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The examination of unclear order lines and what factors behind human knowledge have impact on them

Case study, ABB Oy Motors & Generators

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FOREWORD

I want to thank all of you who have helped me during this process. I am grateful for all the support I have received from my colleagues at university and at work locally and globally.

30.8.2016, Vaasa
Satu Hietala

CONTENT

SYMBOLS & ABBREVIATIONS

DMAIC	Define, measure, analyse, improve, control
ERP	Enterprise Resource Planning
IC	Intellectual capital
IDT	Instructional design and technology
JIT	Just-in-time
KIP	Knowledge-in-practice
KM	Knowledge management
MEPS	Minimum energy performance standard
OMS	Order management system
PDCA	Plan-do-check-act
QM	Quality Management
SPC	Statistical Process Control
TQM	Total Quality Management
VSD	Variable speed drive

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Työolosuhteemme ovat jatkuvassa muutoksessa, ja tällä hetkellä on mahdotonta ennustaa kuinka paljon automatisointi, älykkäät ohjelmistot ja teknologian kehittyminen vaikuttavat tulevaisuudessa työympäristöömme. Yrityksissä yhtenä säilyvänä tavoitteena on kuitenkin saada työntekijöistä paras hyöty irti mahdollisimmin tehokkaasti. Tämä voidaan saavuttaa vain, jos tutkitaan työntekijöiden ympäröiviä työolosuhteita, ja tekijöitä jotka hidastavat tai vaikeuttavat työntekijöiden työskentelyä parhaalla mahdollisella tavalla.

Tutkimuksessa tarkasteltiin inhimillisten virheiden vaikutusta tilaustoimitusprosessin alkuvaiheissa, ja niitä tekijöitä jotka näitä virheitä aiheuttivat. Päämääränä oli selvittää mitä nämä virheet olivat, minkälaisia vaikutuksia niillä oli tilaustoimitusprosessiin, mitkä tekijät mahdollisesti vaikuttivat niiden syntymiseen ja kuinka niitä pystyttäisiin tulevaisuudessa vähentämään ja ehkäisemään.

Tukena tutkimuksessa hyödynnettiin laadunhallintajärjestelmien näkemyksiä virheisiin, ja tiedon roolin tärkeyttä organisaatioiden toiminnan kannalta. Tutkimuksen empiirisessä osuudessa hyödynnettiin tilastollisia ja laadullisia menetelmiä.

Tulosten analysoinnissa saatiin selville, että huomattava osa yrityksen uusista tilausriveistä sisälsi virheen, joka pysäytti tilaustoimitusprosessin heti alkuvaiheissa. Virheitä tutkittaessa havaittiin, että samanlaiset virheet toistuvat. Virheiden syntyyn vaikuttavia tekijöitä olivat muun muassa kiire, suuri työkuorma, päällekkäiset työtehtävät ja ohjeistuksen puute.

Tutkimuksen tulosten johtopäätöksenä voidaan sanoa, että organisaatio menettää tehokkuuttaan pieniin virheisiin, jotka olisivat ehkäistävissä oikeilla toimenpiteillä. Onnistuakseen virheiden ehkäiseminen vaatii organisaation eri tasoilta halukkuutta, sitoutumista ja resursseja toiminnan parantamiseen.

AVAINSANAT: virhe, virheiden ehkäiseminen, tiedon rooli

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ABSTRACT

Work conditions are changing rapidly and it is impossible to foresee how automatization, intelligent programs and technological development will influence on our work environment. However, on organizations one target is to get the best benefit out from the employees in the most effective way. This can be achieved if employees' surrounding work conditions and factors that make their work performance more difficult is examined.

This research examined the impact of human error at the beginning phases of order-to-delivery process and those factors that caused these errors. The aim for this research was to find out what these errors were, how they affect on order-to-delivery process, what factors influenced on their existence and how these errors could be prevented and eliminated in the future.

This research exploit the views from quality management programs and the importance of knowledge for organizational performance. In the empirical part qualitative and quantitative methods were used when results were analysed.

The research pointed out that remarkable amount of new order lines included error, which stopped the order-to-delivery process. When these errors were examined, it was found out that certain errors appeared repeatedly. Factors that influenced on these errors were time pressure, high workload, multitasking and the lack of instructions.

Research conclusion, organization loose its efficiency by small errors that could be prevented with right actions. Preventing errors require willingness, commitment and resources in all level of organizations.

KEYWORDS: error, error prevention, knowledge role

1 INTRODUCTION

Organization core competence is something that unites communication, involvement and commitment in all level of organization. It includes both people and functions in services and shared understanding of customer needs. In the long term, competitiveness is based on the ability to create services or products that are hard to imitate. (Ulrich 1998: 45–51.)

Competitiveness can be valued by surrounding circumstances like prices of the products, economical status or special knowledge shared by the company. Key to achieve competitiveness on markets comes from how well organizations can use its resources and the potential they have. According to Ulrich (1998: 49) base that creates competitiveness is "management's ability to consolidate corporate wide technologies and production skills into competencies that empower individual businesses to adapt quickly changing opportunities".

The idea behind competitiveness and especially people that are part of creating competitiveness on organizations closely relates to this research. This research focus on examining unclear order lines that case company ABB Oy Motors & Generators has on its order-to-delivery process.

ABB is a leading company in power and automation technologies. ABB has invested in research and development and it is a known supplier for its products like motors, frequency converters, wind turbine generators and electricity grids. The company was founded in 1988 but it has a history over 120 years. Today, head office is located in Zurich, Switzerland and globally company operates around 100 countries and it has approximately 135 000 employees. (ABB 2016a.)

Globally, ABB's motor and generator business employs 14 000 people in 11 countries. In Finland, the business employs 1520 people, 530 people works in Vaasa and 910 people works in Helsinki. (ABB 2016b.)

The reason why this research was conducted was that this operational issue is present every day among employees in several departments, not only inside motors and generators factory but also among sales units and their customers around the world. In global working environment, where many employees in various teams and countries must be involved to solve these unclear order lines, it is time consuming and it delays taking care of other tasks each employee has to do.

The purpose of this research was to find out what are these errors, where they come from, how they influence on the order-to-delivery process, what features may cause them, and how they could be prevented. Research questions were selected to keep these points in mind and they are presented below:

1. What type of unclear order lines there are and how they appear at work?

2. What factors behind human knowledge have impact on unclear order lines?

3. Which actions could prevent unclear order lines?

In the second chapter, ideal order-to-delivery process in case company is introduced and how current errors add necessary tasks to this process in reality is also presented. After that, common quality management ideas will give understanding how to see the organizations performance and which directions could be chosen to improve the overall process.

The second chapter also focuses on understanding error and it meaning, and it will introduce how errors appear at work and what features may have impact on their existence. Then different types of problem solving tools is presented which will help to see potential solution for third research question.

Another important topic that relates to research questions, organizations competitiveness and performance is knowledge. In the second chapter, knowledge role and its impact on organization is reviewed and evaluated.

In the third chapter, research methods are introduced. This research consists of two empirical research parts. The first part used a quantitative approach and the second part combines both quantitative and qualitative approaches.

In the first empirical part, under examination are quality notifications created by order clearance, order handling and application engineering departments. For this examination have been selected, all quality notifications during seventeen weeks between June and September 2015. Those quality notifications that had not been resolved or actions made were missing on quality notifications have been left outside from this review. All quality notifications accepted to this examination included a date when the quality notification was created and a date when the matter was resolved. There has also been written information regarding the issue and the solution. Based on this information it was possible to give parameters for these quality notifications. These quality notifications had been created after sales units had entered order lines to the system and before delivery control had released order lines to production. Errors that might have happened after order lines had been released to production was left out from this review.

On the second empirical part, electronic survey was created based on observations received from first part and theory that had been used. The electronic survey was send to employees who are working in sales units around the world. For the validity and reliability, survey was send for those employees whose names were found from these order lines examined in research empirical part one. Reason for selecting this specified group was to ensure these employees know about motors and generators, and have been worked with matters related to them.

Fourth chapter introduces the results that were received from both research parts. First, is presented results related to unclear order lines and then is presented results from electronic survey.

The fifth chapter is for discussion about findings received from this research. Recommendations and suggestions for further research is also given in the fifth chapter.

2 LITERATURE REVIEW

2.1 Where errors come from

2.1.1 A variety of process perspectives

Figure 1 illustrates the order-to-delivery process. The area marked on red presents factory's internal departments. This is a sketch of the ideal process when it goes smoothly from the beginning and it ends when finished product is dispatched to the customer. For example, an ideal situation there would not be errors or possibility for misunderstandings. When product is designed, it should be clear what kind of product has been ordered and need to be manufactured so that the order-to-delivery process would be smooth and efficient. However, an ideal situation like this depicted one cannot always been achieved.

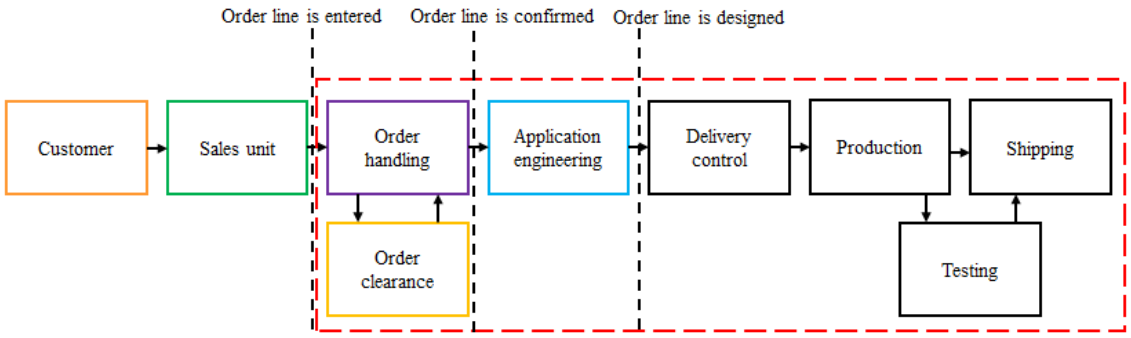

Figure 1. The order-to-delivery process and departments that handle order lines.

In this research, the focus is on errors that appear before order lines are released to production. These unclear order lines can be viewed as errors or invalid input in the process. In other words, this means that there is something wrong with the input and the process stops because of it. The process cannot continue before this invalid input has been corrected. Each error stops the order-to-delivery process and this causes efficiency and

productivity losses. In this research, word mistake is used as a synonym for word error and they mean the same thing. Figure 2 visualize this situation by presenting the process chain of creating and clarifying quality notifications based on errors. In some cases, one round is not enough and there will be several rounds before the issue has been clarified and common understanding has been received. The longer clarification takes time the longer process is stopped.

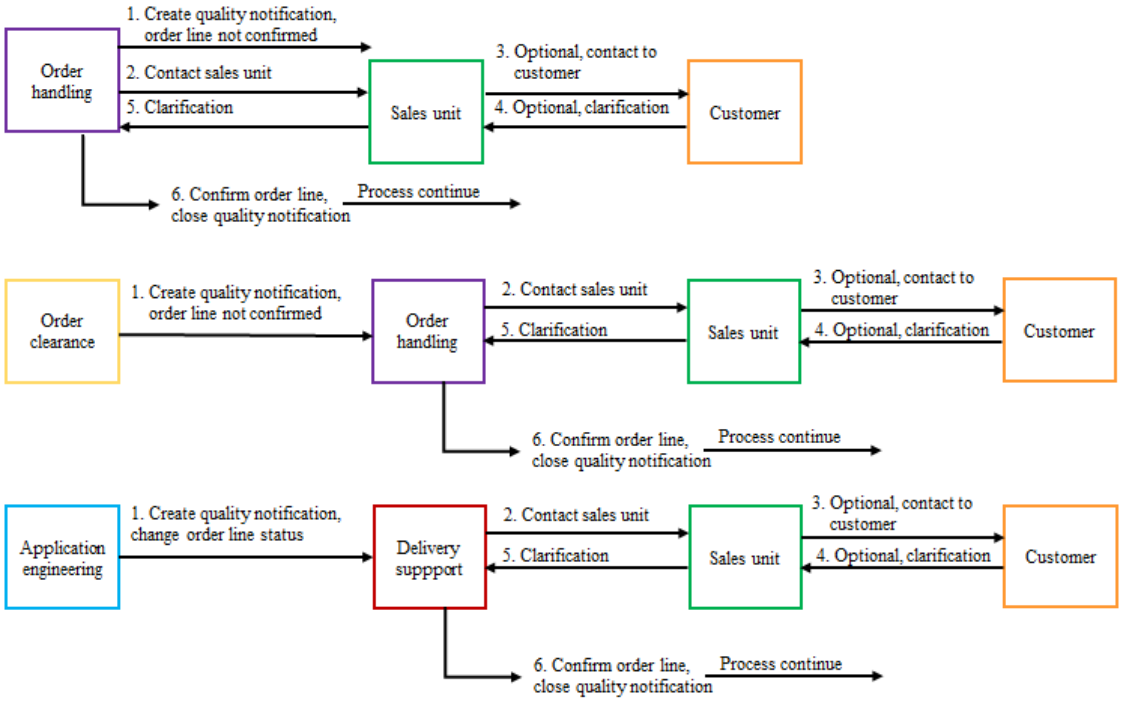

Figure 2. The process chain of creating and clarifying quality notifications.

It is possible to find common theories behind this operational issue that relates to this research depending on the perspective. For example, Total Quality Management (TQM) can be described as a philosophy, culture and attitude of the company that desires to provide both internal and external customers those products and services that fil their needs. TQM requires quality in all points of the company's operations, meaning processes will be done right at the beginning every time, and defects and waste will be exterminated from operations. TQM is a method that involves both management and employees into

the continuous improvement of quality production of goods and services (Fellaque, Bennafla 2015). On the other hand, Six Sigma emphases the idea of improving quality based on data-driven results. Six Sigma focused on prevention of problems by improving process input and this way to improve process output (Chow, Finney & Woodford 2010; Baker, Chow, Woodford, Maes 2012). Lean is often seen as a manufacturing strategy that aims for higher operational performance by eliminating waste in the system and reducing unnecessary tasks that does not bring value to customer (Keyes 2013; Deshpande, Filson, Salem & Miller, 2012; Antony 2011).

Common to these three introduced methods is that they all want to improve quality of operations and processes (Sullivan 2011). Weinstein, Castellano, Petrick & Vokurka (2008) described "quality is not just a collection of facts, theories, and tools. It is an orientation, a way of thinking, and a culture of beliefs, values, and behaviours". Quality has a recognized role in organizations strategies, and maintaining competitive advantage. Thereby, quality in service, products, systems and all its forms affects organization's overall performance. For this reason, TQM, Six Sigma and Lean can be called as quality management (QM) programs (Sullivan 2011; Sharma & Kodali 2008).

Originally, TQM was applied for manufacturing operations and many years only used in that field. Nowadays, it is also recognized as a general management tool that can be applied from services to public sector. TQM support organizations goals to achieve excellence in manufacturing and performance by combining both quality and management tools for purpose to increase business and reduce losses caused by wasteful practices. It is widely understood as a combination of change management strategies that try to face environmental changes in area of manufacturing and service. (Fellaque et al. 2015; Sharma et al. 2008.)

TQM is closely focused on continuous improvement from high level strategic planning and decision-making to detailed performance of work elements on the shop floor. Key idea is that mistakes can be avoided and defects can be prevented. It aims for continuous improvement results by continuously improving abilities, people, processes, technologies and machine performances. Major areas of capability improvement are demand

generation, supply generation, technology, operations and people capability. One point of TQM is that mistakes may be made by employees, but many of them are caused by faulty systems and processes. This leads to a fact that the root cause of these mistakes can be identified and eliminated, and the recurrence can be prevented by changing the methods. (Fellaque et al. 2015.)

The main point to get employees to adopt TQM tools and techniques inside organization is that the human side of these processes is well managed. Management should take each employee to be a part of the change process with facing, training, discussing, involving and challenging employees' opinions and old behaviour models. (Sharma et al. 2008.)

Six Sigma concept is also adopted in manufacturing operations for improving performance but also non-manufacturing, administrative and service functions. Six Sigma requires organizations to build their processes in a way that customer is the key factor and all the functions must support customer requirements and satisfaction. (Weinstein, et al. 2008.)

Six Sigma is known for statistical and non-statistical tools to reduce process variation, for example, Statistical Process Control (SPC), Pareto charts, run charts, multi-variable charts, cause and effect analysis and histograms (Antony 2011; Weinstein et al. 2008). In complex situation Six Sigma tools might not have a clear root cause available immediately (Antony 2011). However, when performing the ideology of Six Sigma it also requires a soft approach and features that are management skills, project leadership, and talent to train team members and to be able to present results of the project (Weinstein et al. 2008).

In Six Sigma, the idea is that you can define, measure, analyse, improve and control all work processes. Common name for these actions is DMAIC system that has been expanded from Deming's PDCA (Plan-Do-Check-Act) cycle, which is well-known continuous improvement method (Chow et al. 2010; Baker et al. 2012). Chow et al. (2010) used DMAIC for how to build a training program based on job analysis results. In their case job analyse data was the input of the process and based on the results their

plan was to create a training program that would help to reduce errors and improve efficiency and productivity. Chow et al. (2010) concluded that Six Sigma tools could provide a clear and easier way to identify required skills, knowledge and capabilities employees should have while performing required work compared to a traditional job analyse tools.

Lean method has traditionally provided various tools and techniques for achieving shorter lead and set-up times, minimize rework, scrap costs and inventories, and other wastes that are hiding inside processes. Quality improvement tools that are closely combined with Lean are value stream mapping, just-in-time (JIT) manufacturing, visual management like Kanban or visual workplace and work flow standardization. (Antony 2011.)

One of the main idea related to Lean thinking is to focus on the process flow with minimum waste, which will lead to higher productivity and make processes faster (Antony 2011). Nowadays, there are defined eight sources of waste, which are most common in processes. These wastes are presented in Table 1 (Floyd 2010:32; Gopinath & Freiheit 2012). Gopinath et al. (2012) writes that organizations must remember that waste cannot be completely eliminated but it can be reduced to a minimum level. This will be possible if everyone in organization is willing to work for achieving this goal. In real life, to be able to achieve benefits of Lean it requires a huge effort for organizations to invest in tools and techniques and to adopt them for usage, will power and new ideas are not enough if goal is to adopt Lean methods (Antony 2011).

Table 1. Eight sources of waste (Floyd 2010:32; Gopinath et al. 2012).

Waste	Description
Overproduction	Production ahead of demand or process ahead of scheduled time, risk of wasting labour, materials or capacity from more urgent tasks.
Defects, Delay	Labour and capacity are waiting instead of producing or making productive work.
Transportation	Moving materials or products in a way it will not add value to process.
Waiting	Waiting resources, materials or information to be able to continue with process.
Inventory	Materials or items not being completely transformed hides unresolved operating problems.
Unnecessary work	Work that is required for continuing process but does not add value to process.
Defective products	Defective products cause waste in each operation they touch.
Human capability	Without an organizational culture of commitment, most of the employees' human capability is wasted.

Lean method can be used to eliminate waste in order confirmation and designing processes. First, it must be identified what are those nonvalue adding activities that consume time but doesn't bring value to process itself and then those activities must be eliminated. These early state processes should be seen as value adding activities so it is a good target to consider the quality of information available at these points. Does the input that comes in has invalid information, is the information clear or complex and how much effort it takes to transform this information in a form it will help employees to understand customer requirements. (Deshpande et al. 2012.)

When organizations are able to improve the quality of inputs they can minimize the time which is consumed for clarification of nonvalue adding activities, reduce variability in the processes, reducing confirmation cycle time and also improve the output quality which will naturally help the next phase of the process. (Deshpande et al.2012.)

Deshpande et al. (2012) writes that many problems repeated at management process when applying traditional Lean tools are lack of documentation, failure at communication,

inadequate information, resources are disproportionate, capricious decision making and limited capability to reduce insecurity and effects caused by complexity.

For manufacturing industry, a key to be able to operate in markets is to produce a great quality product without loose in production process, and to be able to manufacture products with lower cost is to have minimum amount of errors in processes which can also lead to shorter lead times (Jamaluddin, Razali & Mustafa 2014). In large manufacturing organizations it is common to use QM tools that are integrated organizations own databases, software systems or implicated as a part of enterprise resource planning (ERP) system (Garstenauer, Blackburn, Olson 2014).

However, these traditional QM tools can be heavy to work with and they are not necessarily serving their purpose in rapidly changing work environment (Garstenauer, et al. 2014). SPC and quality improvement with techniques and tools represents hard factors of QM but soft QM factors that include realizing the importance of customers role and human resources functions are constantly arising (Jamaluddin, et al. 2014).

Change in today's organizations for achieving common target requires a mutual trust and discussion among participants. In other words, to get employees participate in change or new processes managers must commit first and support employees during these processes. Without employees' commitment to new technologies and tools, no success can be achieved (Sharma et al. 2008). Antony (2011) writes that most critical components for continuous improvement are management support through all organizational levels and employees' commitment. Without commitment and support from these groups, pursuit for improvement will most likely fail.

2.1.2 The human side of mistakes

Myszewski (2012) described, "The term "human error" is used to describe the actions of a worker that does not conform to the standards provided, despite the qualification of the result of the action". Another description that consider lack of attention, carelessness, misinterpretation and laxness as a cause of human error says it is "a mistake made by a

person rather than by a machine" (O'Donnell 2009). Steward & Grout (2001) writes that psychologist have studied in human side why mistakes happen and in cognitive science approach humans are information processor, which try to make correct actions and decisions with limited resources.

Wachter & Yorio (2013) wrote that almost 80 % of mistakes in work place were caused unintentionally by human error. Rest of the errors came from material or equipment failure. When these 80 % of human errors were analysed in a deeper lever it was found out that 30 % of these errors had roots in individual knowledge and the way employee used the system. Rest of the mistakes where caused by organizational weaknesses (Wachter et al. 2013). In conclusion, even though at first it may seem that a human causes these errors but in fact, organizational weakness is the biggest underlying feature that causes errors.

When errors happen at workplace it is often considered a certain individuals fault. Normally, most humans have a narrow point of view and it is easily forgotten that also managers, co-workers, systems and work conditions could be the potential source of errors. In many case it should be seen that the workplace, procedures, instructions and environment also needs improving and not only the certain individual. (Cohen & Cohen 1991.)

Most of the organization problems comes from the system problems (Liang & Chang 2010). This leads to the fact that errors will happen as long as there are weak processes, organizational culture is not clear and complex systems will not be corrected (Wachter et al. 2013). In these cases, problems have been built inside organizations frame and no matter how good job individuals try to do surrounding conditions does not allow them to perform a great quality job (Liang et al. 2010). This proofs that it is a wrong way of thinking that errors happen as employees does not perform their job properly (Wachter et al. 2013). Mistakes occur though employees have documented information, rules and guides but they still need to overtax themselves in unsuited situations (Steward et al. 2001).

Human errors are illustration of the inefficiency on the organization. Sometimes human error occurs and they are not anyone's fault not employee nor the manager. This means that they cannot always been eliminated (Myszewski, 2012). Few reasons why errors can't be detected is that employees whose have made these errors doesn't understand those errors occurred because of the actions made by them or that they are not sure what they should do or unclear instructions may lead to error. Further reason may be that errors that happens are not taken seriously. There might be actions that will correct the result of the error but the person who made it does not get information or recommendations how to avoid it from happening again (Steward et al. 2001). If this leads to situation where employee' does not want to communicate errors and managers are not interested to fix and change the circumstances no development and improvement cannot be achieved, and there will be mutual distrust (Myszewski, 2012).

Table 2 lists possible error precursors. These are points that may cause errors but not necessarily. These precursors can be corrected in work environment, and by doing so, it may help to reduce the amount of errors. Error precursors have been categorized in four areas that are task demands, individual capabilities, work environment and human nature. (Wachter et al. 2013.)

Table 2. Typical error precursors found in the workplace (Wachter et al. 2013; U.S. Department of Energy 2009).

Task Demands	**Individual Capabilities**
Time pressure	Unfamiliarity with task / First time
High workload	Lack of knowledge
Simultaneous	New techniques not used before
Repetitive actions	Imprecise communication habits
Irreversible actions	Lack of proficiency
Interpretation requirements	Indistinct problem-solving skills
Unclear goals, roles or responsibilities	Unsafe attitudes
Lack of unclear standards	Illness or fatigue: general poor healthy or injury
Work Environment	**Human Nature**
Distractions	Stress
Changes	Habit patterns
Confusing displays or controls	Assumptions
Work-arounds/Out of service instrumentation	Overconfidence
Hidden systems / equipment response	Mind-set
Unexpected equipment conditions	Inaccurate risk perception
Lack of alternative indication	Mental shortcut or biases
Personality conflict	Limited short-term memory

2.1.3 Different methods for solving errors

As agreed earlier mistakes are actions that does not lead to desired result and can cause that things need to be done again (Steward et al. 2001). Anfield (2007) writes that possibly 10–15 % of an organizations' output may be lost since human errors and their causes are not recognized. For this reason, the error prevention should be important in all levels of organization.

Cause-and-effect analysis is a problem-centralized approach and its goal is to find and identify root causes of problems and errors. One known tool is a fishbone diagram where members of a team first identify the problem and then they start to sort out possible causes. By doing this in training environment, it may help organizations and employees to see possible failures and trouble spots. When transferring knowledge that relates to

these problems that are present in real work tasks in orientation phase, it helps to handle these in actual situations. (Chow et al. 2010.)

One method for eliminating input that might cause errors is to make system design visible. System should be design in a way it includes simplified task structures and descriptions on the way user needs the information. Computer based information system or database should help an employee to create self-assertion, and when errors occur system feedback about them would be helpful since the employee will get a chance to know what action created the error. (Steward et al. 2001.)

Mistake proofing (poka-yoke) is also a tool from Six Sigma. A goal is to reduce process variation by analysing each step of the process carefully and make preventive actions to reduce errors. It is large concept that can protect employees with right kind of equipment like safety glasses, shoes, helmets but also in the service industry and customer service it can contain work instructions, job descriptions and checklists (Chow et al. 2010). Idea behind mistake proofing is rather simply to explain and understand. When it focuses on human error, it is sometimes forgot that theory behind human behaviour is lying on human psychology. In many cases what employees do in work environment is analysed based on numbers and figures but those factors that affect their behaviour is ignored (Steward et al. 2001).

In training environment mistake proofing makes trainee specialist to research potential problems and document them. Checklists can also help to see if trainee will execute instructions correctly and if not it is easy to point what needs to be done differently next time. (Chow, et al. 2010.)

According to Liang et al. (2010) “a problem is defined as a discrepancy between an existing standard or expectation and the actual situation”. Liang et al. (2010) have made their own version of Deming’s PDCA problem solving tool that is presented in Table 3.

Table 3. Six steps of problem solving (Liang et al. 2010)

Step 1.	Identifying and selecting problem. Firstly, it is necessary to define a problem as the difference between the target and the actual. A problem report should be written based on measurements.
Step 2.	Analysing the problem cause. In this step, only spend time on finding the cause(s) and not to go to think about the solutions.
Step 3.	Generating potential solutions. It is necessary to explore alternatives because only one solution is not good enough.
Step 4.	Selecting and planning the best solution. Makes sure the right people do the right things at the right time and planning the best solution results in low cost.
Step 5.	Implementing the solution. Seeing the job through to conclusion is necessary, with appropriate contingency planning in case some of the new ideas do not quite work out.
Step 6.	Evaluating the solution. Reviewing the results is very important; to be sure the problem really has been solved.

Human performance tools idea is to help employees to prevent and realize possible errors, precursors and hazards so that they will be able to handle the situation. Situational awareness means completely understanding the work environment, job requirements and needed knowledge in actual situation before acting. Situational awareness tools help employee to see unsafe conditions and possible underlying problems and with their help, employees are able to develop their abilities (Wachter et al. 2013). Anfield (2007) also said that human factor "acknowledges that an individual's awareness of error potential is the single best defence against their occurrence."

Other human performance tools help employees to seek warning signals. They can be minor but they can also indicate if something that differs from the standard must be taken into account or bigger warning signals that operates with the system and when employee is performing some task and something important fact or feature must be remembered, it signs. These tools also challenge employee to face their assumptions. Assumptions normally have roots on facts but during time it can be hard to separate facts from own assumptions. With these tools, employees can learn to question assumptions and develop mental models and problem solving skills. (Wachter et al. 2013.)

Self-checking tools offers employees a way to observe themselves or team members by peer checking. It can offer help to foresee, prevent and catch possible skill-based errors. Especially in rule-based environment where tasks are repetitive, errors are possible to detect with self-check tools since those will help employees to understand the appropriate action and how does it affect on the desired outcome. Target for self-check tools is to develop employees' situational and self-awareness. A member of the team or group can create a self-check list related to a certain task and then other people can perform the same task and if something needs to be updated, it is possible to do and the cycle goes on. Team can benefit for having a common operating model that they are able to develop and discuss together. Table 4 presents worker based S-T-A-R (Stop-Think-Act-Review) model that show recommended steps for self-checking when employee recognize that error might happen. (Wachter et al. 2013.)

Table 4. Self-checking, S-T-A-R-model (Wachter et al.2013).

1. Stop, slow down.	Pause to focus attention on the immediate task.
2. Think.	Think methodically and identify correct actions to perform, and understand what will happen when correct/incorrect actions is performed.
3. Act.	Perform the action.
4. Review.	Confirm anticipated result has occurred or apply contingency of required.

To manage these issues and finding solutions teamwork is a good way to start. Liang et al. (2010) mentioned three different team types which purpose is to improve quality. First, one is a quality circle that consists of employees that are doing similar work tasks and supervisor. They have regular meetings where they discuss quality problems they have faced and then they try to find out solutions to these issues and implement them with the support of management. The second group is a problem-solving project team. This group is built up when high-level member of the organization identifies a problem that needs to be analysed and solved. The third group is a quality improvement team. This team model can consist of employees in different departments of the organization, customers and even suppliers. There can be many reasons to gather up this team but the purpose is to eliminate waste and minimize actions that does not bring value to the process and improve quality of actions. (Liang et al. 2010.)

However, it is not possible to fully control how employees will behave, instead it is relevant to raise awareness about existing errors and how to identify and prevent them. When employees are thought how to recognize and prevent errors, there is a change to reduce possible errors. (Harvey 2013.)

2.2 Knowledge in organization

2.2.1 Knowledge role in work environment

In today's organizations knowledge economy, competitive advantage and organizational performance are driven more from the point what organizations knows and how to use the human capital inside organizations and not just a traditional manual labour. For organizational survival, it is critical to manage knowledge and provide a framework for knowledge creation, and understand the knowledge that is needed for performing daily work. (Mciver, Lengnick-Hall, Lengnick-Hall, Ramachandran 2013.)

Walsh & Ungson (1991) writes "organizational memory consists of mental and structural artefacts that have consequential effects on performance". Organizational effectiveness can be thought as a response for organizational memory. When considering this idea must be remembered that the environment organizations operates is constantly changing. Forgetting this fact can be harmful for the organization if they repeat old patterns that will not be suitable for current situation anymore (Dunham & Burt 2013).

Table 5 present six different knowledge themes around organizational memory that should be remembered when discussed knowledge role in organizations (Dunham et al. 2013).

Table 5. Six knowledge themes in organization (Dunham et al. 2013).

Theme	Description
Job knowledge	The knowledge employee needs to perform job requirements effectively.
Social knowledge	Employees' social capital that support them to cope with personal networks.
Political knowledge	Understanding the frame organization operate and how these features affect their decision-making and management.
Cultural knowledge	Shared values, norms and beliefs.
History	Organizations are able to avoid repeating mistakes or reinventing successful models again if they remember from the past what has/has not worked and why.
Industrial knowledge	Knowledge of markets, competitors, environment and external networks.

2.2.2 The importance of knowledge

Obeidat, Masa'deh & Abdallah (2014) describes knowledge to be "information, facts, and concepts that usually reside in practices, norms, processes, documents, and the expertise and experience of individuals, which are required for performing tasks". Organizations have woken to understand that their excellence and high performance in markets does not only come from products and strategies but also from their employees (Jackson 2010: 908–911). Organizations know that the knowledge their employees have has led to intellectual capital (IC) management to be the key for their effectiveness and remaining competiveness (Brunold & Durst 2012).

Human resource and knowledge management (KM) are important factors for organizations that want to be on top of global markets and keep their competitive advantage. Organizations should be able to know how to use the knowledge their employees have. Qualified employees are a great bank of power in rapidly changing markets, facing technological changes and operating in globalized cultural environment. (Obeidat, et al. 2014.)

For example, consultants, practitioner and researcher's claims that KM can generate important strategic outcomes like improve productivity, raise operational effectiveness, increase agility, uplift innovation and product development and widen intellectual assets. In consequence, KM activities are aimed at constructing and influencing knowledge creation and integration. This has lead as a particularly powerful organizational competence that reshapes the work environment. (Mciver et al. 2013.)

Reus, Ranft, Lamont and Adams (2009) mentioned it is important to realize the use of knowledge in organization. It depends on organization and their efforts. Not all efforts for increasing knowledge have desired positive outcome. Some companies may have unrealistic expectations how knowledge improves the performance. It is important to understand surrounding conditions and those ways to invest in knowledge adaptation in a way it would benefit the company. (Reus et al. 2009.)

Organizations should remember that there will be different results that depends on the work context and performance metrics that have been used. Improvement in some section may lead to regression in other section. Example of previous description can be that the company is focusing too hard to increase operational efficiency and productivity to achieve more competitiveness on the market. However, this action may have negative outcome and it may neglect for customer service problems. (Mciver et al.2013.)

Mciver et al. (2013) also challenges the belief that all KM efforts would improve organizations performance and be beneficial. They suggest to focus on structures beneath and to realize what type of knowledge is required to get the work done in practice. They use term knowledge-in-practice (KIP) for describing these activities that consists of information and know-how. Data and facts that are known and can be stored and redistributed forms the base of information. Know-how is defined to be action based on skills and expertise in this context. KIP can viewed from different perspectives. It can be something that an individual member of organization, team, unit or department do or it can contain the knowledge sharing and know-how of the whole group of people that are working together. (Mciver et al. 2013.)

Organizations face intense task when adopting KM activities. They should be able to categorize work environment and to see it is constantly developing and changing its nature. These KM actions require realizing the nature of the work and work settings that influence the behaviour and wanted results. Then organizations can select those KM activities they see would be most beneficial. Sometimes KM can be something new that arises on the process unintentionally. (Mciver et al. 2013.)

2.2.3 Knowledge types

Tacit knowledge is information that has not been transformed to readable form so that other members of organization or team could use. It can be called an individual internal information that has been formed their minds over time and experience, and it also affect their behaviour unconsciously (Vilkkumaa 2007: 168–170). Toom (2012) describes tacit knowledge in business environment to be feature that include mutual and shared knowledge base of all employees.

Explicit knowledge is easy to share, and it is presented in numbers, reports and words and it can be directly related to job instructions (Jackson 2010: 908–910; Garstenauer, et al. 2014; Gilson, Lim, Luciano & Choi 2013). The amount of tacit knowledge can be enormous compared to organizations explicit knowledge (Vilkkumaa 2007: 168–170). North & Kumta (2014: 33–34) writes that if iceberg metaphor is used in this context the peak that is above water is organizations explicit knowledge and the rest of the iceberg that is unseen below waterline is organizations tacit knowledge.

Tacit knowledge is more difficult to share than explicit knowledge. When forming tacit knowledge to explicit knowledge organizations should use techniques that make individual idea or knowledge visible so that others can perceive it. When this information has been changed to explicit, it turns to group knowledge and that can even create new knowledge. (Jackson 2010: 908–910; Garstenauer et al. 2014.)

2.2.4 Why to collect knowledge

Large organizations must understand that baby boomers will leave from workforce in the coming years and an enormous amount of tacit knowledge, organizational stories and history will leave with them if they do not find a way to prevent it (Jackson 2010; Dunham et al. 2013). Majority risk related to human capital is that organization will lose its key employee(s) not only due retirement but also due termination, contract expiry and employees own will (Kupi, Ilomäki, Talja, Sillanpää & Lönnqvist 2008: 22–23). At the same time, companies should be able to train new employees whose have used to get answers right away trough different communication channels and databases. This creates a challenge for knowledge capture (Jackson 2010: 908–910).

The effect of knowledge losses vary between organizations but it can cause reinventing solutions again and mistakes made earlier can be repeated (Jackson 2010: 908–910). For some companies this may cause direct financial impacts but also it can lower motivation of the rest team members and weaken the overall atmosphere. Other side effects it may cause are increasing other employees work load and stress level (Kupi et al. 2008: 22–23). The long-term absence of key employees and staff turnover can be harmful to the company since it affects its productivity as well (Brunold et al. 2012).

The reduction of human capital can happen slowly without losing key employees. For example, unsuccessfulness at training or developing skills of employees may lead to point where their existing knowledge and skills are not good enough for performing tasks in a desired way. This can cause human errors that affect productivity and customer relations. (Kupi et al. 2008: 22–23.)

Table 6 presents intellectual capital risks that are closely related to human capital, KM and organizational atmosphere. Many of these features influence employees' behaviour unintentionally or intentionally and that way they can affect employees' way to share knowledge.

Structural capital risks are closely related to human capital risks. Reasons that cause failure in structural capital can be that components of IC are not understood properly or information infrastructure does not support its purpose. For example, if poor documentation of needed and required knowledge is not available it may lead higher lead-time in projects and tasks. (Brunold et al. 2012.)

Relational capital risks also go together with human capital risks. In some cases if certain employee leaves the company, some customers may be more attached to the individual person and have built mutual trust relationship with that employee and the customers may follow the employee. When employees are changing in the organization, the new employees might not be able to understand customer needs in a way the employee earlier did. This can cause lower trusting and offering bad solutions for customers. (Brunold et al. 2012.)

Table 6. Intellectual capital risks (Brunold et.al 2012).

Human capital risks	Time and pressure → stress Frustration and demotivation Unclear communication, rumours Concentration of knowledge on a few people Narrow mindedness, resistance to change Lack of managerial appreciation Ill-functioning knowledge transfer Unsuccessful recruitments Inadequate training and development of personnel Loss of competencies and expertise (leading to repeated mistakes and wrong decisions) Crimes of personnel against the company (Voluntary vs non-voluntary) personnel turnover Inexperienced top management
Relational capital risks	Low quality of products and services: decreasing customer satisfaction Underestimation of non-consideration of benefits related to relationships with different stakeholders Low commitment and trust of subcontractors and suppliers Loss or decrease of corporate image → decreased workplace Attractiveness Risks related to strategic alliances Dependency of subcontractors and/or individual customers
Structural capital risks	Undocumented knowledge Organizational knowledge base remains status-quo Inflexible organisation structure Inadequate information systems Lack of transparency, i.e in terms of knowledge base given Inappropriate corporate culture Inadequate product development Uncertainties related to product development processes Lack of innovations, patents and copyrights Risk related to intellectual property

To avoid key employees' knowledge lost organizations should be able to train all the employees and create standardized documents that help employees to understand the requirements of a certain task (Wang, Chiang & Tung, 2012). This leads to the fact that it is crucial for organizations to collect and transfer tacit knowledge to form that other members of the work community can internalize and use (Jackson 2010).

Knowledge distribution is a process that shares knowledge from a person to group or another individual (Obeidat et al. 2014). Capturing tacit knowledge from experts can be problematic since it has gave advantage for those employees who know wanted skill or information and have that extra asset that is hard to learn. (Jackson 2010: 908–911; Dunham et al. 2013). It also brings them safety mentality and competitive advantage towards other units or individuals. At the same time it might weaken trust among co-workers and collaboration will be more pre-planned (Brunold et al. 2012; Dunham et al. 2013). Main obstacle for sharing knowledge openly is a trust between members (Obeidat et al. 2014).

One way to capture tacit knowledge inside organization is mentoring. Normally this means that more experienced employee will teach and share vital knowledge to a less experienced employee. When a mentor teach another employee, they should see it as a privilege and courtesy and not as an obligatory. When the mentoring program is well designed and there is enough time for it, both employees can benefit from it. However, this only happens if both are willing to share their thoughts and knowledge with each other. (Dunham et al. 2013.)

One issue that should be investigated better is more experienced employees social networks and contacts and their willingness to share this information in mentoring situation with less experienced employees or employee who has just started working in the organization. Inside organization, this can mean employees who are specialist in some area and when certain type of information is required, their knowledge is essential. (Dunham et al. 2013.)

Sometimes employees may have a lot job specific knowledge but organizational structures or systems outside that unit may be unfamiliar. This can be harmful if employee would need information outside that unit. For this view idea is not that everyone know everything, main target is to know which team member or person is able to help. This supports the idea of knowing the employee that has certain type of knowledge. (Gilson, et al. 2013; Shelby, Mazzuchi & Sarkani 2013.)

Sometimes new information may be hard to adopt and complicated to transfer in the database (Mciver et al.2013). Methods or practices behind tacit know-how can based on individual capital and might be even impossible to transfer to form that other employees or team members can benefit from. Recognizing this valuable knowledge can take longer than transferring it to the form other can use it. (Jackson 2010).

It would be important to organize new information in a way it support those routines, skills and practises that have already been formed over time. This way the connection would be clear between old information and existing knowledge compared to information gathered latest. (Mciver et al. 2013.)

Obeidat et al. (2014) found positive relationship between organizational commitment and KM process. When employees feel they are part of the community and that organization is willing to invest in them, they share knowledge more openly and want to receive and develop it as well. (Obeidat et al. 2014.)

2.2.5 Knowledge sharing and learning

Knowledge can be transferred many different ways inside organizations. Most commonly used methods are email, newsletters, monthly reports, information screens, search databases and communication with other people (Mciver et al. 2013). However, sometimes organizations believe that when they want to change something, teach new skills, or give new knowledge to employees they can only send new instructions or newssheet to employees and then everyone should know and adopt this information. In most cases, this kind of approach is not enough. Employees can only learn new things and change the acting habit of old practices if adopting and learning new knowledge process is well-trained and managed (Viitala 2005: 180).

Those tools that are designed to share knowledge also matters. Format of knowledge, how easy it is to find, does employees have access to it. These are all factors that affect the atmosphere of sharing knowledge. In many organizations, information is gathered in

computer-based software so the layout and system infrastructure are relevant. (Obeidat et al. 2014.)

Learnability consist of efforts, thoughts, skills and existing knowledge capability that is used to understand how to perform work activities. One example of learnability is how new employee can be able to learn those practises that are necessary to perform daily tasks and routines. Learnability separates tasks that are easy from those that are more challenging to learn despite the amount of know-how and information behind knowledge structures. In this view, time is not the key figure that defines challenging task from easier ones. Naturally, these may go hand in hand but learnability is more interest in points that makes some tasks easy and other more difficult to learn. It is said that learnability wants to question the idea that all tacit knowledge is hard to learn and all the information is rather simply to learn. (Mciver et al. 2013.)

Organizations human resource management should consistently design and implement ways for recruiting, training and evaluating employee's performance (Wang et al. 2012). Managing the behaviour of employees is challenging but when it is done properly, organizations can achieve the desired output from their employees. Key for this is to manage and develop the knowledge. Organizations need to invest in training so that employees will have the feeling that organizations care about the knowledge and skills they have and want them to be able to develop themselves. These factors are important, as organizations cannot just expect change to happen if they are not providing tools, training and time for it. Proper training and caring also increases the motivation of employee (Obeidat et al. 2014).

Human resource management influences employees learning capability since they have the potential to support adopting new knowledge and simulate learning. However, if human resource management is not supporting learning it can cause a loss of human capital. Manager role and commitment to learning process is something organizations should not ignore. When manager adopt the value of learning and support it by bringing openness inside teams so that they would feel comfortable to share and develop

knowledge together it is possible to find flexible solutions together for existing problems as well as problems that may come to future. (Lopez-Cabrales, Real & Valle 2011.)

Baker et al. (2012) says that companies can identify its learning needs in a better way if they use continuous improvement tools with instructional design and technology (IDT) tools also known as instructional design and development. IDT gives variety of strategies, models and methods for developing and designing training materials for different context. When these IDT tools are implemented to continuous improvement processes, it can improve training and educational processes. (Baker et al. 2012.)

Trainees will benefit most at the training when materials and guidance have been made in a relevant way and they reflect the job instructions. When designing training material there should be job related and clear objectives on the material and feedback from trainees should be heard (Chow et al. 2010). When designing training materials different learning methods must be taken into account. Active learning method includes activities where trainee must take an active role in learning process. For example, there can be group activities, interactive computer program or simulating real situations. Passive learning methods are more traditional and they can include lectures, audio presentations and e-training material. Bridging materials and practices between these two methods is recommendable so that learning will be more intensive and things can be combined with possible real life situations (Baker et al. 2012: 58).

Organizations should focus on sharing best practices and creating clear procedures with examples how some task can be performed and what facts need to be taken into account when performing it. Standardized routines are helpful for achieving tacit know-how since they also bring sense of community in work environment, make individual learning more visualised and structured. (Mciver et al. 2013.)

When using balanced routines and defined patterns in work environment where KIP that has low tacitness and work tasks are not too hard to learn it can lower error rates and increase efficiency by increasing reliability and punctuality. Reason to make standards that helps employees to perform daily routines is to augment productivity and to spread

well-founded practices. This only applies in KIP environment that is stable and operating principles are known. Standardized routines are not efficient in unpredictable environments. (Mciver et al. 2013.)

Learning by doing is efficient way to gather new skills and knowledge. Work environment should also support learning that allows employees to make errors and mistakes while practicing new tasks so that employees can understand those circumstances, right rules and context that will lead to the desired outcome. Many work settings around know-how is based on personal experience, observation and perception. Job rotation, training exercises and on-the-job training programs are examples of KM activities that can be adopt as a part of organizational learning and these practices are good for improving especially tacit knowledge skills. (Mciver et al. 2013.)

When employees are able to understand tacit know-how trough learning by doing and they have time to rehearsal new practices it will develop individual capabilities. After employees have adopted skills that fills quality and ability standards, they are able to transfer things they have learnt back to the work environment which bring proficiency to the company over time. (Mciver et al. 2013; Chow et al. 2010.)

On the same time, organizations should recognize those tacit skills that are too extreme to learn in required scale. They should not invest in sharing that type of tacit knowledge, more likely it would only be waste of time and effort. It is important to realize difference between tacit know-how that can be achieved with guided training and tacit knowledge that is hard to learn and based on personal expertise. (Mciver et al. 2013.)

Job rotation is one method for sharing knowledge. It offers help to decrease distance and barriers for multicultural organizations that normally have heterogeneous teams. Job rotation also include high risk if it is not properly managed. For example, if predecessor does not have documented critical knowledge for follower, follower must learn by his own the knowledge that is crucial for performing tasks. This is also time consuming and decrease followers' motivation. In worst case there will be broken learning cycle which

means that some knowledge may be lost, mistakes will happen repeatedly and wheel will be reinvented. (Brunold et al. 2012.)

Especially in jobs where tasks are complex and performing them is mainly done independently managers need to spur employees to share their knowledge and experiences to others to avoid low knowledge transfer. Diversity inside teams also matters, more likely employees with different background and skills can bring new knowledge, perspectives and variety of viewpoints inside group. However, diversity does not automatically improve team overall performance it can only bring value if individual experiences and knowledge will be shared. (Gilson et al. 2013.)

Codification orientated KM strategy means that organization use computer systems for data sharing and to communicate together. In this strategy idea is to hire people who can use computer systems for education, learning and develop document system and share the information among company. In individual-orientated KM strategy idea is to hire people who has great problem solving skills and can manage with uncertainty. In this scope, learning happens trough another workers that shares their tacit knowledge. (Wang, et al. 2012.)

3 METHODS

3.1 Case study research

There are no right definition for case study and it always depend on the context and surrounded conditions. Case study can be though as a thing that try to find answers for research questions by finding evidence from multiple sources, and it is preferred when examining contemporary events. None of the evidence will be enough by its own, there should be evidence from different sources and aspects that will be collected and analysed the best possible way (Gillham 2000: 1–2; Yin 2009: 11). Hirsjärvi, Remes & Sajavaara (2004: 124–126) adds that case study examines intensive information from single case or a small number of cases that relates to each other. Typical characteristics are that single case, situation or group of cases focused on certain processes where individual, group or community operates in real life situations. Data is collected using multiple methods and sources for example, observations, interviews or document research. One purpose for case study is to make a depiction of the phenomena.

Yin (2009:27) defines five components that are important for case study:

- A study's question;
- Its propositions, if any;
- Its unit(s) of analysis;
- The logic linking the data to the propositions; and
- The criteria for interpreting the findings.

3.2 A quantitative approach

A quantitative research method can be consider as a direction that try to link causes and effects. This idea has roots in realistic ontology, which depict reality to be something that consist of facts that can be objectively ascertainable. (Hirsjärvi et.al. 2004: 130; Brannen 1992: 4–5.)

In quantitative research method, it is possible to present information as numbers. This means that the subject and its features are possible to describe and understand as numbers, which reflects the situation (Vilkka 2007: 14). The results can be presented by using percentage tables and conclusions can be formed based on statistical analysis (Hirsjärvi et.al. 2004: 130). For example, it can be seen how common, how much and how often certain features occur. In quantitative method researcher can have information as numbers or researcher can form qualitative information to numbers (Vilkka 2007: 14).

3.3 A qualitative approach

In qualitative research method, it is important to examine the real life object comprehensively. It include the idea that reality is diverse and it is not possible to shatter the reality into pieces arbitrary. Events will shape each other at the same time and for that reason, it is possible to find parallel relationships. In traditional way, it is not possible to be objective since the researcher and the known is linked to each other. However, it is possible to receive contingent explanations in that time and place. In qualitative research, the purpose is to figure out and reveal facts rather than to verify existing claims. (Hirsjärvi et.al. 2004: 152; Brannen 1992: 5–7.)

Features that are common to qualitative research is the use of human as an instrument for information. Researcher can use own observation or have assistive devices such as forms and tests. Researcher try to reveal unknown facts by examining objects in detail rather than test theories or hypothesis. The target group is selected appropriately and cases are

dealt with unique and construed in accordance with the material. (Hirsjärvi et.al. 2004: 154–155.)

In general, quantitative and qualitative approach should be seen methods that fulfil each other and it is hard to separate these methods in an exact way. For example, they can be used alongside in circumstances where using simple computational techniques, and with the help of intensive qualitative research, received results can be extended to cover the entire data set in situations where it is difficult to get a grip otherwise. Quantitative research can also be before qualitative phase. For example, collected quantitative material can form a base to qualitative part. Numbers and meanings are mutually dependent on each other. Numbers based on concept that have a meaning and conceptual phenomena containing meanings can be expressed in figures. Measuring something in both quantitative and qualitative way can give opportunities to understand the complexity of the phenomena. (Hirsjärvi et.al. 2004: 127–128; Brannen 1992: 127–129.)

3.4 Research reliability and validity

In general, researchers try to avoid mistakes while doing research. Despite this fact, reliability and validity may vary. For this reason, reliability and validity needs to be evaluated and it can be done by using different methods. Reliability means repeatability of the measured results. In other words, it means research ability to provide non-random results. On quantitative research, there are several statistical methods, which can provide help when trying to analyse the reliability of the chosen methods. (Hirsjärvi et.al. 2004:216–218.)

Validity means research ability to measure exactly that what is supposed to measure. For example, on surveys it is possible that respondents understand questions differently than the researcher has thought. If researcher analyses the results based on their own way, the results will not be truthful of valid. (Hirsjärvi et.al. 2004:216–218.)

Researchers' detailed explanations about the research phases improve the validity of the qualitative research. Are the explanations given suitable for the depiction? The surrounding circumstances when the data is collected should be clearly given. (Hirsjärvi et.al. 2004:216–218.)

In both quantitative and qualitative research, validity of the research can be improved by using multiple methods on same research (Hirsjärvi et.al. 2004:216–218). To guarantee this research reliability and validity, there have been used multiple methods, different aspects and large data group.

3.5 The examination of unclear order lines

Table 3 earlier, presented six steps of problem solving and the first step was to identify and select the problem. It was also recommended to make a problem report based on the measurements. The original problem that has been identified was the appearance of unclear order lines. However, there has not been a clear picture what does it actually mean in practice, and for this reason it was necessary to examine selected amount of quality notifications first. Examining quality notifications would provide a comprehensive understanding of the consequences unclear order lines cause. Figure 3 illustrates those features that were selected to measure from quality notifications, and there are three rows as an example how the collected quantitative data was categorized.

Notification Created on	Notification Closed on	Duration in work days	New production slot (0 =no, 1 = yes, 2=cancellation required)	Problem category (Electrical= 1, Mechanical= 2, Other= 3, Electrical & Mechanical= 4)	Variant code / other description	Status (Well founded=0, Unfounded=1)
20.8.2015	21.8.2015	1	0	1	002	0
20.8.2015	25.8.2015	3	0	1	163	0
20.8.2015	26.8.2015	4	0	2	999	0

Figure 3. Measured features from quality notifications.

Pearson correlation formula

$$r_{xy} = \frac{\sum_{i=0}^{n}(x_1-\bar{x})(y_1-\bar{y})}{\sqrt{(\sum_{i=0}^{n}(x_1-\bar{x})^2 \sum_{i=0}^{n}(y_1-\bar{y})^2}} \quad (1)$$

can be used to find out does two variable (*x*,*y*) have correlation between each other. When correlation coefficient $r_{xy} \approx 0$ is low, and if r_{xy} is closer to value +1 or -1, correlation is high. (Lehtonen & Malmberg 2008: 52–53.)

Pearson correlation formula was used to resolve does the amount of new order lines created per week and the amount of opened quality notification per week have correlation.

3.6 Electronic survey

Second step from Table 3 six steps of problem solving was to analyse the problem cause(s) and find reasons that may cause the problems and in this case, it means to find out factors that might cause unclear order lines. Even though there are employees in sales units that inputs detailed order lines to the system most of the errors are caused by some other factor than individual knowledge as said by Wachter et al. (2013). For this reason, it was decided to send electronic survey (appendix 2) with cover letter (appendix 1) to selected employees who are working in sales units. The electronic survey questions were divided in five parts and first part focused on the profile of respondents. Part 2 focused on possible error precursors viewed in chapter 2.1.2 The human side of mistakes, and idea was to get information from different angles. Part 3 was about knowledge sharing and communication. Part 4 deal with training, materials, and the usage of available information and in this part the results from unclear order line examination was also taken into account. Part 5 was for open feedback.

3.7 Dataset

The time interval of the collected data was 17 weeks between June and September 2015. Total amount of new order lines created during this time period were 8290 pcs, and 1565 pcs of them were marked unclear by quality notifications. These 1565 unclear order lines were examined by using statistical, quantitative methods. The base for unclear order line analyse was formed by sorting the data from quality notifications according to Figure 3 that was presented earlier.

Electronic survey was send to 354 respondents and 106 personnel replied during required time period. Total response rate was 29,9 %. Responses were analysed by using both quantitative and qualitative methods. Statistical methods were used for Likert scale questions (appendix 2) and qualitative approach were used for responses received from part 5, open feedback.

4 RESULTS

4.1 The general examination of unclear order lines

4.1.1 Distribution of order lines

Figure 4 illustrates new order lines that were opened between selected time period and the amount of order lines that were marked unclear by opening a quality notification at one of these three departments before order lines would have been released to production. According to Figure 4 18,9 % per cent, almost one fifth of new order lines have been marked unclear. In practice, this means that each of these unclear order lines will stop the order-to-delivery process and it cannot continue before the order line has been cleared. The amount of clear order lines have been 81,1 % a bit over four fifths of the new order lines passed these three departments of the order-to-delivery process smoothly.

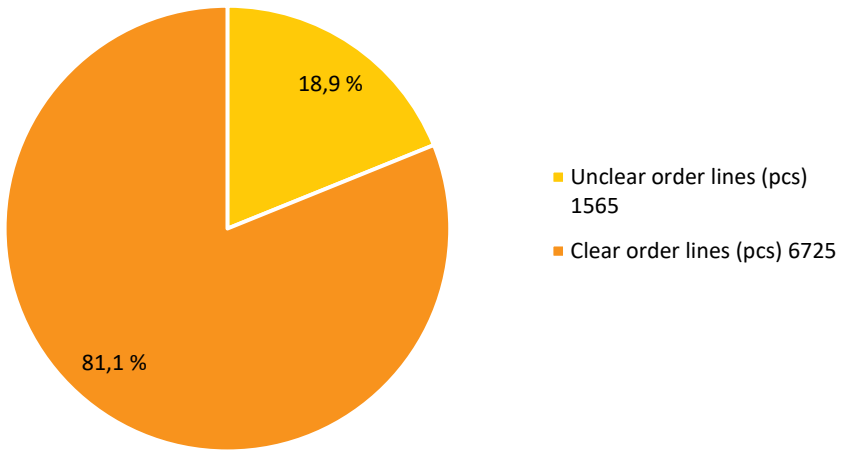

Figure 4. Distribution of order lines.

4.1.2 Correlation between order lines and created quality notifications

The time interval of the collected data was 17 weeks and each week the amount of new order lines and created quality notifications were different. To check would there be any kind of correlation between these two parameters correlation was decided to calculate. As a result, correlation was -0,429. In this case, it means that the amount of created quality notifications does not depend on the amount of new order lines opened per week. Figure 5 shows relationship between new and unclear order lines. There can be seen that between these parameters are no clear dependence. Correlation was also calculated for each department if there would be different outcome. As a result, order clearance opened quality notifications and the amount of new order lines correlation was 0,077 so it is slightly positive. Correlation between new order lines and quality notifications created by order handling department was -0,317 and between quality notifications created by application engineering department correlation was -0,573.

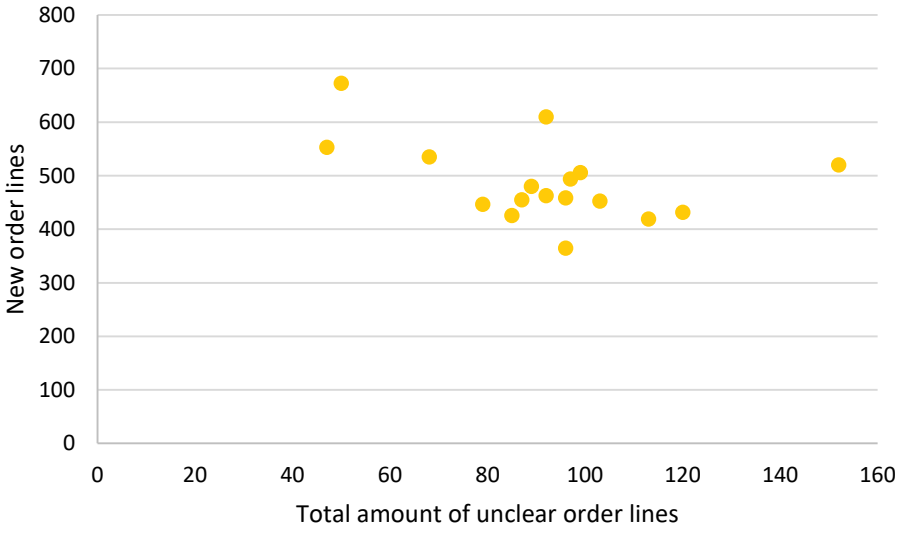

Figure 5. Relationship between new order lines and created quality notifications.

4.1.3 Distribution of quality notifications by department

Figure 6 presents the 18,9 % of unclear order lines which was presented on Figure 4. Figure 6 illustrates how created quality notifications from unclear order lines are divided between departments. Order clearance created approximately 39,4 %, order handling created 31,2 % and application engineering created 29,4 % of these quality notifications.

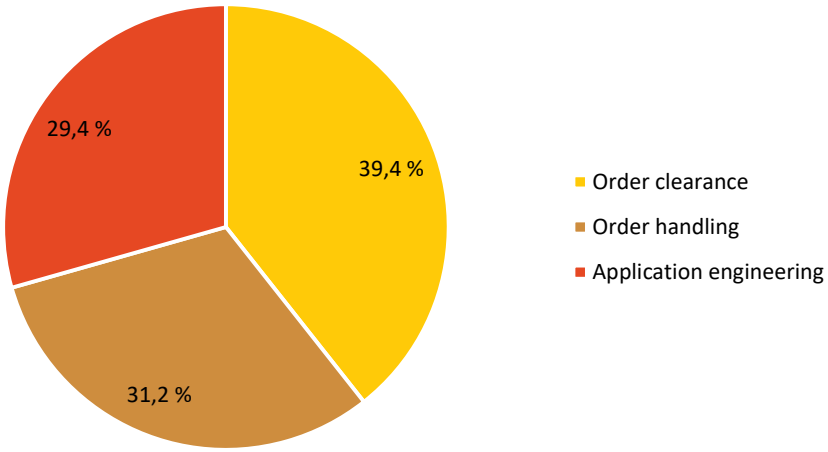

Figure 6. Distribution of created quality notifications by department.

4.1.4 Distribution of quality notifications categories

Figure 7 illustrates the 18,9 % of unclear order lines presented on Figure 4 divided by quality notification categories. Most common category for created quality notifications has been other with share of 42,9 %. The second leading category has been electrical with share of 41,2 %. Smaller categories have been mechanical with 13,9 % share and category that include both electrical and mechanical issues have been smallest with 2,0 % share.

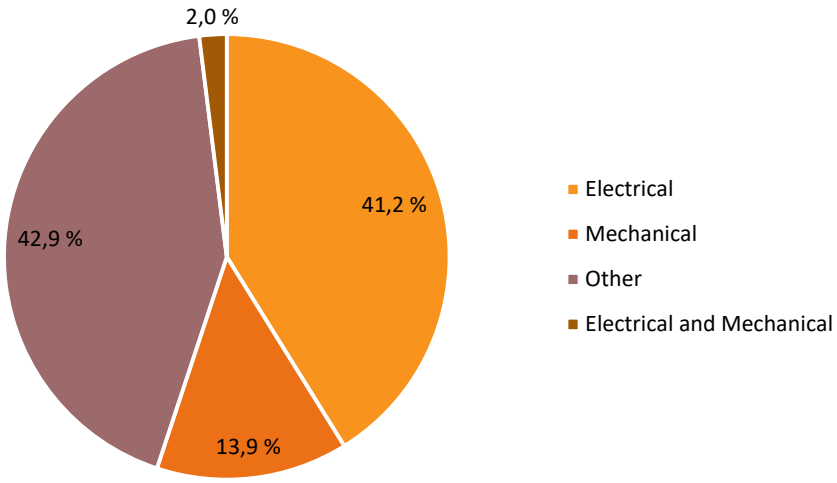

Figure 7. Distribution of quality notifications categories.

4.1.5 Clarification duration

It was decided to calculate the overall duration it takes to clarify quality notifications created from unclear order lines. Clarification duration was on average 3,3 days when all quality notifications and the hours used to clarify them was calculated. Table 7 presents clarification duration in work days divided by each department. Table 7 shows clearly that the earlier the unclear order line will be solved the less work days it takes. For example, clarification duration for quality notifications opened by application engineering department took on average 2 work days more compared to order clearance or order handling department clarification duration.

Table 7. Clarification duration for quality notifications in work days.

Department	All	Electrical	Mechanical	Other	Electrical & mechanical
Order clearance	2,5	3,0	1,5	2,3	2,9
Order handling	3,1	2,0	1,8	3,2	7
Application engineering	4,7	4,8	4,7	3,2	4,9

4.2 Order clearance

4.2.1 Order clearance, well-founded quality notifications, distribution by category and action made after clarification

In this part, focus is on those 39,4 % of quality notifications created by order clearance, presented earlier in Figure 6. One part of the study was to explore the amount of quality notifications that were created unnecessarily. Most common reason for unfounded cases was that quotation reference could not be found from the system where it supposed to be. However, as a result, quotation references were available but for some reason they were not found at first try. These cases did not depend on sales units, and that is why they are called unfounded quality notifications. Total amount of order clearance's unfounded quality notifications were 4 % and 96 % of order clearances quality notifications were well founded. Description for the well-founded quality notification was that order handling department needed to contact sales unit for help to clarify the issue, otherwise it would not have been possible to proceed.

Figure 8 reflects the distribution of this 96 % of order clearance's well-founded quality notification categories. Electrical matters represent 53,5 % of all cases, second largest reason is other with 26,7 % share, mechanical reasons share is 18,3 %. Only few quality

notifications included issue with both mounting position and stamping details and these have been categorized as electrical and mechanical with 1,5 % share. Electrical, mechanical and other reasons will be handled more specific, since shares have been remarkable.

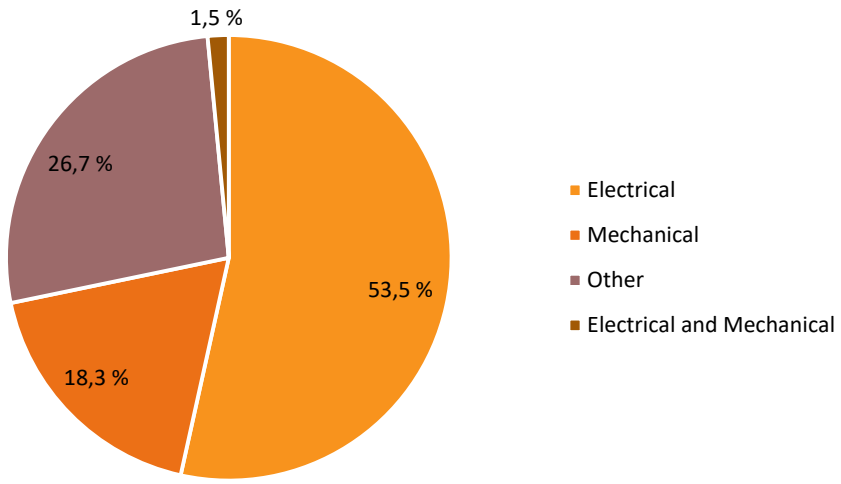

Figure 8. Distribution of order clearance's well-founded quality notifications categories.

Figure 9 illustrates required action that was made to unclear order line after issue was clarified. The order line was possible to confirm in 93,1 % of the cases. Only 0,2 % required new production slot and 6,8 % of the order lines could not be confirmed so cancellation was the only possible action. When cancellation is made, it means that it is not possible to modify the order line in a way it would achieve wanted features. Some contradiction will remain and for that reason only option is to cancel and rebook a new order line or second reason was that the clarification reply was not received in a reasonable time and for that reason the order line was cancelled. Electrical causes for cancellations were VSD (variable speed drive) loadability, output power, stamping and winding code. Other minor reasons were wrong product code, mounting position, special variant code text is missing, the quotation is not found or the connection is not right.

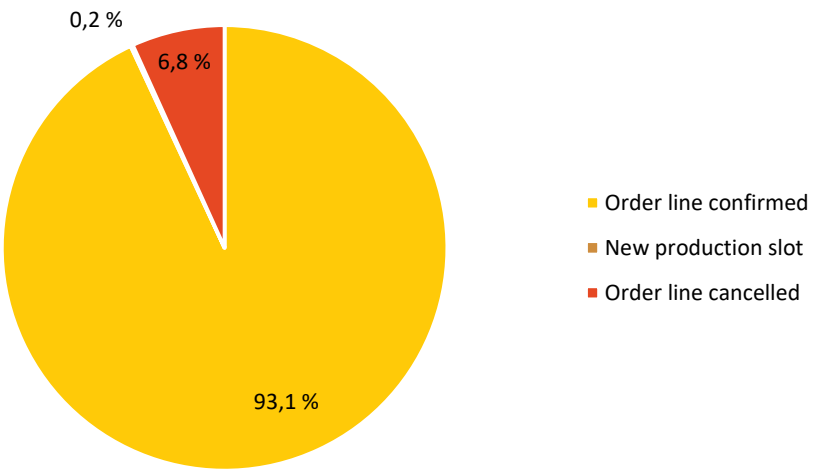

Figure 9. Order clearance, required action after clarification.

4.2.2 Order clearance, electrical quality notifications

Figure 10 describes more specific where Figure 8 53,5 % electrical reasons consisted of. Variant code not defined with 17,1 % share means those quality notifications where the described issue was electrical but accurate variant code was not mentioned on the quality notification or electrical problem did not relate to specific variant code from the order line. These not defined matters consists of following issues: output power, should there be tachometer or not, tachometer type, VSD loadability, converter type, wrong connection, the voltage code is incompatible, contradiction between rating values and values mentioned on the quotation and the motor type is not right. Causes with VSD and variant code 163 consist 29,4 % of electrical quality notifications. Some data related to VSD load, converter type or duty was missing or existing data was not applicable. The largest reason has been special winding, variant code 209 with 32,9 % share. Most common question was why variant code 209 has been ordered or its requirements. Variant code 813 hazardous environments formed 5,1 % of cases and reason behind this issue was that there is some feature on the order line that requires variant code 813 to be added on the order line. Ratings must be clarified, wrong connection or information missing on

variant code 002 formed 6,0 % of the cases. Rest of the cases 9,5 % variant code was defined but the amount of certain individual issue was so minor and for that reason these variant codes are not mentioned separately.

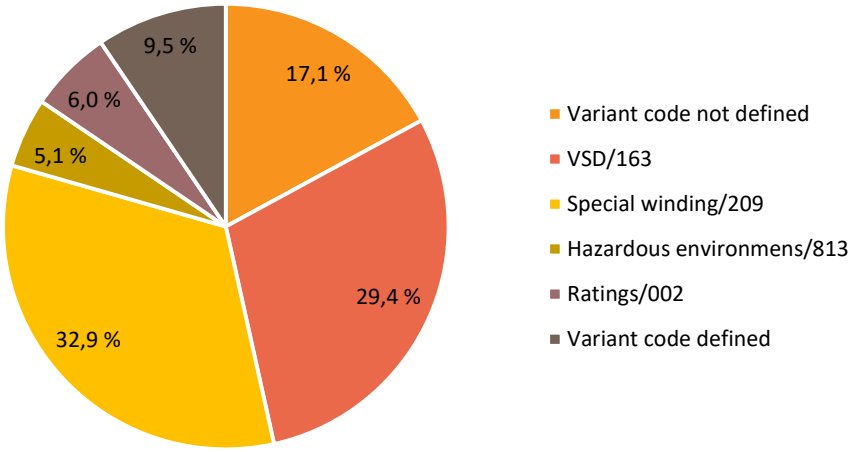

Figure 10. Order clearance, electrical reasons.

4.2.3 Order clearance, mechanical quality notifications

Figure 11 makes visible those 18,3 % mechanical reasons presented in Figure 8. Variant code not defined formed 35,2 % of the quality notifications where described issue was mechanical but accurate variant code was not mentioned on the quality notification or mechanical problem did not relate to specific variant code on the order line. These reasons were mounting position is wrong and mounting position must be re-checked. Over half of the cases 55,6 % mounting position were mentioned and it related to variant codes 005 and 066. These cases variant code 005 or 066 needed to be added on the order line because it was missing or it needed to be clarified. Rest of the mechanical cases formed 9,3 % where variant codes were defined but the issues were so rare and for that reason variant codes are not mentioned individually.

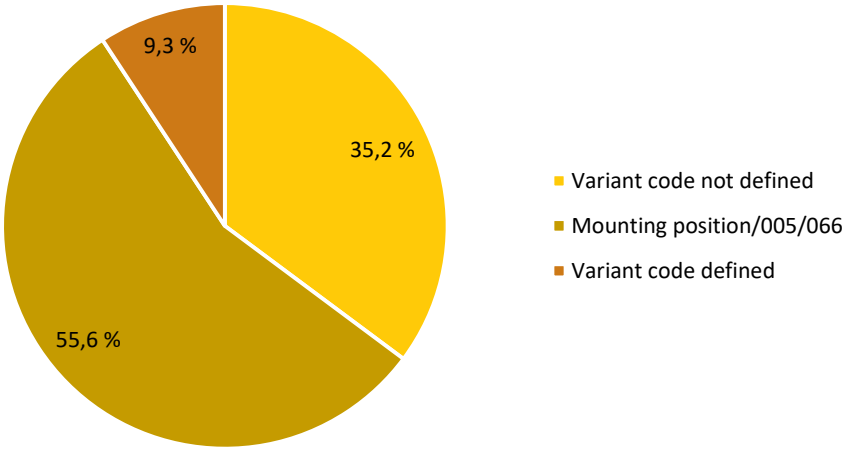

Figure 11. Order clearance, mechanical reasons.

4.2.4 Order clearance, other quality notifications

From Figure 8 category other formed 26,7 % of quality notifications and their deviation is pictured on Figure 12. Unclear information has been the reason for 31,6 % of the cases. In practice, it means some variant code text needed to be defined or the datasheet is not applicable. Missing information with 7,6 % share included cases where colour field was empty, for example. The unclear quotation was the second largest reason with 29,1 % share and the reason behind was that quotation reference given did not match with the order line. The missing quotation was the cause of 23,4 % and most cases the quotation reference needed to be re-checked. Fewer than 5 % shares were variant code missing, wrong product code and wrong variant code.

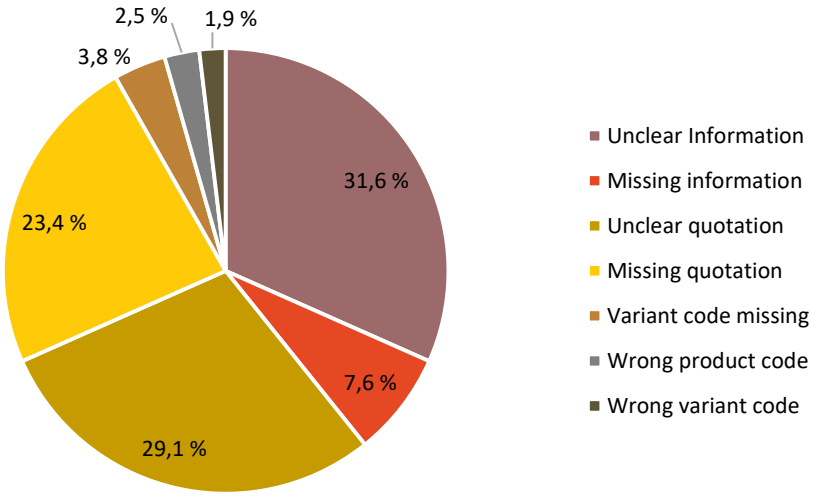

Figure 12. Order clearance, other reasons.

4.3 Order handling

4.3.1 Order handling, well-founded quality notifications, distribution by category and action made after clarification

In this part, focus is on those 31,2 % of quality notifications created by order handling, presented in Figure 6. The amount of unfounded quality notification created by order handling was low, only 1 % of all created quality notifications were unfounded. Reason was misunderstanding caused by human error. This leads to the fact that 99 % of quality notifications were well-founded. Figure 13 includes these 99 % of well-founded quality notifications and illustrates the deviation by categories. Other category is the biggest with 96,3 % share and this category will be examined more specific later. Three other categories electrical with share of 1,9 %, mechanical with share of 1,7 % and electrical and mechanical with share of 0,2 % where visible in order handling department quality notifications, even though these issues weren't as common as other issues. Connecting

factor for these issues were that some certain variant code was missing and it was clearly announced which one.

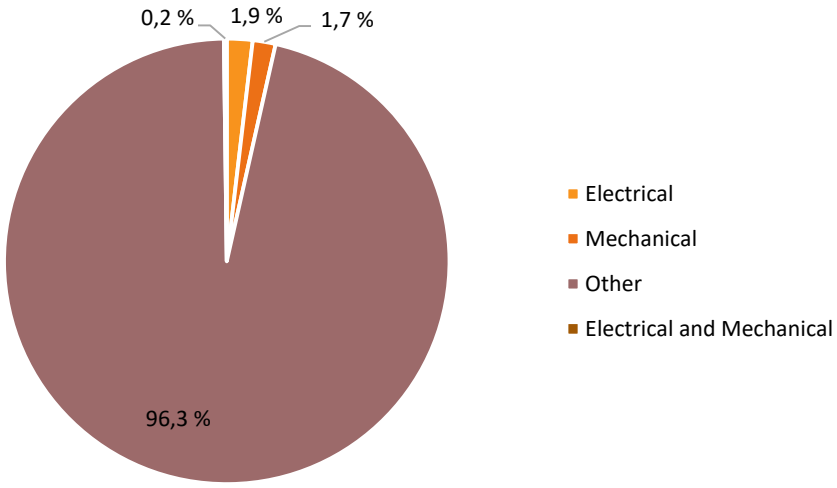

Figure 13. Distribution of order handling's well-founded quality notifications categories.

Figure 14 presents the required action that was made after clarification. Order handling department was able to confirm 90,0 % of order lines. Only 0,4 % required new production slot and 9,5 % of the cases order lines were cancelled. Most common reasons for cancellation were that clarification reply was not received in a reasonable time or it was the wish from sales unit. Almost half of the cases the issue behind cancellation was that quotation and order does not match.

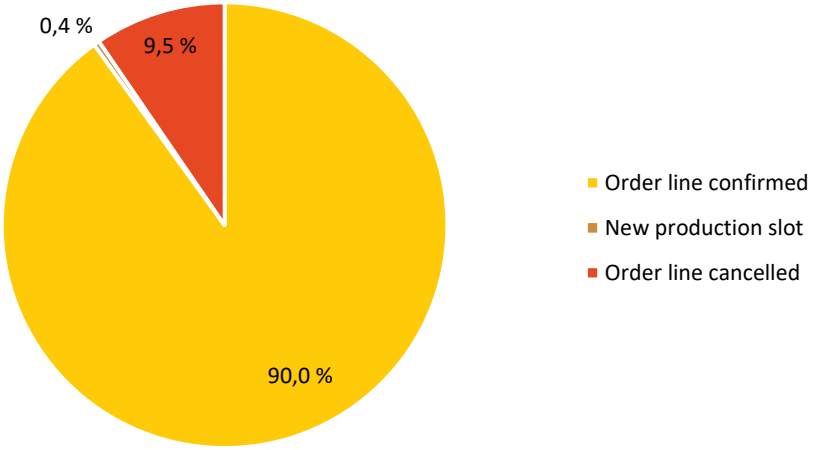

Figure 14. Order handling, required action after clarification.

4.3.2 Order handling, other quality notifications

Figure 15 depicts the 96,3 % share presented on Figure 13. The category other has been divided to pieces based on the issues which forced to create quality notifications. Incomplete order was a reason for 19,2 % of the cases. It is second biggest reason and it included cases were incoterm, delivery address or shipping information was missing, too many motors were ordered on the same order line, two different quotation reference were used or special variant code prices were missing. Quotation reference was missing 7,1 % of cases. In these cases, the order line included special feature that required the quotation but when order line was placed, the quotation reference was not mentioned. The main reason for creating quality notifications have been the fact that the quotation and the order does not match with 51,9 % share. In practice this means that the quotation and the order line doesn't have the same content, even though details added on the order line should be same than the ones mentioned on the quotation. Quotation update required share was 12,5 %. These are the cases were quotation status was something else than ready or quotation was no longer valid. Both cases update was required before continuing. Minor issues have been wrong information with 4,3 % share and GTS block with 1,3 % share, and unclear

order line with 3,7 % share. For unclear order lines, clarification required multiple changes to be performed so that the order line could be confirmed. Wrong information included cases were wrong order handling code was used, wrong currency was used or wrong quotation reference was given.

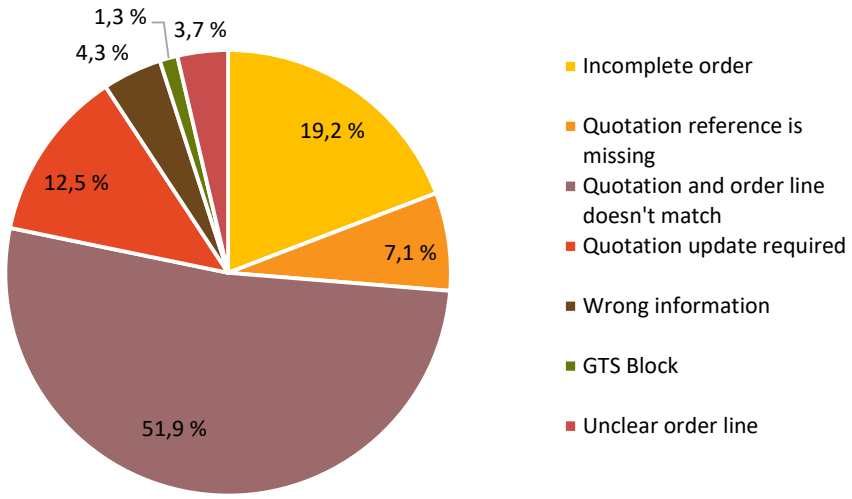

Figure 15. Order handling, other reasons.

4.4 Application engineering

4.4.1 Application engineering, well-founded quality notifications, distribution by category and action made after clarification

In this part, focus is on those 29,4 % of quality notifications created by application engineers presented in Figure 6. Application engineering department designs order lines after confirmation. In this point of the process order lines already have scheduled production slots when they supposed to be ready to production. However, when order lines are designed issues also appears. Figure 16 shows the distribution of application

engineering well-founded quality notifications categories. The amounts of well-founded quality notifications have been 93 % and 7 % have been unfounded. Common reason why unfounded quality notification was created was misunderstanding regarding regional regulation like MEPS (minimum energy performance standard) or misunderstanding of allowed stamping values. Electrical is largest category with 66,4 % share, mechanical is second largest category with 22,4 % share, third is other 6,3 % share and smallest category is electrical and mechanical 4,9 % share. Electrical and mechanical categories will be examined specific later. Main reason for other was that information was missing or it was unclear. Electrical and mechanical category included cases which have several issues like too many accessories, mounting is wrong, electrical values are not right and certain variant code is missing even though some other detail requires it.

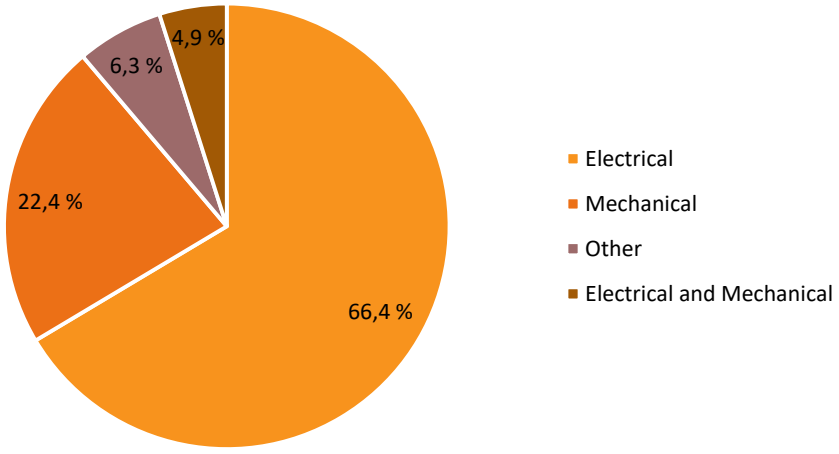

Figure 16. Distribution of application engineering well-founded quality notifications categories.

Figure 17 shows action required after clarification. It is seen that when issues are discovered at this point it causes more work and actions compared to situations presented in Figure 9 and Figure 14. The order line could be confirmed 75,3 % of the cases but remarkable fact is seen when comparing new production slot. In this point of the order-

to-delivery process it was required for 20,5 % of the cases. In other words, every fifth order line needed to be rescheduled. Quality notifications that lead to the order line cancellation included 4,2 % of the cases. Wrong product code and unclear information were the main reasons for cancellations. When cancelling or rescheduling production it means that maintaining the original delivery date is unlikely and delivery delay is possible.

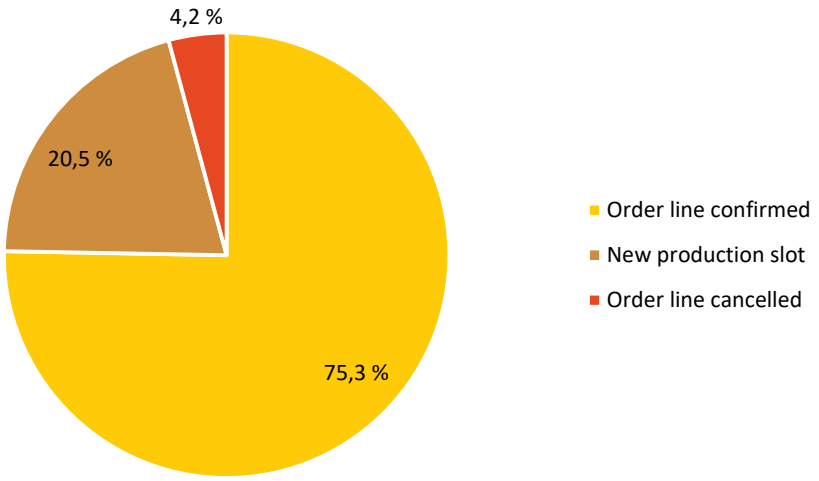

Figure 17. Application engineering, required action after clarification.

4.4.2 Application engineering, electrical quality notifications

Figure 18 presents Figure 16 electrical quality notifications with share of 66,4 %. Variant code not defined formed 18,9 % of the quality notifications. Described issue was electrical but specific variant code was not mentioned or problem did not relate to specific variant code on the order line. Reasons for these matters were unclear stamping data, wrong connection used and wrong calculation reference. VSD and variant code 163 with 17,5 % share were third common issue. VSD load, duty or other rating data was missing. Most common reason for creating quality notification with share 22,8 % has been special

winding, variant code 209 same one than in Figure 10. At this point most questions related to unclearness of special winding, calculation reference could not been found or calculation reference given was wrong. Ratings, variant code 002 with 18,2 % share was reason for unclear stamping details, some values was not possible or they were missing. Smaller issues related to variant code 004 with 4,2 % share, special variant code 999 5,6 % share and energy regulations variant code 540 with 3,2 % share. Rest of the cases 9,5 % variant code was defined but the amount of specific issue was so minor and for that reason, these variant codes are not mentioned separately.

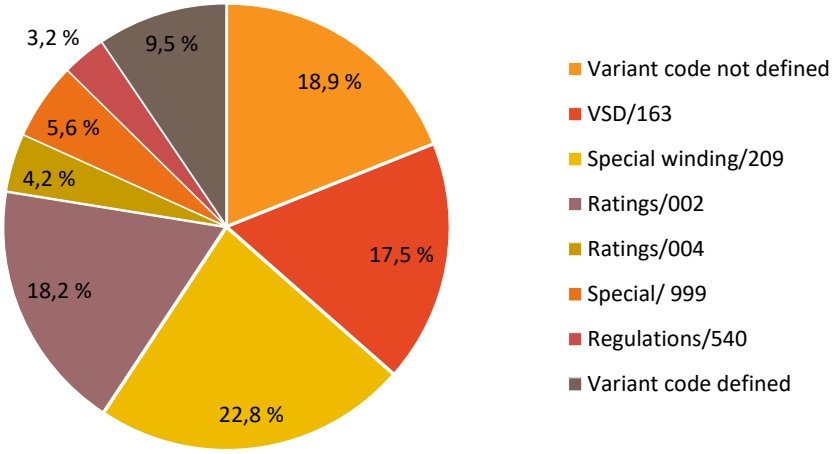

Figure 18. Application engineering, electrical reasons.

4.4.3 Application engineering, mechanical quality notifications

Figure 19 presents mechanical reasons 22,4 % mentioned on Figure 16. Variant code was not defined 17,7 % of the cases, even though problem was mechanical like labyrinth sealing, connection parts mismatch or shaft key height information missing. Mounting position, variant codes 005 and 006 formed 8,3 % of quality notifications. Special variant code 999 share was 15,6 % and in these cases some detail was missing. Cable gland

variant codes 732 and 734 formed 14,6 % share and 43,8 % share formed variant code defined category. There were many different variant codes mentioned but their appearance was not notable.

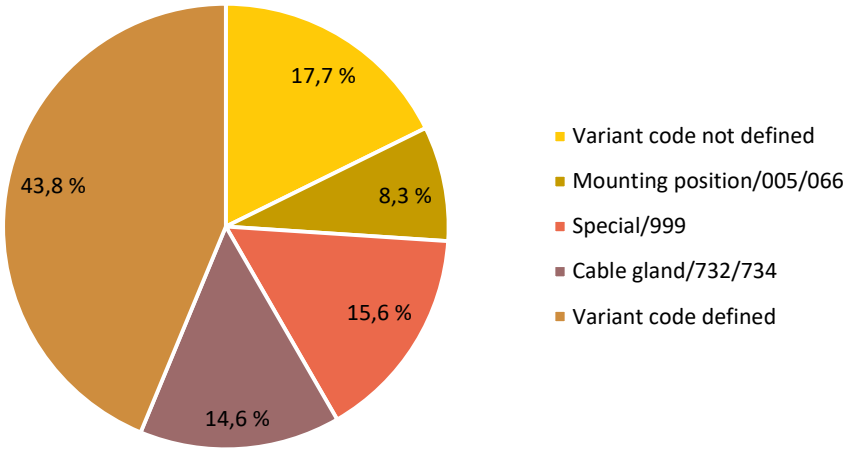

Figure 19. Application engineering, mechanical reasons.

4.5 Electronic survey

4.5.1 Profile of respondents

The original target was to send electronic survey for 372 people. However, some of the target group did not work for ABB anymore, they were on maternity leave, or contact information was not found. Finally, electronic survey was send to 354 respondents and 106 personnel replied during required time period. Total response rate was 29,9 %.

The respondents' most common job titles related to different tasks with sales-, manager-, engineer-, and support functions.

Figure 20 shows the time period respondents have worked at ABB. It can be seen that most of the respondents have worked many years at the company. Over 40,6 % have worked more than 10 years and 30,2 % have worked 5 to 10 years. Some of the comments also described the relationship between the time and willingness to work at ABB. For example, it was said that in general we work in a wonderful company despite the bureaucracy, and after about 20 years nothing can surprise anymore.

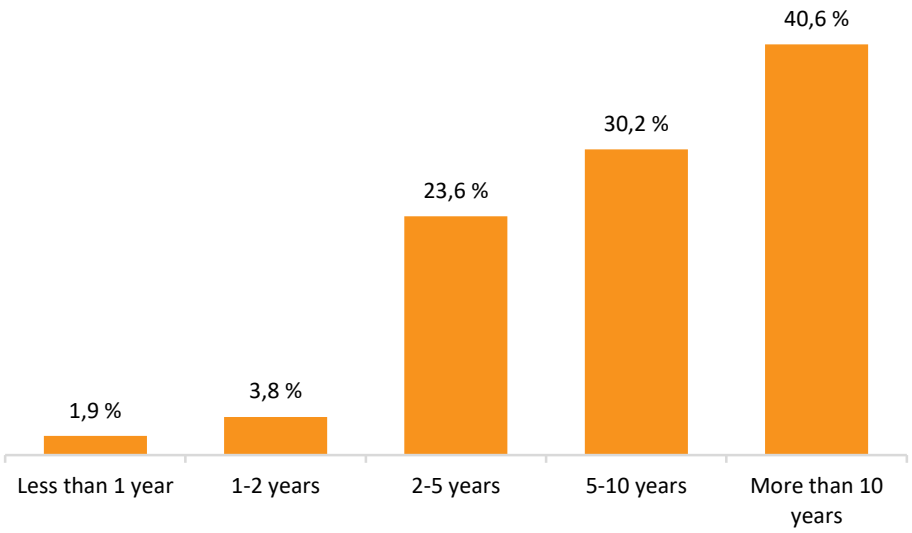

Figure 20. How long respondents have worked at ABB.

Figure 21 illustrates locations respondents work. 39,6 % of respondents works in Central Europe and 17,9 % in North Europe. 13,2 % works Mediterranean countries and 10,4 % of respondents' works in North Asia and 10,4 % works in South Asia. When looking Figure 20, must be remembered that respondents were selected based on the names that could be found from selected order lines, so there has not been same amount of people working in each continent.

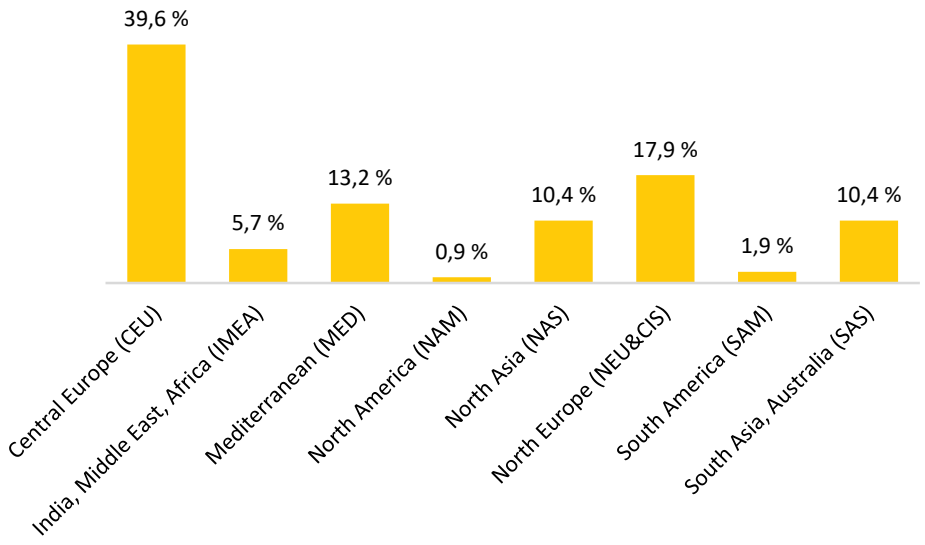

Figure 21. The continent where respondents work.

4.5.2 Possible error precursors

Figure 22 illustrates how often respondents face features that can also be possible error precursors at work. It is seen that time pressure while performing tasks with 53,8 % share, high workload with 48,1 % share and multitasking with 66,0 % share have a daily presence. In weekly and daily scale each of these features are common for approximately 85 % of respondents. In weekly and daily scale over 35 % of respondents felt that help or consultation is not available when needed, and distractions caused by work environment is also a feature that happens often. Over 20 % of respondents also face new and unfamiliar tasks to work with, unclear goals, roles or responsibilities, and lack of job related instructions in weekly and daily scale. In other side, over 70 % of respondents only face these features monthly, rarely or they have never faced them.

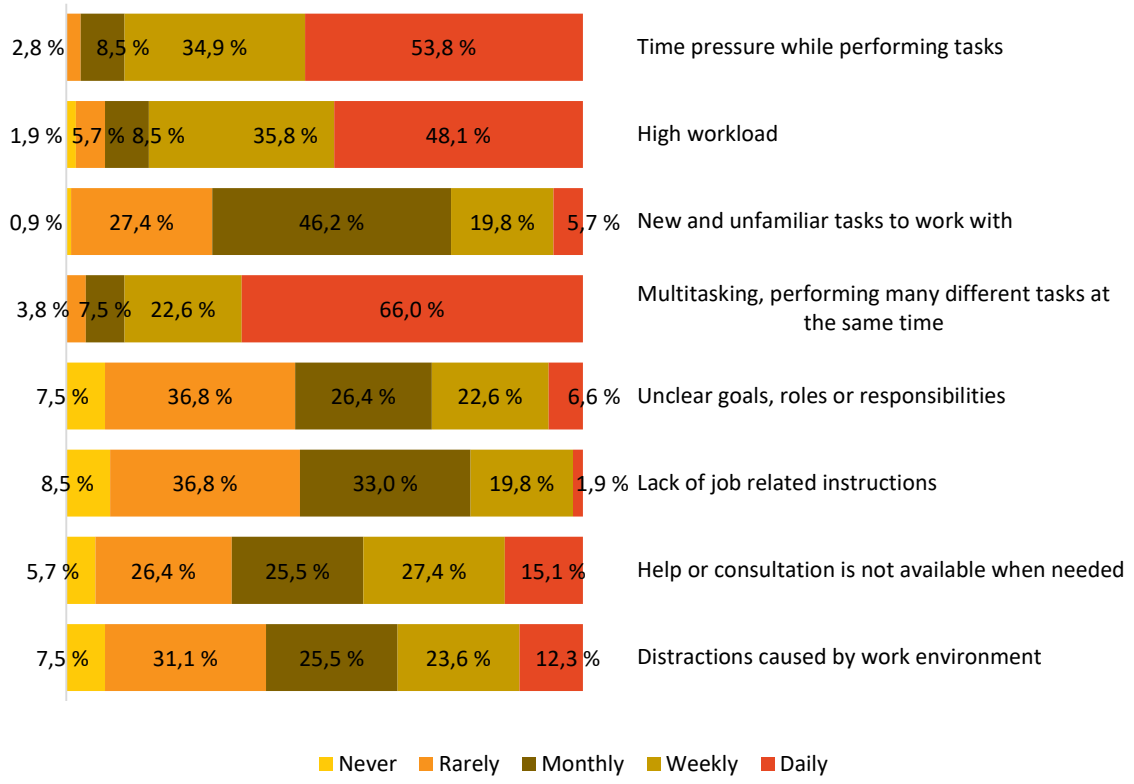

Figure 22. How often respondents face following features at work.

Figure 23 describes similar error precursors as Figure 22 but in different point of view. Figure 23 shows how often respondents felt that these features cause harm to their work. Over 20 % of respondents felt that time pressure and high workload causes harm daily. In weekly and daily scale over 50 % of respondents felt that time pressure, high workload and multitasking causes harm. A bit under 40 % of respondents' felt, that help or consultation is not available when needed causes harm mainly in weekly but also in daily scale. Approximate 80 % of respondents felt that new and unfamiliar tasks and lack of job related instructions does not cause harm or if it does, it only happens rarely or monthly. Under 75 % of respondents felt that unclear goals, roles or responsibilities and distraction caused by work environment only causes harm rarely, monthly or never. A bit over 15 % of respondents felt that distraction caused by work environment does not ever cause harm to their work.

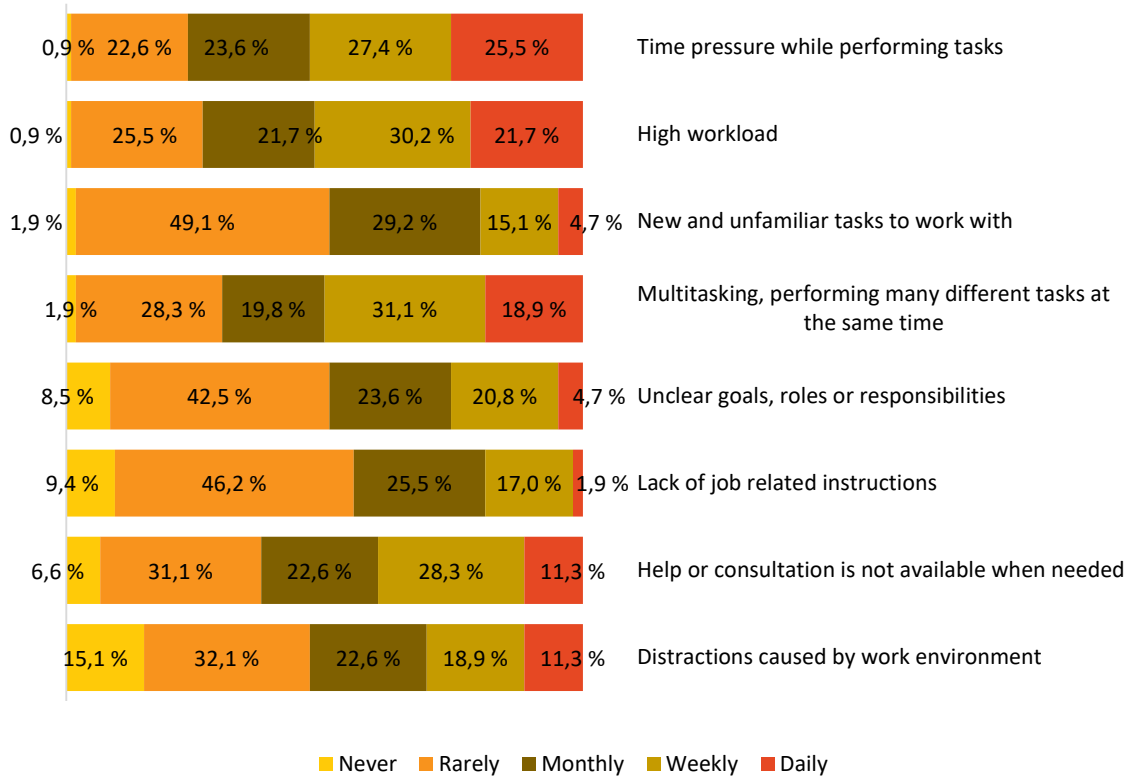

Figure 23. How often following features causes harm to respondents work.

Each respondent also had to select three error precursors they felt most disturbing at their work and the distribution is presented in Figure 24. Three most disturbing features have been time pressure 55,7 %, high workload 62,3 % and multitasking 53,8 %. Fourth biggest individual feature has been that help or consultation is not available when needed with 43,4 % share. Four features that have had less votes are new and unfamiliar tasks to work with 19,8 %, unclear goals, roles or responsibilities 27,4 %, lack of job related instructions 17,0 % and distraction caused by work environment 20,8 %.

Many comments received from respondents told about error precursors and issues that relates to them. These issues were that normally customers are expecting to receive a response to their questions within 2–3 days and because the lack of support or information they are not receiving from pre- or post-order due that time it causes harm to them and they are constantly losing their own efficiency because of it. Respondents would hope to

receive more detailed explanations to their questions. Respondents felt that if it would be possible to receive faster replies for those questions they have asked it could improve the performance and be really beneficial to all parts of the order-to-delivery supply chain. It was also said that it is unavoidable to have complications at work such as multitasking, high workload and time pressure but management on these features are rather important. The possibility to reduce the amount of reporting and protocols to follow regarding single things was also hoped.

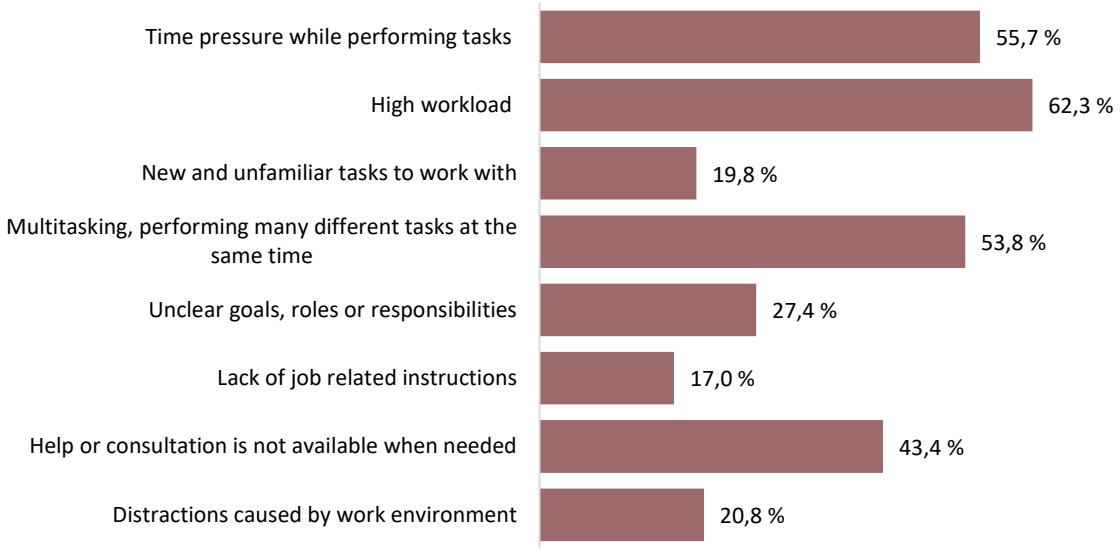

Figure 24. The distribution of features respondents felt most disturbing at their work.

4.5.3 Knowledge sharing

Figure 25 illustrates respondents thought about knowledge sharing and communication. It is obvious that most of the respondents agree or mostly agree that it easy to communicate and share knowledge with their co-workers. Almost unanimously, respondents also like to help and give consultation to their co-workers when they need it. They also feel that knowledge and new information is shared openly in their team and approximately 65 % of them knew whom to ask help or consultation when needed.

Approximately 17 % find it uncomfortable to ask help or consultation but most of the respondents felt that it is not uncomfortable.

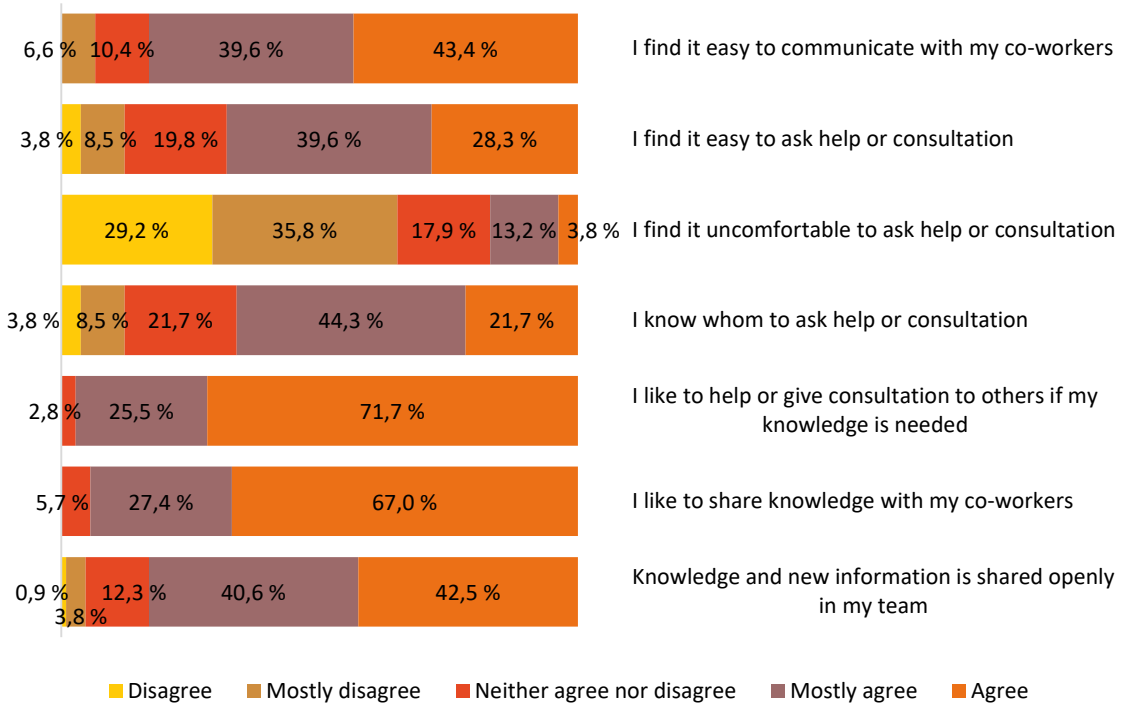

Figure 25. Respondents thoughts about knowledge sharing and communication.

Figure 26 shows respondents' thoughts about instructions and how easy it is to find or hear changes related to them, and materials that are available and systems they mostly used when placing the order. In general, votes were distributed pretty evenly in the middle. Over 60 % of respondents agree or mostly agree with proposition to know the circumstances when quotation is required and approximately 50 % of respondents agree or mostly agree with propositions that OMS (order management system) is clear and easy to use, they have received enough information how to use OMS and where to add specific details in OMS, and that quotations are clear and easy to use. However, under 40 % of respondents agree or mostly agree that it is easy to transfer information from quotation to OMS.

Many respondents also shared their thoughts about OMS and they felt like if they are beginners it is not so easy to use OMS since there are no specific instructions about non-standard procedures. It was hoped to receive training course in OMS and how does it work since there are many unclear things. It was also said that OMS should be more user friendly and respondents also felt when placing order lines to OMS it requires dedicated timing and during that time, distractions are not recommended since when placing many order lines manually mistakes might happen especially with stamping and tag numbers. They also hoped that if they have place many order lines and all the other order lines include specific paint colour or specific voltage except one order line, that factory would contact them and ask if the one different order line is placed correctly. Not all the respondents are able to use OMS for placing order, so they have different method they need to use. It was also said that it is hard to understand why there are motors available to enter in OMS but the price rules are missing and this will not help with the efficiency, and that there are many tabs in OMS that are only rarely checked. It was also said that why there couldn't be a break down list depending on the accessory type that is wanted and then you could only click on the technical feature you want to add, rather than placing variant codes individually.

It was also questioned why there is not a system that would generate the quotation and its information automatically when order is decided to be placed because now they have to transform same information manually instead of using quotation file directly. Before they are even able to place the order they have to use multiple systems and tools to get the information the quotation requires. For example, nowadays many quotations need to include drawings, and technical data from Motsize, but Motsize for example is not updated with all the necessary information. Respondents hope systems and tools integration would be improved and many felt that the system used for quotation is outdated and if possible, maybe OMS could be used for quotations so transferring quotations to orders would be easier.

Five topics which appeared in the least agree or mostly agree answers, all under 37 % share were changes related to products are well informed, new instructions and guidelines are well presented, changes related to job tasks are well informed, it is easy to find

knowledge or instructions from internal databases. Only under 22 % of respondents agree or mostly agree that it is easy to find knowledge or information about new or unfamiliar tasks.

Respondents would hope that when product changes, variant code changes, new rules are made they would receive information more frequently since sometimes they are informed afterwards or they have to find themselves if some changes have been made. They would also hope to be involved in these changes. They also felt that information they receive regarding new rules, new products or new efficiency regulations are never clear. It was also said that there should be updated common database where all information customer require could be found, it was also unclear what type of documents or support they can expect from factory. Another matter that was hoped was to unify procedures used in documentation, for example using same format for drawings. They also thought that motors are quite simple but design variation is too huge and that sometimes customer prefer low cost product since the simplicity and clear documentation they can get.

Over 40 % of respondents agree or mostly agree that they have well prepared training methods and materials and that all kinds of variant code descriptions are clear and easy to use. Respondents also have many thing that could be improved regarding variant codes. For example, they would like to get descriptions from all variant codes since now there are variant codes that does not have a description. It was also hoped that there would be more detailed explanations and examples about variant codes, and that a certain variant code is used and made in a same way for more products in a full range.

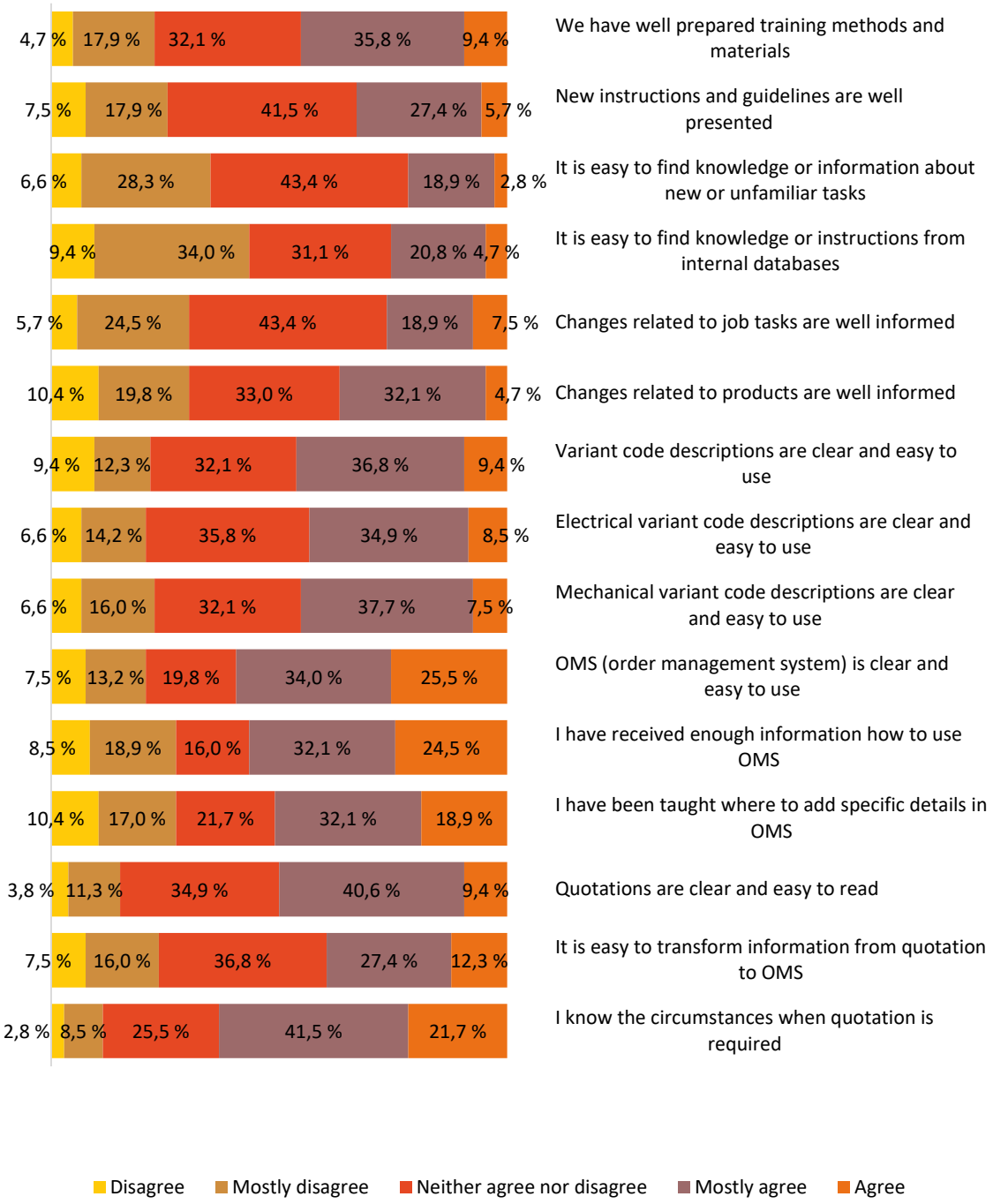

Figure 26. Respondents thoughts about instructions, materials and systems.

5 DISCUSSION

5.1 Overview of the research

This research has been made since there has been a daily issue regarding unclear order lines that affects operational activities. In practice, unclear order line stops the order-to-delivery process and it can only continue after unclear matter has been solved. Starting point for this research was to see where these unclear order lines consist of and what can be found from them. One purpose was to find possible root causes to these issues and make suggestions how to prevent or minimize them. For this reason, there were two different empirical research parts.

Research method was a case study that mostly consisted of quantitative analysis with a hint of qualitative aspect. Main reason for this selection was the amount of data that was gathered and examined.

First part of the results focused on examining 1565 quality notifications that were created every time the order-to-delivery process had to be stopped by order clearance, order handling or application engineering department. Second part focused on to find out possible root causes why there are unclear order lines and it was carried out using an electronic survey, where 106 replies were received. When first part examined the data from quality notifications second part concentrate on employees that inputs data into the system or works with customers and possible new orders. Based on these results suggestions how to prevent unclear order lines have been made and they are be presented on 5.3 Recommendations chapter.

5.2 Summary of findings

General examination of unclear order lines point out that almost every fifth new order line placed on the system had to be stopped for clarification before releasing it to production. This means that data that has been placed to the system has been inadequate and due the high amount of unclear order lines, there is a reasonable cause for quality improvement. Clarifying unclear order lines has caused efficiency losses, waste of time, double work and unnecessary tasks not only in the order confirmation and designing processes but also on sales units. Basically unclear order line can be considered as a waste that needs to be identified, detected and eliminated from the order-to-delivery process. This should be done by improving process input by offering employees' proper tools, materials and guidance that they require on that phase. This way it will be possible to improve process output as well.

Results made visible the fact that the later the error was identified the higher the consequences were. For example, Table 7 presented time it took to clarify unclear order lines on average, and it was clear that on designing phase clarification took almost 2 work days more comparing to order clearance and order handling phases. Unclear order lines that were found at designing phase caused harm approximately every fourth of those order lines. Those order lines needed either new production slot or cancellation, presented in Figure 17. Most of the cases both actions meant delay from the original delivery time and that is a factor that influence on customers satisfaction.

In general level most of the errors from unclear order lines were categorized to be other error or electrical error. Other error included cases that mostly related to quotation, wrong or missing information. Electrical errors mainly related VSD, special winding and other rating plate data. When quality notifications were divided by each department deviations between electrical, mechanical and other issues categories changed rapidly compared to general level. For this reason, it was justified to examine each department individually. Deviations presented earlier in Figures 7, 8, 13 and 16.

When unclear order lines were examined in a profound level in earlier presented Figures 10, 11, 12, 15, 18 and 19 it was possible to observe that there are many similar errors that happens repeatedly. This supports the idea that it is possible to make actions to prevent these errors focusing on the human capabilities at the beginning of the process. Deshpande et al. (2012) and Wachter et al. (2013) listed many reasons that may cause inefficiency and weakness on the organizations and mistakes can be considered to be one symptom. However, most of the mistakes have roots somewhere else than employee's individual capability. There can be complex systems and circumstances where employee has to manage with limited resources. Mistakes can also be corrected but if there are no recommendations how to avoid certain mistake from happening again it can be easily repeated. For example, does employees at the beginning of the process know how their actions affect to the next step of the process if they do not have clear information of those requirements that is expected from them?

Possible error precursors were presented in Table 2 and electronic survey also focused on them. It could be seen on earlier presented Figure 22 that time pressure, high workload and multitasking were most surrounding conditions for many employees from sales units daily and weekly. It was relieving to see that despite these features are present often they does not cause interference to respondents ability to work in the same scale. However, approximately half of the respondents felt that time pressure, high workload and multitasking cause harm weekly or daily at their work, so this should be considered as a signal that maybe something could be done to improve surrounding work conditions so that employees' would have better starting point.

Positive surprise that came out from results was that knowledge sharing and communication is easy and employees are willing to discuss and help their co-workers. Most respondents also knew whom to ask help but when they need to select three options from possible error precursors that disturbs most at their work when they appear "help or consultation is not available when needed" was one factor that disturbed most, even though it doesn't appear as often as time pressure, high workload and multitasking.

In general, results shown earlier on Figure 26 can be considered to be on average level but it should be seen that there is a possibility for improvement as well that could help employees from sales unit to perform their job tasks even better. For example, changes related to products, tasks and rules should be communicated on time so that there would be time to adopt and process with this new information. Another message that was received was to make detailed variant code descriptions for all variant codes and unify the content of them.

One factor that came up in many replies was the existence of multiple systems that are needed to gather information. It was questioned could it be possible to wider the scale of OMS and maybe let go on some other system. Placing order lines also requires a lot of manual work when details must be placed individually and it was wondered why the information that exist on quotation for example can't be directly transferred to orders. It was also hoped that support functions could respond faster to their inquiries so that they could keep customers pleased. In practice, this means that sales units would hope to receive replies to their questions in 2–3 work days.

5.3 Recommendations

Third step from Liang et al. (2010) six steps of problem solving, presented on Table 3 was to generate potential solutions and explore alternatives. One way to prevent mistakes or make them visible was to design system in a way it would alert each time possible error might happen. It would be positive to have a system that could block the errors so that employees does not have to remember that much from memory. It could help to reduce workload and stress when performing task since there would be a back-up system that would give feedback when possible error could happen if correcting action will not be made. However, in this case not all the employees who place order lines use the same system. This option would require systems updates, resources and time before advantages from it could be received.

Another possible option suggested by Wachter et al. (2013) was self-checking. Idea is to stop and think before acting again. Self-checking tools awakes employee self-awareness and help employee to foresee and prevent possible errors. They are also suitable for rule-based environment where tasks are repetitive. The self-check list can be effective if its recommendations are followed properly.

It was seen from results that many errors happen repeatedly and the reasons behind errors are not that complicated to fix if only there is enough support and understanding the importance of the issue. Step 4 from Liang et al. (2010) six steps of problem solving presented on Table 2 was to select and plan the best solution. Based on the results received from empirical part 1, an example of possible self-check list (appendix 3) has been planned to be the solution that could help to minimize the amount of unclear order lines. It consist on most common errors that could be prevented by checking details carefully before order line is placed.

Recommendation that would support and help employees on sales units, is to make a proper step by step instructions on self-check list that are easily available and clear for usage and when employee is following these detailed instructions it would be hard to make an error. The self-check list could also be designed to be electronic so right proposals/instructions for correcting actions would be just one click away and this way it would be easy to update, correct and modify

The calculation (appendix 4) show that 71 % of these errors, over two thirds, could have been prevented if issues mentioned on self-check list (appendix 3) would have been checked and corrected while the order lines were placed. The boxes (appendix 4) marked on green are the issues, which the proposed self-check list could have correct and red boxes are issues that the proposed self-check list could not directly prevent but it could have influence on those as well. Simple action as checking certain details can have a huge impact on the end result.

Step 5 from Liang et al. (2010) six steps of problem solving presented on Table 2 was to implement the solution. One easy way to share self-check list to sales units would be to

send it to managers and via them to employees, or directly to employees each time when offering a quotation to them, and contacting them for clarifying some error that has been found from order line. Another step would be to involve managers to support their team members to follow recommendations presented on the self-check list each time when placing new order line and explain the impact these errors have if they are not corrected on that phase. When employee recognizes that this detail need to be corrected before continuing a good way of acting is the S-T-A-R- model presented in Table 4. Second step on this model is “think” and what this should mean in practice is to check on the self-check list what is the correct action to be performed to receive the right information before continuing.

Other recommendation that require more resources but would benefit all parts of the order-to-delivery chain, is to make actions that improve and guarantee faster customer support on each stage of the process. These actions can consist of training, new instructions, job rotation and open discussion between departments.

5.4 Research limitations

This research only focused on errors that appeared during order confirmation and designing processes. Errors that happened after order lines have been released to production was left outside from this research.

5.5 Suggestion for further research

In this research, unclear order lines were examined in general level. Data that was gathered was not divided by each country or sales unit. Point for this research was to see this issue on upper level perspective. Next researches could focus on different sales units and differences between unclear order lines on them. Another research in future after suggested propositions have been implemented would be to observe how suggested corrections have changed the situation and have new issues appeared that was not

mentioned on this research. Table 3 Six step of problem solving, step 6 also required that implemented actions are revaluated and possible corrections are performed and this can only be done through observation and future research.

5.6 Conclusions

One unclear order line might sound a minor issue, but when approximately every fifth order line stops the order-to-delivery process and they require time and capacity from many employees globally the efficiency losses are remarkable. On the positive side, now those details unclear order lines consist of are known and it will be possible to prevent them with proper actions that are suggested on earlier chapter.

Organizations should invest on understanding what certain mistakes are and find possible causes to them since even minor sounding issues can have results that negatively influence on work conditions for many employees. Time employees use to clarify or correct something they already done once is away from something more productive. Mistakes are a reminder of organizational weaknesses and for better organizational performance, effectiveness and customer satisfaction these matters should be taken seriously. Organizations should understand that there are not mistakes that could be left ignored and uncorrected. Idea behind all quality management programs starts with the concept that everything can be improved and designed in a way there would be a minimum amount of activities that does not bring value to processes.

This research point out that not all mistakes are hard and complicated to fix. They just require time to investigate possible causes and think reasonable ways to prevent them. Problem solving tools provides a guidance where to start when some issue have impact on operational performance. However, it will not be possible to prevent mistakes from happening if proper guidance, instructions and behaviour models are not implemented in the work environment. This require a management level commitment and willingness to improve these matters if they want that employees are able to perform their job in an efficient and ideal way.

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APPENDIX 1. Electronic survey, cover letter for respondents

Dear respondent

My name is Satu Hietala and you may remember me from Fimot's customer support team. I'm also a master's degree student at University of Vaasa (Finland). The reason why I contacted you is that I'm currently writing my master's thesis and I need your help. This is a case study for ABB Motors and Generators about unclear order lines and what kind of factors behind human knowledge may have impact on them.

Participation will take approximately 10 minutes and your responses are really important and valuable since they can point out what can be done better, and how to improve the process in a way order lines could be confirmed faster in the future and that way to improve customer satisfaction.

Answers will be anonymous and the data will be treated confidentially.

I hope you will participate in this survey between 15.3.2016 - 24.3.2016, and I will be extremely grateful to you for helping me with this. If you want to know more about the results when they are ready or where to find them please let me know.

Link : https://eforms.uwasa.fi/lomakkeet/4225/lomake.html

Username: #tunnus#

Password: #salasana#

Yours sincerely

Satu Hietala

APPENDIX 2. Electronic survey, questions

Part 1

Current job title

How long have you worked at ABB

- ☐ Less than 1 year
- ☐ 1–2 years
- ☐ 2–5 years
- ☐ 5–10 years
- ☐ More than 10 years

Which continent you are working

- ☐ Central Europe (CEU)
- ☐ India, Middle East, Africa (IMEA)
- ☐ Mediterranean (MED)
- ☐ North America (NAM)
- ☐ North Asia (NAS)
- ☐ North Europe (NEU&CIS)
- ☐ South America (SAM)
- ☐ South Asia, Australia (SAS)

Part 2

How often you face following features at your work

	Never	Rarely	Monthly	Weekly	Daily
*Time pressure while performing tasks	○	○	○	○	○
*High workload	○	○	○	○	○
*New and unfamiliar tasks to work with	○	○	○	○	○
*Multitasking, performing many different tasks at the same time	○	○	○	○	○
*Unclear goals, roles or responsibilities	○	○	○	○	○
*Lack of job related instructions	○	○	○	○	○
*Help or consultation is not available when needed	○	○	○	○	○
*Distractions caused by work environment	○	○	○	○	○

Does the following features cause any harm to your work

	Never	Rarely	Monthly	Weekly	Daily
*Time pressure while performing tasks	○	○	○	○	○
*High workload	○	○	○	○	○
*New and unfamiliar tasks to work with	○	○	○	○	○
*Multitasking, performing many different tasks at the same time	○	○	○	○	○
*Unclear goals, roles or responsibilities	○	○	○	○	○
*Lack of job related instructions	○	○	○	○	○
*Help or consultation is not available when needed	○	○	○	○	○
*Distractions caused by work environment	○	○	○	○	○

Please select 3 of the following options that disturbs you most at your work

- ☐ Time pressure while performing tasks
- ☐ High workload
- ☐ New and unfamiliar tasks to work with
- ☐ Multitasking, performing many different tasks at the same time
- ☐ Unclear goals, roles or responsibilities
- ☐ Lack of job related instructions
- ☐ Help or consultation is not available when needed
- ☐ Distractions caused by work environment

Part 3

Please select option that suits best for you

	Disagree	Mostly disagree	Neither agree nor disagree	Mostly agree	Agree
*I find it easy to communicate with my co-workers	○	○	○	○	○
*I find it easy to ask help or consultation	○	○	○	○	○
*I find it uncomfortable to ask help or consultation	○	○	○	○	○
*I know whom to ask help or consultation	○	○	○	○	○
*I like to help or give consultation to others if my knowledge is needed	○	○	○	○	○
*I like to share knowledge with my co-workers	○	○	○	○	○
*Knowledge and new information is shared openly in my team	○	○	○	○	○

Part 4

Please select option that suits best for you

	Disagree	Mostly disagree	Neither agree nor disagree	Mostly agree	Agree
*We have well prepared training methods and materials	○	○	○	○	○
*New instructions and guidelines are well presented	○	○	○	○	○
*It is easy to find knowledge or information about new or unfamiliar tasks	○	○	○	○	○
*It is easy to find knowledge or instructions from internal databases	○	○	○	○	○
*Changes related to job tasks are well informed	○	○	○	○	○
*Changes related to products are well informed	○	○	○	○	○
*Variant code descriptions are clear and easy to use	○	○	○	○	○
*Electrical variant code descriptions are clear and easy to use	○	○	○	○	○
*Mechanical variant code descriptions are clear and easy to use	○	○	○	○	○
*OMS (order management system) is clear and easy to use	○	○	○	○	○
*I have received enough information how to use OMS	○	○	○	○	○
*I have been taught where to add specific details in OMS	○	○	○	○	○
*Quotations are clear and easy to read	○	○	○	○	○
*It is easy to transform information from quotation to OMS	○	○	○	○	○
*I know the circumstances when quotation is required	○	○	○	○	○

Part 5

In this field you can share your own thoughts about these subjects based on your own experience. You can also write your wishes and suggestions how to improve/develop these matters.

Proceed

Save

APPENDIX 3. Self-check list example

When placing the order, please check that following details are correct before continuing. Otherwise, order (lines) will be stopped for clarification and that will increase the order confirmation time and may impact on the delivery time. When checking these details and some ambiguity is found, please make actions to correct the issue before continuing again. This way you can help the order (lines) to pass through confirmation process smoothly and without interruptions.

ELECTRICAL MATTERS

Check correct data (e.g. voltage, frequency, power, calculation reference and other details).

- VSD/163 (loadability, converter type, duty)
- Special winding/209 (requirements)
- Hazardous environments/813 (requirements)
- Ratings/002 (connection, information missing)
- Rating/ 004 (details)

MECHANICAL MATTERS

Check when and how to use.

- Mounting position/005/066
- Cable gland

OTHER MATTERS

Check details are correct, valid and mentioned on the right place.

- Product code (is it correct)
- Variant codes (features are specified, no information missing)
- Quotation (reference match with the order line(s), right reference is used, reference is placed on the order line, quotation is valid e.g. status is ready and date hasn't expired)
- Details (incoterm, delivery address, shipping information, order handling code, currency, and the amount of motors per order line doesn't exceed the recommended amount)
- Special/999 (needs quotation, price clarified)

APPENDIX 4. Calculations based on APPENDIX 3.