, 130)

3.2.2 Process owners

The owner of the process is a leadership role brought by process thinking. He/she can be compared to a business unit manager or department manager in a functional organization. His/her task is to ensure business process results and performance affecting the whole process. He/she defines the content and settles interfaces with other processes to create a functional process entity. Process owner is responsible for the results of the process meeting the set standards. The responsibility includes, among other things, solving problems, or obtaining a solution, if it requires external decisions, choosing the right indicators and monitoring them, as well as process audits for ensuring quality. The owner also has to identify potential needs for changes and to assess their impact on the process. The owner is also responsible for the acquisitions of resources and effective functioning of the process personnel. (Lecklin 2006, 130-131)

3.3 Process description

Process descriptions are a part of the quality system. With the actual process the quality system also includes measuring and control systems, and their task is to collect feedback about the process during and after it. In addition to a visual presentation of a process it is advisable to draw up a verbal overview. It describes the main issues of the process. (Lecklin 2006, 137-138)

When processes are described, it is necessary to solve the structure of the description. In the organization one should stop for a moment and make a conscious choice about

the issues to be described. Describing selected issues makes them more relevant to the organization. There is sometimes fierce debate, dialogue at best, around the issue, which in this context means that on the question being asked we will get several different perspectives. Trough different aspects people involved in the dialogue become aware of important ideas and principles, and the realization of which one they want to promote. Process description includes what is important for the organization's success. (Laamanen 2002, 77)

A good process description:

- Includes critical issues from the process point of view
- Presents dependencies between issues
- Helps to understand both the entity and its role in achieving the objectives
- Promotes co-operation between people working in the process
- Provides an opportunity to work in a flexible way according to the requirements of the situation.

(Laamanen 2002, 76)

A process chart divides the process' steps and persons involved, and represent functions in a drawing. The aim is to illustrate the contents of process descriptions. (Lecklin 2006, 140) Actions are described for many different purposes. Such purposes include for example understanding and improving operations and development of information systems, and understanding that the operations provide a base for self-direction, speed and sensitivity. A relatively rough description is sufficient for understanding. Improvement needs a more detailed description of the subject. It is important to agree on an appropriate imaging technique, since it defines the language of the development. If people speak a different language, it will be difficult to understand one another. (Laamanen 2002, 79)

According to Laamanen (2002) the most difficult thing to understand is how closely the activities should be described in the process chart. To this Laamanen has not found any good rule. The main recommendation is that the process should be described in such

detail that its logic is apparent. Almost all processes are associated with hundreds of actions. All of them should not be described in the chart whose objective is to understand. The situation will change substantially if the description is for process or information system development, or part of a problem-solving project. In this case, there is a need for detailed descriptions. Too precise describing leads to a large number of subprocesses, which do not help in understanding. The aim is to identify the critical functions and decisions and to promote their good execution. (Laamanen 2002, 81)

3.4 Process measurement

Measurement has become such an accepted approach within organizations that considerable effort is expended in trying to identify “What” can be measured and “How” to measure it. However, few people genuinely challenge “Why” they should measure in the first place. Measurement activity incurs costs to both implementation and maintenance. Without the knowledge of the exact circumstances under which a measurement system either will or will not improve performance, it is difficult to genuinely justify the additional cost of implementing a measurement system. (Robson 2004, 510)

Measures should not be selected randomly, but should together form a whole that reflects important characteristics and performance aspects of the process studied. A balanced and related set of measures is needed. The collecting of unrelated measures may even be counterproductive. (Process Measurement 2002, 262)

Organizations measure performance for several purposes. We can measure a whole organization’s performance for example from the economy, efficiency, customer satisfaction, and motivation perspectives. These are known as strategic indicators. Performance is measured in order to improve and develop the organization’s effectiveness, when the indicators are, for example, shortening the lead time, productivity improvement and cost reduction. (Laamanen 2002, 154)

To enable optimal business operation companies must know how their internal processes work. When business leaders know the performance of their processes exactly, they will be able to react to any situation in the correct way. To this end company has to be able to measure the processes and their performance and based on that information the company can either keep the process intact, develop it or even eliminate it entirely.

With indicators one can produce important information related to success. (Study notes 2013)

If one can not measure the process, one can not control it, and if one can not control it, one can not lead and manage it. Support processes are managed by indicators, because product development, production, and delivery processes have their own indicators. Performance indicators measure the quality of the final product in the process. We can review the different external features such as durability, performance, weight, dimensions and so on. The indicators can also be of value for the customer, customer satisfaction and market success. The quality of the process end result quality is important to the customer, and plays a key role in the returns obtained by the company from the process. (Lecklin 2006, 151-152)

Internal quality indicators are generally associated closely with the company's capabilities rather than performance management. Process measurements should rather give information about the evaluation and development of the process than of monitoring its financial performance. For example the gross profit margin is not a good measure of the process, because following it will create the difficulty in identifying how the process should be improved to raise the profit margin. Monitoring the quality cost of the agreed indicators related to sales and production processes provide more information on where the changes should be made in the process in order to raise the profit margin. In industrial and control processes part of the indicators are real-time supervising indicators, so that when a certain limit value is reached, they will automatically adjust the process, for example the temperature or start a repair or exception routine such as an alternative power source. A large part of the process indicators are however statistical indicators; in other words, they can be read and interpreted only after the process. (Lecklin 2006, 151-152)

For a good process indicator we can set the following requirements:

- reliability
- unambiguity
- understandability and ease of use

- fairness
- affordability
- speed
- relevancy.

The indicator must be clear so that its interpretation does not create controversy. One should not be able to manipulate it to one's liking. There should not be too many indicators set, only a few, that describe the essential and important things in the process. If the personnel involved in the process are connected to the indicator, they should be able to influence the indicator by their own work. Using the indicator should not be expensive. Separate data collection will always cause additional costs. It is important to get results quickly. A good indicator is forward-thinking and guiding into the right direction. The indicator also is not eternal. The indicator's functionality should be regularly assessed. When the process changes and develops, it is often necessary to develop also the indicator. (Lecklin 2006, 153)

Each process is a target for measurement. Strategic process indicators, which stem from the company's values, visions and mission are set for key processes. Diagnosis indicators should also be in the lower levels of the process hierarchy. The company's management sets the key indicators, but defining indicators does not work exclusively on the top-down – principle, but the process teams should have a say in the indicators. The team involved in the process knows the important points to watch and is generally better able to show indicators that are relevant for development. (Lecklin 2006, 152)

Neilimo and Uusi-Rauva (1997) highlight the importance of indicators in quality and productivity. Indicators also serve as excellent management tools. When the measurements are done properly one will get tangible results to show to the employees and the results will serve as an incentive.

One aspect in management is influence. Incentives are aimed at influencing employees' productivity and achieve better results. At their best correctly selected indicators and properly set out results have a positive impact on the work community. After a well thought-out selection of indicators one must begin monitoring the results given by the

indicator. According to Neilimo and Uusi-Rauva (1997) the results given by the indicator must be used efficiently for the benefit of the managing company. That is why the company has to set the operating principles for measurement results. This includes among other things the following questions:

- Who is responsible for the end result?
- What is the target value, critical limit value?
- What is the print mode, display format?
- To whom do you report the results?
- How often are the results reported?
- Who takes care of calculation?

When developing indicators one need to take into account that all measurement results should not be so-called “hard values”, which are clear, unambiguous figures. Because of a good atmosphere and employee satisfaction it is also important to measure “soft indicators”. These indicators measure people’s feelings and views. One of the possible “soft indicators” could be the overall atmosphere of the organization. (Neilimo & Uusi-Rauva 1997, 292)

3.5 Process development

A company’s processes indicate how well the company understands its own operations as well as effectiveness. For a company to be able to develop its operations, one must first asses the operations and current state. The basic premise is that without an assessment improvement is not possible. After the assessment the company is able to identify critical areas for improvement. When designing or developing a process we need to know what the critical functions in the process are. (Robson 2004, 511-512)

Martola and Santala (1997) indicate that continuous change is key feature in business, and in the public sector. According to Martola and Santala (1997), organizations need to

manage the process of change and in order to keep up with the change, the organization must be ahead of change in the operating environment. Companies must, therefore, in practice be able to predict changes in the environment and adapt to them before the changes occur.

Desire or need to change usually starts when something goes wrong. Potential initiators for change can also be for example the company's new management. Martola and Santala (1997) describe that change needs enough negative push factors, i.e. incentives to leave the old model and positive push factors which describe the urge for a new approach.

Process development is an essential part of change. Managers of the organization should constantly analyze the state of current processes and the need for change. Good process indicators will help in this. Continuous improvement helps the company also in fact that changes do not need to be radical every time. Martola and Santala (1997) also indicate this: The changes cannot always be radical, but after a radical change a company needs to aim at permanent evolutionary development. The aim is therefore continuous improvement model. A model of continuous improvement is a never-ending quest to always develop small things to be slightly better. Companies should concentrate on actions that could be removed from the process, while making the process more straight forward.

3.5.1 Continuous development

Continuous development of processes is important in ensuring good quality and maintaining efficient operations. Development is also important because the process has to meet the targets also in the future.

The aim of process thinking is that each player in the organization understands the whole and their share of the entity. The intention is that the organization interface with customers is the results and not the operational units, and when one wants to improve and develop it will be based on the customer's needs. (Liiketoimintaprosessien kehittäminen 2006)

The process development (Figure 1) begins by describing the current state of the process, and analyzing process' features and the state of process indicators, as well as

expectations for the process. At the end one defines the process again and prepare an implementation plan for change, taking into account the training of personnel and informing. (Liiketoimintaprosessin kehittäminen 2006)

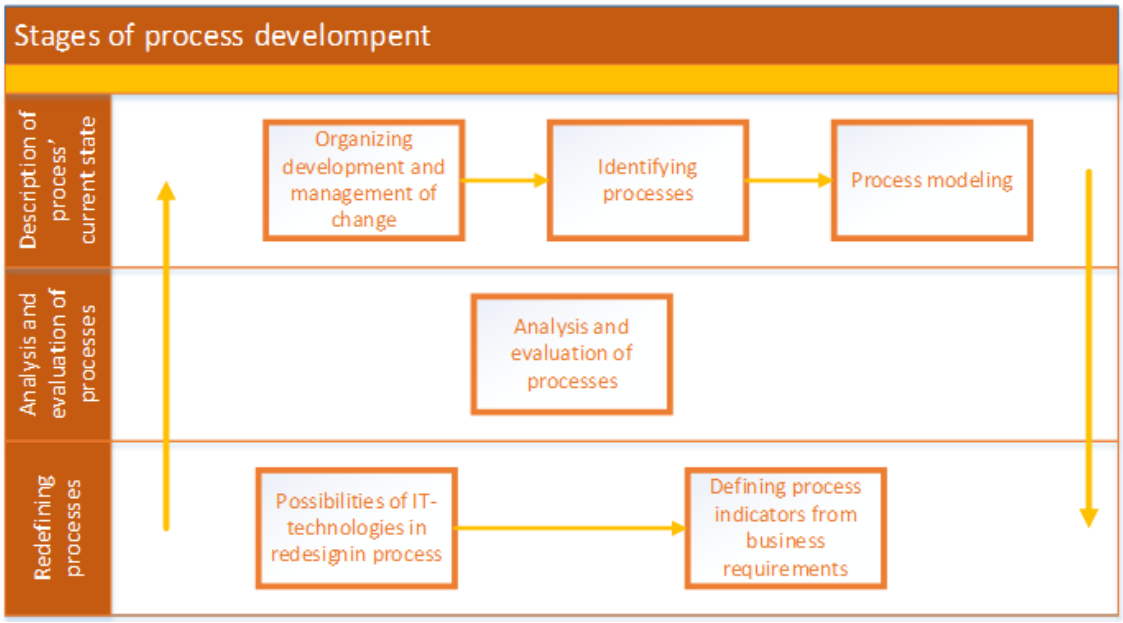

Figure 1. Stages of process development (Modified from Liiketoimintaprosessien kehittäminen 2006)

The employees are most familiar with the current state of the process. Management usually sets the criteria for the target state, of which the middle management may present their own views. The middle management and workers are involved in describing the target state, particularly new employees may have innovative ideas. In addition to representing external points of view in the depiction of the target state you can have employee from other processes or external "sparring partner", which will bring visions based on previous experience of the new approaches to implementation. (Liiketoimintaprosessien kehittäminen 2006)

Redesigning a process requires communication between different people, as well as the right people to work at the right time. Process development can only be achieved if the organization is committed to it on every level, meaning everyone in management, middle management and employees must participate. Consultants can often be used to help, but they cannot do the job on behalf of the company. It will take a long time to introduce the newly defined processes if the lower levels of the organization are not committed to

change and do not see themselves benefiting from the new practices. (Liiketoimintaprosessien kehittäminen 2006)

Continuous improvement of processes is based on continuous assessment of activities. To achieve evaluation success, quality objectives are set for process operations, which will be monitored with process indicators. When measurement requires resources, one can not measure everything about the process. One should identify critical steps of the process, set controlled approval limits that fulfill the requirements and create indicators that make it possible to monitor development. Many requirements in line with the process are defined by estimating the values statistically. (Tuurala, 2010)

Improving the performance of the processes is created as a continuous action. A learning organization's characteristic is that it is constantly seeking targets for improvement actions. Everything cannot be constantly improved. Activities that do not have particular problems should not be tampered with. In improving, the situation where the process will be adjusted, although in reality the change is kept within the allowed limit or due to external causes, is called an alpha-error. When facing real problems one has to be able to make choices. There is no need to start everything at the same time. Within the scope of quality work, methods have been developed for understanding the causes of the problems, and to evaluate their significance and means of finding a solution. Many of them are used in the frame of PDCA – cycle. (Tuurala, 2010)

PDCA is an iterative four-step management method (Figure 2) used for continuous improvement of processes and products. PDCA stands for Plan-Do-Check-Act (or Adjust). PDCA – cycle is also known as Deming cycle, Shewhart cycle or control cycle. (Wikipedia – PDCA, 2015, ASQ - Plan-Do-Check-Act (PDCA) Cycle)

Figure 2. PDCA Cycle (Copied from PDCA Lean Methodologies)

Explanation of the acronym PDCA is as follows:

- Plan: recognize an opportunity for improvement and plan a change.
- Do: test the change. Carry out a small-scale study. Collect data for the next steps.
- Check: review the test, analyze the results and identify what you have learned. Compare actual results against the expected results.
- Act: take actions based on what you learned in the previous step. If the change did not work, go through the cycle again with a different plan. If you were successful, incorporate what you learned from the test into wider changes. Use what you learned to plan new improvements, begin the cycle again.

(Wikipedia – PDCA, 2015, ASQ - Plan-Do-Check-Act (PDCA) Cycle)

PDCA-cycle is an important method for continuous quality improvement. It is somewhat misleading to talk about a cycle. It would be more correct to talk about a spiral. In the model, development is seen as an unending process in which connected stages follow each other rising on a higher level of development. Within the model a variety of quality methods are used in searching for development targets, investigating, understanding and repairing as well as assessing the results of the development. Applying the method and carrying a project through requires expertise in the use of quality methods. (Tuurala, 2010)

3.5.2 Process tailoring

It does not matter how well a process is understood, how often it is used or how well specified it is, since processes always need to be tailored. Tailoring a process means specifying it in some way, which could be for any number of reasons:

- A natural evolution of the process due to change in internal process requirements: All processes must be reviewed periodically to ensure that they are still fit for the purpose. As time passes on, the process itself may evolve in terms of the way that it is being implemented by people in the organization.

- A natural evolution of the process due to change in the organizational requirements of the process: in many instances, the process must evolve due to change inside the organization. Maybe the business of the organization has evolved and the processes need to be checked to make sure that they meet the new requirements – in other words, validation.

- A forced evolution of the process (change in external requirements): As well as the internal, organizational requirements for a process to change, there can also be external, or outside, influences that affect the process.

- New applications/projects: As time goes on, any organization will evolve in terms of the way that it operates, the products that it produces, and so on. As the organization evolves, then so must the products.

- Off-the-self process: The process may be an off-the-self process that can be bought from a specialist company, such as the content of a book or standard or,

in some cases, a shrink wrapped product. Any predefined process will invariably not meet every requirement of any organization. Such an off-the-self process is an excellent basis for a bespoke process model but, as is the inherent nature of any bespoke system, it must be tailored to meet specialized requirements.

(Holt 2009, 47-49)

4 Research methods

In this chapter the research method used and reasons for choosing it are presented. Since the study focuses on a certain process in a specific environment, choosing the method was not difficult.

On a general level the research method means a systematic way to perform a task, i.e. try to resolve a problem, explain or predict a phenomenon or to try to develop a mode of operation. Research methods can be divided into two interrelated subsections.

- Data collection methods: ways in which the findings are generated, e.g. interview, inquiry, perception etc.

- Analysis methods: ways and regularities, according to which findings are processed, analysed and interpreted so that conclusions can be drawn.

(Pönni 2013)

A case study usually investigates only one of the following: an event, a process, a person, a group of people or an object. A case study is a specific and fundamental description of a selected phenomenon. The starting point is to gather diverse information of the selected case and present it thoroughly. A case study usually views a complicated long-term phenomenon, so it easily answers questions how and why. The goal of a case study is to increase the understanding of the selected case. A case study can also try to describe or explain a certain case. (Laine, Bamberg & Jokinen 2007, 10, 31)

The research will dictate the kinds of research methodologies one uses to underpin ones work and methods one uses in order to collect data. Research methodologies are divided into quantitative and qualitative. In quantitative research one usually measure variables and verify existing theories or hypotheses or question them, basically it is figures and statistics. Some people feel more comfortable with quantitative research because figures are safer and more reliable because they can not be challenged as easily as opinions. However, collecting statistics and crunching figures do not give answers to understanding meanings, beliefs and experiences, which are better understood through qualitative data. These methods are also used together to back up the results gained by other methods. (Palgrave Study Skills)

The best way to approach the scrapping process in this study was through participant observation, a typical data collection method in qualitative research. With this method it was easiest to gather up to date information about the process, its current state and how to improve it. Participant observation involves variable methods such as informal interviews, direct observation, collective discussion, participation in the group and analysing documents produced within a group. (Participant observation, Wikipedia 2015)

The purpose of interviews, formal or informal, is to explore the views, experiences, beliefs and/or motivations of individuals on specific matters. Before an interview takes place, respondents should be informed about the study details. This gives respondents some idea of what to expect from the interview. (Data collection strategies II: Qualitative research)

The best benefit of observation as a data collection method is that you can get first-hand knowledge in a natural environment. Also one can make an analysis of the behaviour, attitudes and situations more accurately. Only problem is that the information one gains from observing the object of the study is difficult to transform into academically useful information. (Räsänen 2009)

The first steps in beginning the study are to analyse the research problem, figure out what information one needs from the interviewees and find out who can provide the needed information. (Räsänen 2009)

5 Scrapping process

In this study the term scrap or “own scrap” refers to the components that are for some reason faulty but cannot be complained about to the supplier, an item has broken due to a worker’s mishandling or components revision changes and the old revision can’t be updated or used as such anymore. These are components that cannot be used in any way and are physically thrown away. Internal errors generate scrap and the costs fall into the category of traditional costs. At the moment ABB does not do any corrective actions to decrease the amount of scrap.

ABB Oy, Drives uses SAP ERP system for material and warehouse management. All the materials that are in the factory are managed in SAP. One can see the basic information of items, balances, requirements etc. in SAP with transaction MD04 – Display Stock/Requirements Situation. Stock taking for every item is done annually, so stock balance should be correct in SAP.

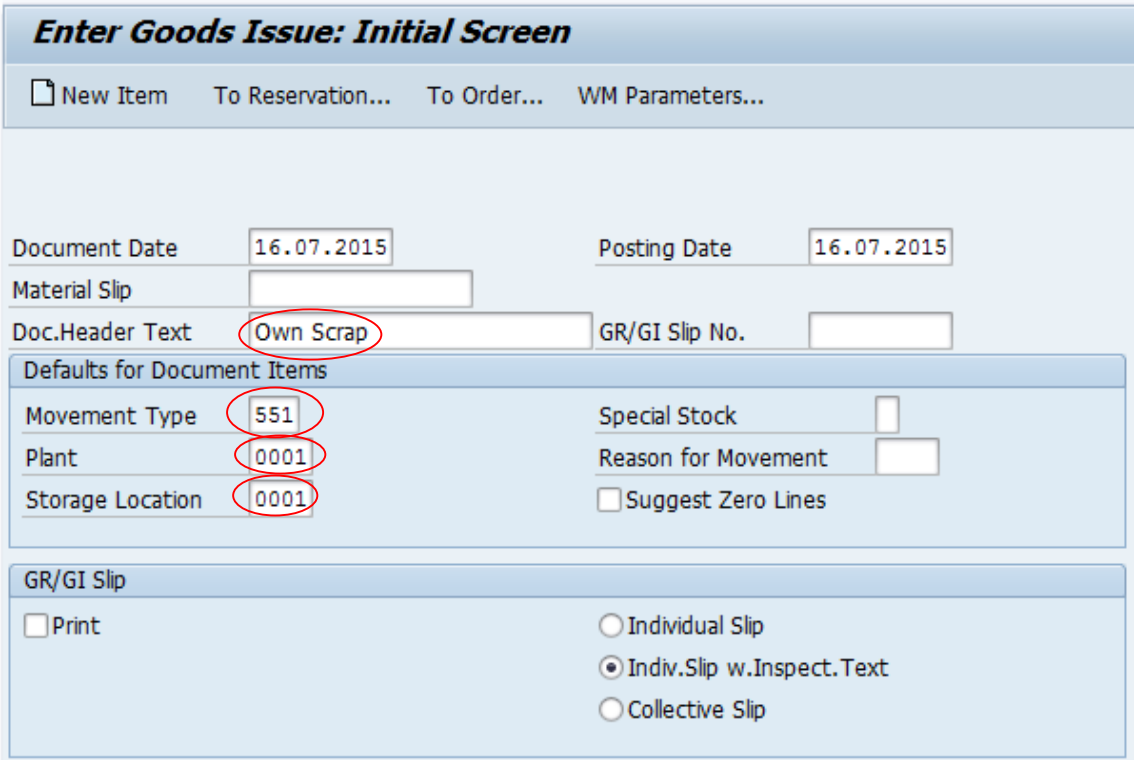

Figure 3. Transaction MB1A – Goods Withdrawal

Scrapping in SAP is done with transaction MB1A – Goods Withdrawal (Figure 3). Fields that need to be filled are Doc.Header Text, Movement Type, Plant and Storage Location.

The Movement type used for scrapping is 551, withdrawal for scrapping, Movement type code for reverse scrapping is 552.

When scrap is generated at the production line and the scrap needs to be removed from stock balance the fields are filled out as shown in Figure 4 using transaction MB1A, for example a production line worker drops the component or in some other way breaks it or if there is not enough sufficient evidence to complain about the faulty item to the supplier. The same movement type is used when something is sent to laboratory or to be complained about to the supplier. In these cases Doc.Header Text is the complaint number generated by SAP when quality notification is opened. At one production line transaction ZNAP is used at the repair station and with that transaction they scrap the one rejected in the test and replace it with a new component.

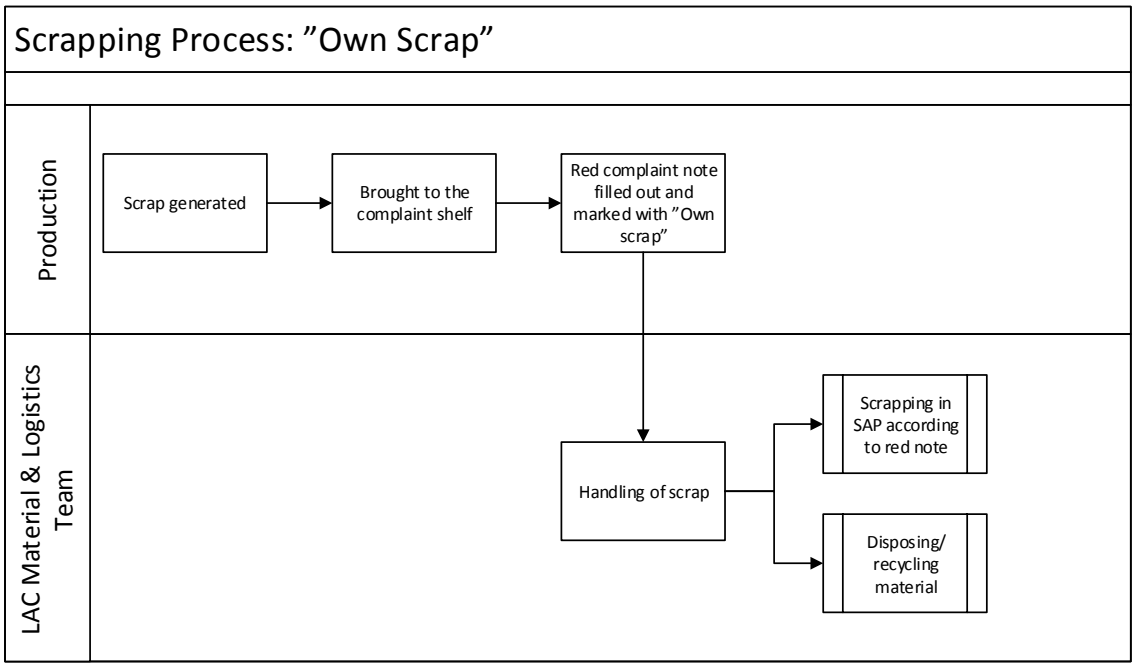

Figure 4. Scrapping Process: “Own Scrap” (Appendix 2)

Currently the scrapping is done by the Material & Logistics team, but there is a need to explore a possibility where the scrapping is done in the production line by the assembler while he or she replaces the faulty component. In Figure 4 is the current scrapping process. It begins with the creation of scrap. After that the worker from the production line takes the component to a predetermined place which is at the moment the complaint shelf of the production line. The worker fills out a red rejection note shown in Figure 5. In the case of own scrap, the production line worker usually fills out the circled information:

material code, fault description and quantity if more than one piece of the same material is broken, and marks the material as “own scrap”.

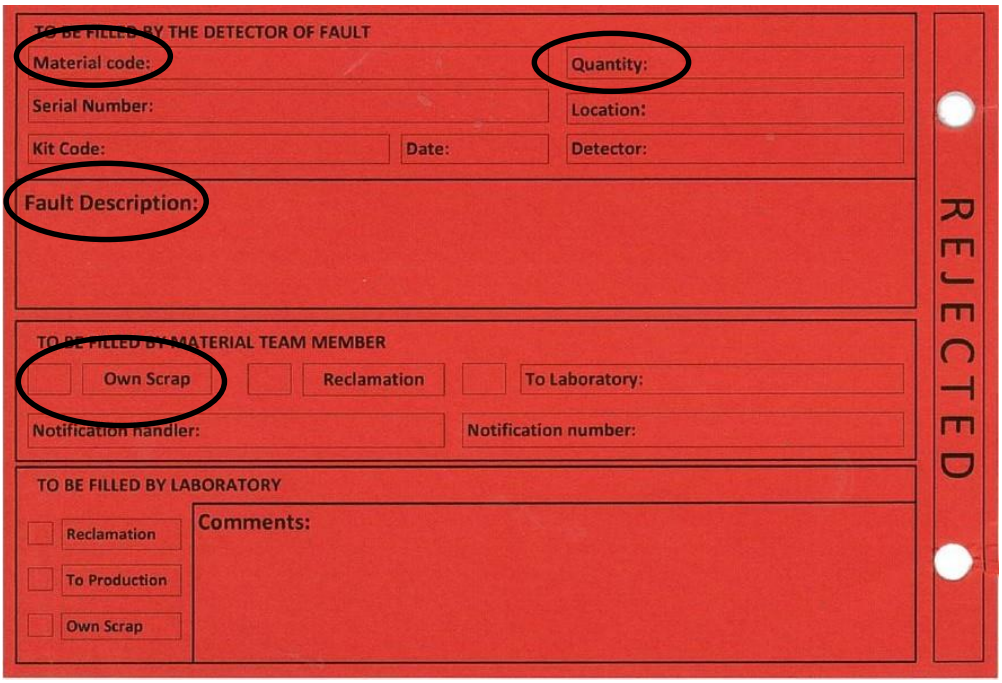
TO BE FILLED BY THE DETECTOR OF FAULT
Material code:
Quantity:
Serial Number:
Location:
Kit Code:
Date:
Detector:
Fault Description:
TO BE FILLED BY MATERIAL TEAM MEMBER
Own Scrap
Reclamation
To Laboratory:
Notification handler:
Notification number:
TO BE FILLED BY LABORATORY
Reclamation
To Production
Own Scrap
Comments:
REJECTED

Figure 5. Red rejection note

ABB does not in any way measure the current scrapping process. There are many indicators for complaints, but none for “own scrap”. It is easy to run a list from SAP that gives all the withdrawals from stock with movement type 551, but that list also contains every piece that has been complained about to the supplier or gone to the laboratory for closer examination. So if we wanted only to know for example how much one production line has its “own scrap”, it would require time to filter the data we get from SAP. Even if someone did this for example quarterly, it would not give us any useful information because we would not know the exact reasons why something is scrapped or by who and where it is done. So ABB is not able to do changes and improvements based on the information they can currently gain from SAP.

6 Results and recommendations

6.1 New process chart and description

Since prevention is the cheapest way to eliminate errors, the new process should be aimed at making prevention possible. An ideal situation is that the scrapping of materials in SAP and physically is done already at the production line by the production line worker. In this way there would automatically be information in SAP about who did the scrapping in which production line and in which workstation. Only manually added information would be a reason for scrapping in the form of already existing explanations. This would reduce the work put into scrapping materials. Instead of two different persons handling it there would only be one. The scrapping process would be more straightforward, less time-consuming and cost-effective. It would release time for the material team to do other tasks.

The benefit of this is that when we know by whom and where the scrap is generated, we will be able to intervene and eliminate problems caused by lack of motivation, training or for example faulty work equipment. With further training we can eliminate mistakes done by the same person over and over again or if it is always at the same workstation that the mistakes occur, regardless of who is working, there might be something wrong with the tools. If it is the same supplier that always delivers pieces that break, even though handled correctly by the production line worker we will be able to intervene and notify the supplier.

The best way to achieve these changes is to start using transaction ZGWQ_ZNAP for removing the production lines “own scrap” from stock. ZNAP is currently used in one of the five production lines by their repair station. The repair station uses it to remove the faulty component and replaces it with a new one and with the transaction is able to maintain the correct tracking information and stock balances for components. So ZNAP is in use only at one repair station and it is only used to manage tracking information when the transaction has potential for much more versatile use. (Nybäck, 2015)

Next I will introduce some development ideas that would make the process work in a way that ABB wants. These ideas, if implemented, would give ABB the ability to measure and develop the scrapping process also in the future.

The new process is shown in Figure 6. The process begins with the generation of scrap at the production line, after something breaks and the production line worker determines it as “own scrap”, he or she will remove the component from stock balance with transaction ZNAP filling out the needed information (listed and explained later) and recycle the component. In some cases the production line worker might not be sure whether the component is “own scrap” or if it can be complained about, he or she will take it to the complaint shelf and fills out the red reject note and Material & Logistics team will handle it from there.

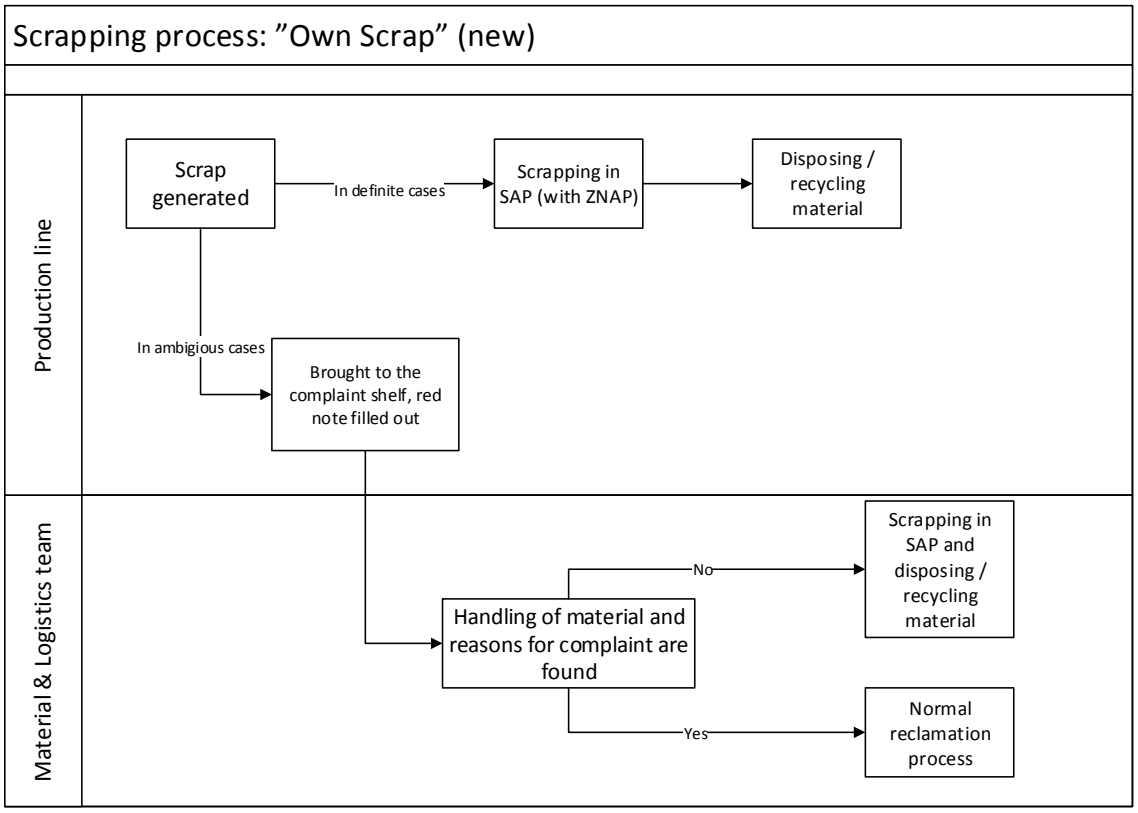

Figure 6. Scrapping Process: “Own Scrap” (new) (Appendix 3)

When everything from complaints to scrap are removed from stock balance with the same movement type, we need to have a way to separate them from each other. The simplest way to do this is to start using reason codes when scrapping in transaction ZNAP or in MB1A. At the moment there are reason codes for scrapping (Table 2) in SAP but they are not in use because they are not useful for ABB’s needs.

New reason codes can also help us separate complaints and components that are going to the laboratory for analysis. Reason codes should be different for complaints, “own scrap” and laboratory components. When using ZNAP, SAP will remove the material

from stock by using movement type 551 and it will create a document number (Doc.Header text e.g.0003xxxxx), which is one way to help us separate them from other components removed with movement type 551.

Movement Type	Reason Code	Reason for Movement
551	0001	Shrinkage
551	0002	Spoiled
551	0010	Prosessi (Process)
551	0011	Aloitussusi (Start defective)
551	0012	Varivirhe (Color error)
551	0013	Pintavirhe (Surface error)
551	0014	Konevika (Breakdown)
551	0015	Viallinen muoviosa (Defective plastic part)
551	0016	Viallinen metalliosa (Defective metal part)
551	0017	Leimausvirhe (Labeling error)
551	0018	Muu (Other)
551	0020	Varaston siivous (Warehouse cleaning)
551	0030	Tuotteen lopetus (Ending product)
551	0040	Testissä hylätyt (Rejected in test)
551	0050	Epäkurantti (Obsolescent)
551	0060	Muu syy (Other reason)
551	0070	Versiomuutos (Version change)
551	0080	Suunnitteluvirhe (Design error)
551	0090	Tilattu väärin (Ordered incorrectly)
551	0100	Hitaasti kiertävät (Slow movers)
551	0110	Rikkoutuminen (Breakage)
551	0120	LSO/LTQ käyttänyt (LSO/LTQ used)
551	0130	Asiakaspalautus (Returned by customer)
551	0140	Visuaalinen vika (Visual defect)

Table 2. Reason codes for movement type 551 (scrapping) in SAP. (Keski-Rahkonen 2015)

Reason codes would give ABB the ability to separate all the different cases form each other. These reason codes can be used in transaction MB1A, but the possibility to use them also in ZNAP needs to be explored. If every work station had transaction ZNAP in use, it would be easy to track by whom the scrapping is done in which workstation, which production line and why, and with this information ABB would be able to measure and improve the process further.

New reason codes should be as simple as possible and with them one should have to be able to separate “own scrap”, complaints and laboratory items. Table 3 shows a proposition of what some of the new reason codes could be. A reason code for complaints is simply used for separating it from scrap and does not give any detailed information about

what the reason for complaining is because reasons for that will be explained in more detail when a quality notification is opened.

Movement Type	Reason Code	Reason for Movement
551	0001	Rejected in test (repsta)
551	0002	Complaint
551	0003	Laboratory
551	0004	Dropped (scrap)
551	0005	Broken threads (scrap)
551	0006	Revision change (scrap)
551	0007	Surface error (scrap)

Table 3. New reason codes for movement type 551 (scrapping) in SAP.

Components that go to the laboratory have their own reason codes. Items that go from the repair station to laboratory are marked with reason code “Rejected in test (repsta)” and materials that go to the laboratory after being handled by the Material & Logistics team are marked with reason code “Laboratory”. All the other reason codes are for “own scrap” and they have to be more detailed because the code has to tell what has happened or why the component is scrapped. These changes would of course require development work in SAP and training of employees, but in the long run it would be beneficial.

6.2 Measurement and indicators

ABB wants to be able to measure scrapping because it is quite a large expense that could quite easily be minimized. Measuring scrapping is a big help in finding ways to prevent errors and since prevention is the cheapest way to eliminate errors, measuring scrapping and analysing the results to find root causes is important and cost-efficient. Scrapping costs are classified as internal failure costs and they are costs that in theory would disappear if no defects existed in the products before shipment to customers. Virtually this is not possible because there will always be mishaps that are unavoidable when people are involved.

ABB needs to be able to pin out the persons, works stations etc. so that certain patterns will be found out and root causes can be determined, not in the sense of being able to

blame workers, but to train them, or if it is about the motivation of workers, to find incentives. With SAP we are able to measure the amount of scrap generated in each production line. If the changes that were suggested earlier were put into practice, it would be easy to separate “own scrap” from complaints. Also in transaction MB51 – Material Doc.List, if possible, we could make scrapped components their own layout or variant, so that it would be easy to get the needed information from SAP to Excel without having someone filter the data.

Changes that need to be done are implementing new reason codes, and taking transaction ZNAP into use in all work stations and production lines. Transaction ZNAP might need changes before it can be used. These changes to transaction ZNAP make it compulsory to fill out the following information:

- Personnel number
- Work station
- Cost center (production line)
- MRP code
- Quantity
- Reason code.

Another change is that a specific work station would have cost centre and work station data automatically in ZNAP as a variant. When these changes are done, it will reduce loss-work and be congruent with ABB’s Lean thinking. After all the proposed changes are done, it should be easy to measure scrapping and through measuring it should also be easy to be able to find targets for improvement and development. Different indicators that ABB wants include the following:

- How much scrap does different production lines have in euros and pieces?
- Who does the scrapping? (Personnel number and amount)

- What is the amount of scrap per workstation, MRP code and reason code?

(Cederlöf 2015)

It is possible to run a list from SAP with transaction MB51 –Material Document List (Picture 3.), which would give the data for the wanted indicators. This is where the importance of reason codes comes in. For example if we want a list with all the components scrapped within the first quarter of 2015 in the factory, we would have to fill out Plant, Storage Location, Movement Type, and Posting Date fields. At the moment we would get a list of all the movements made within that time period with movement type 551. This list would include all complaints, “own scrap” and components sent to the laboratory for analysis.

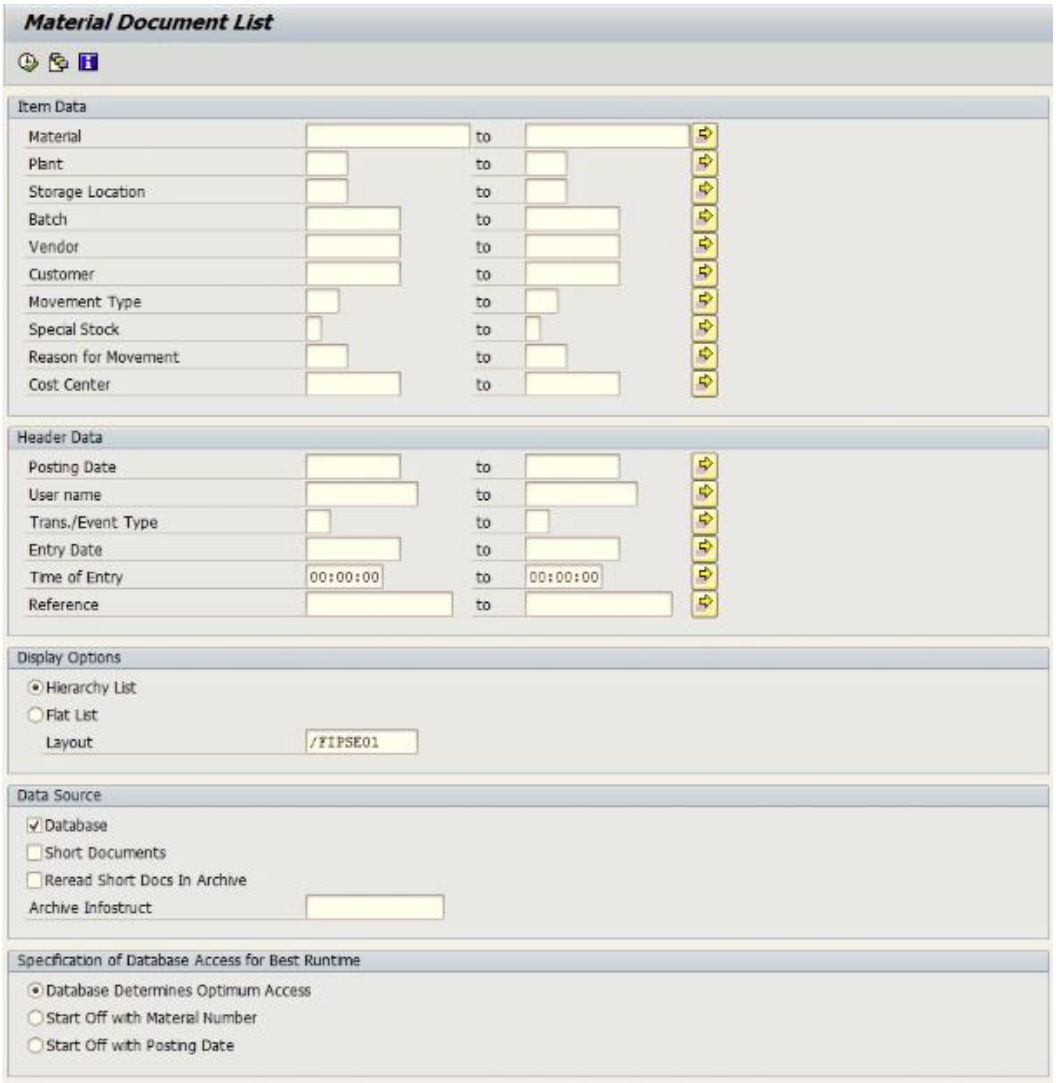

Figure 7. Transaction MB51 – Material Document List

Now if we start to use the proposed reason codes, we can separate all these. For example if we had these codes in use in the second quarter of 2015 and we wanted only to know which pieces complained about to the supplier, we would fill out the same fields as previously but also the field Reason Code with 0001 (Complaint) and SAP would run a list with only those movements done with movement type 551 and reason code 0001 (Complaint). When SAP creates this list, it will be easy to export it to an Excel spreadsheet and make use of the data. The easiest way is to export the data into an already made pivot table that would automatically calculate the wanted data into the wanted indicators that would be presented in different charts.

7 Conclusion

At the moment ABB is not able to continuously improve its scrapping process. There are several changes that need to be done so that ABB would be able to get the information they need, and based on that information develop their process. The first step to continuous improvement of the process is to be able to measure it. Since ABB does not in any way measure their scrapping process, the process will need to be changed so that it is measurable.

The first step in making this all happen is to start using reason codes when making withdrawals from stock with movement type 551. The Material & Logistics team that is currently responsible for scrapping in SAP will take these new reason codes into use as soon as possible. There is an ongoing research concerning transaction ZNAP and how it can be implemented to all work and repair stations and after that research has been conducted, ABB will continue with its results as they see fit. If ZNAP is found to be the best solution, it should be modified so that the information needed for the wanted indicators would be mandatory to fill out in transaction ZNAP. After these changes are done, the tool for presenting the wanted indicators must be chosen so that it will serve ABB's needs. The easiest way to do this is use to Excel, since the wanted data is easy to export from SAP. This is where the reason codes play a big role. Without them it would be impossible to separate all the different cases from each other. In SAP one can exclude all other cases, complaints and components gone to the laboratory for analysis when creating a list of the scrapped components in transaction MB51.

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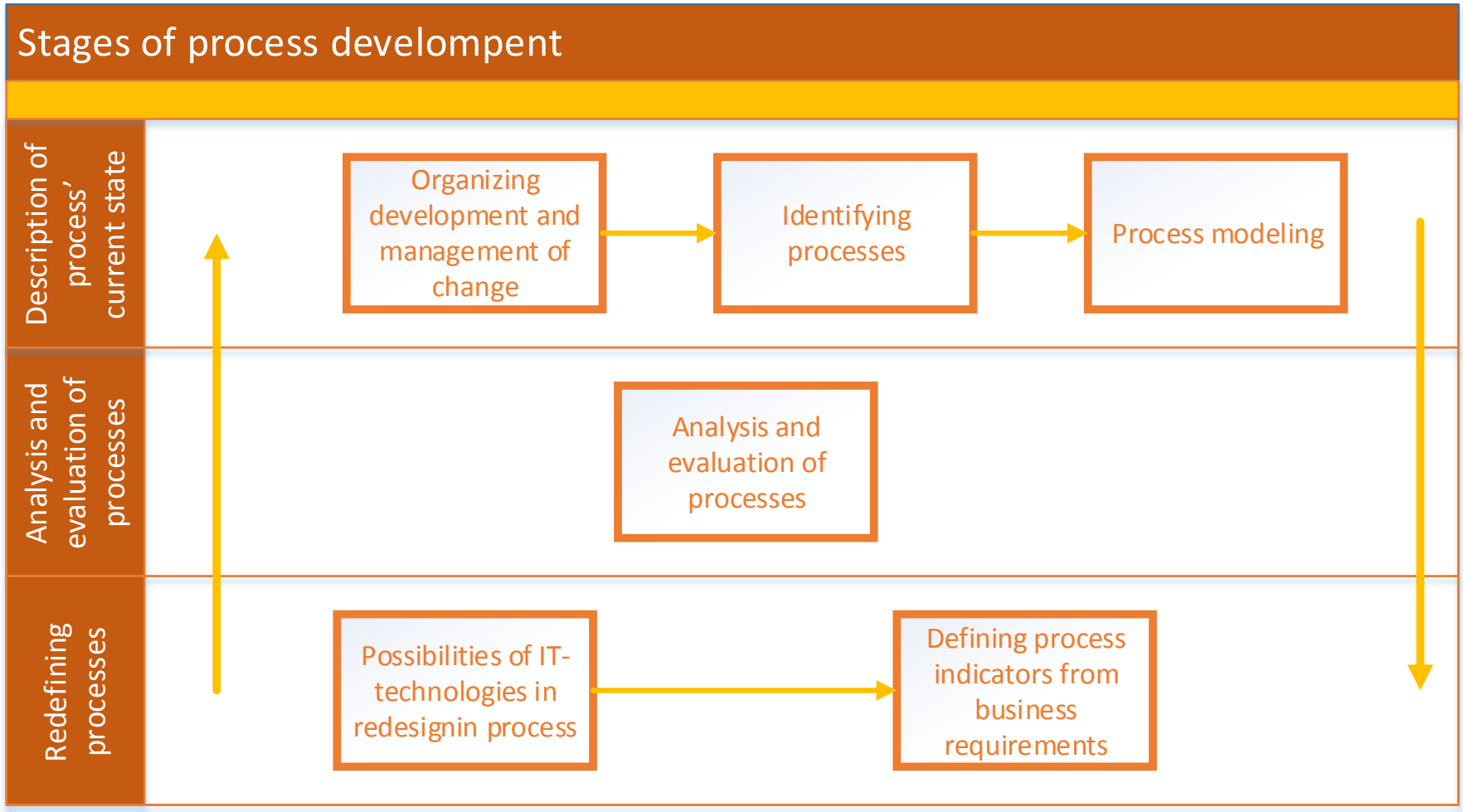
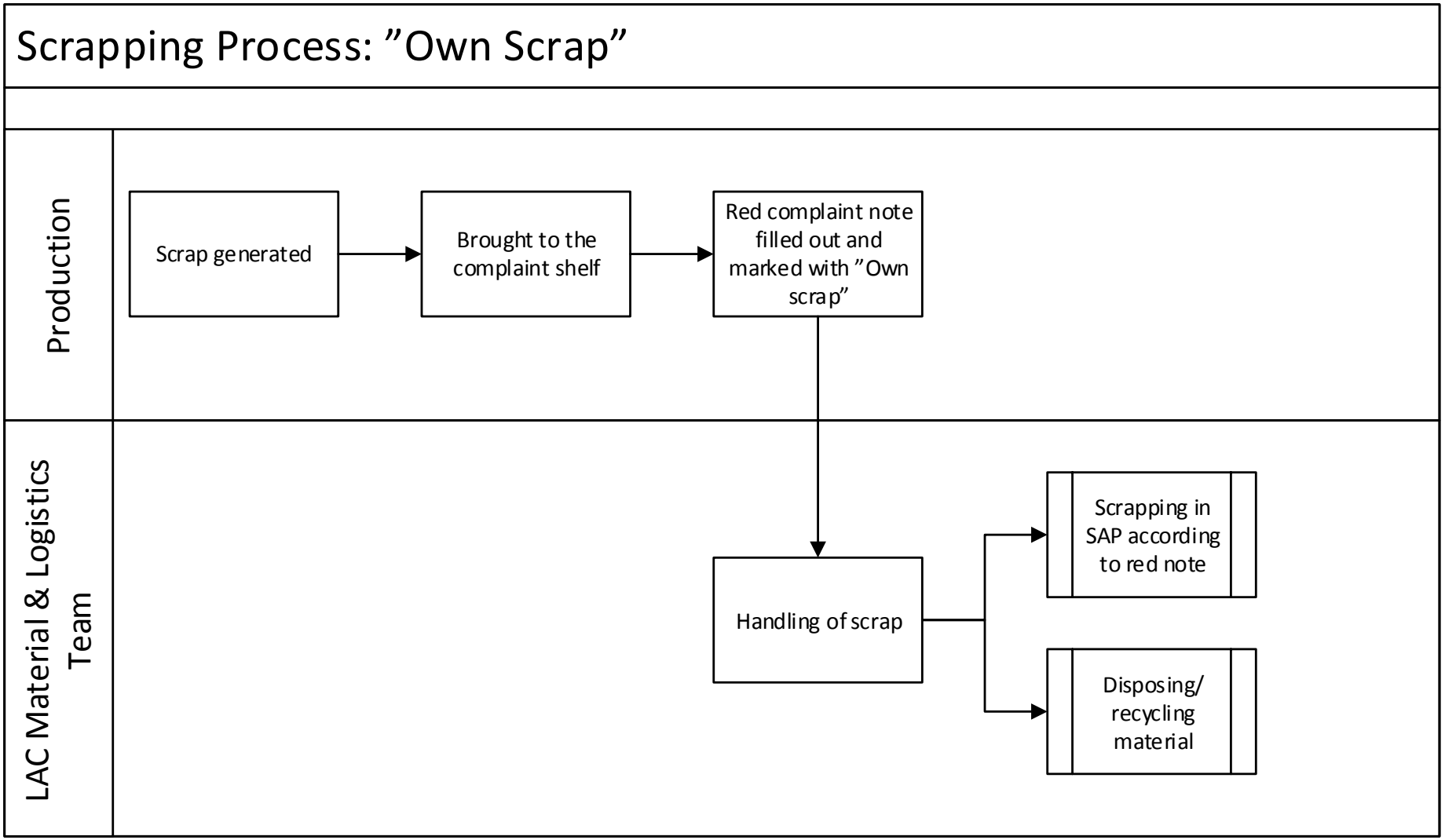
Stages of process development



Scrapping Process: “Own Scrap”



Scrapping Process: “Own Scrap” (new)