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Layout Tender Process Harmonization

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TIAINEN VILLE
Layout-tarjousprosessin harmonisointi

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Tämän kehitysprojektin tavoitteena oli harmonisoida tarjousvaiheen hissitasonsuunnittelun prosessit ja toimintamallit ja se tuotettiin KONE, Hyvinkään toimitusyksikköön. Taustana oli suunnittelutiimien yhdistyminen ja tästä johtuvat lukuisat eri työtavat, joita haluttiin yhdenmukaistaa.

Tutkimusmenetelmiä ja projektin toimintamalleja tarkasteltiin Lean-periaatteiden avulla. Kehitysprojekti aloitettiin Kaizen-työpajalla, jossa kartoitettiin nykyprosessi, prosessin tavoitetila, sekä uuden prosessin käyttöönottoon vaaditut toiminnot. Prosessikehityksessä käytetiin myös muita Lean-tutkimusmenetelmiä, kuten arvovirtakartoitusta. Arvovirtakartoituksella löydettiin merkittäviä parannuskohteita erityisesti prosessin läpimenoajan lyhentämiseen.

Projektissa harmonisoitiin tarjoustiimien ja layout-tiimien toimintoja. Suurimmat toimintoihin koskevat harmonisointitoimet keskittyivät layout-piirustusten sisällön uudelleen määrittelyyn. Tämä määrittely myös pilotoitiin kymmenen projektin volyymilla ja palautetta kerättiin myyntiyhtiöistä ja tarjoustiimeistä. Toinen suuri kokonaisuus oli layout-palveluntarjonnan uudelleenmäärittely, dokumentointi ja implementointi. Samaan aikaan uudistettu tarjousprosessi otettiin käyttöön.

Tarjousprosessin nykytilaa analysoitiin Lean-menetelmillä. Projektin lopussa muodostettiin tavoitetila prosessin jatkokehitykselle. Tavoitetilaa arvioitiin projektissa kerätyn datan, analyysien ja lean-periaatteiden kautta. Tavoitteena oli erityisesti parantaa tarjousvaiheen virtaustehokkuutta ja lyhentää vasteaikaa. Projektin tulokset esiteltiin suunnittelun johdolle, mikä johti prosessin jatkokehityksen käynnistämiseen.

Asiasanat: Lean, Kaizen, arvovirtakartoitus, prosessin harmonisointi

ABSTRACT

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TIAINEN VILLE
Layout tender process harmonization

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The goal of this development project was to harmonize elevator level engineering tender phase processes and functions for KONE, Hyvinkää supply unit. The background of this project was the merging of several engineering teams and different ways of working.

Lean was the main principle when research methods and project operating models where considered. The development project was started with a kaizen event in which “as is -situation” of process was mapped, “to be -process state” was created and the tasks needed to be carried out before taking the process into use were defined. Other lean methods like value stream mapping were utilized during this process. Value stream mapping analysis led to remarkable developments particularly in tender lead times.

During this project, different functions inside tender teams and layout team were harmonized. Harmonization actions were concentrated specially to redefines layout drawing content and output in general. A piloting period was arranged for this phase and feedback was collected from frontline units and tender teams. Another large activity was the redefinition, documentation and implementation of tender layout service content. During the process, a renewed and harmonized tender layout process was taken into use.

During the project the current state of the process was analyzed with different lean methods. At the end of this project, the target state for future process development was set. The target state was analyzed with data-analysis and lean methods with the purpose of improving flow efficiency and lead times of the process. The results were presented to engineering management and further development of the process was already started.

Key words: lean, kaizen, value stream, process harmonization

TABLE OF CONTENT

ABBEREVIATIONS AND TERMS

CDE	Chief Design Engineer
CSE	Customer Solution Engineer
CSM	Customer Solution Manager
DMAIC	Define, Measure, Analyze, Improve, Control
FC	Feasibility Check
FL	Front line
JUMP	Jump lift elevator platform
KSS	Kone Supply Service (ordering organization in KONE)
Layout	Elevator level design team in KONE
MDL	Main Data List
MP	Major Projects (ordering organization in KONE)
MR	Elevator platform with separate machineroom
MRL	Machineroomless elevator platform
NNVA	Necessary but Non-Value Adding
NVA	Non-Value Adding
PDM	Product Data Management
PDSA	Plan, Do, Study, Act model
SM	Supply Manager
SOF	Supply Operations Finland
SS	Solution Study
TE	Tender Engineer
TLM	Tender Layout Memo
TLO	Tender Layout
TP	Transfer Price
TPS	Toyota Production System
VA	Value Adding
VSM	Value Stream Mapping

1 INTRODUCTION

This thesis was ordered by the Layout design team which is part of KONE company's supply unit located at Hyvinkää, Finland. The background of this thesis was the merging of various layout design teams during 2017. Engineers of the current layout design team used to work in various tender teams, which served different frontline units. The variation in tender processes, methods and designing outputs has resulted time lags and uncertainty while serving different front-line units. The need in order to overcome these challenges has created a need to harmonize the layout processes and create one common way to serve our customers, front-line units and other stakeholders.

Layout process harmonization is a long-term development process in an ever-changing environment. Because of this, only part of the development can be taken into the scope of this final thesis. A qualitative research method was followed, and it was implemented mainly as constructive research.

The development project was started with three-day kaizen event. The kaizen team was formed to determine problems, run analyses, create a task list for further development and to propose the first stage of the tender layout process. After that development a project plan was created. After that it was divided into several subprojects. Some of these actions were defined to be part of this thesis.

The kaizen development tasks were divided into the tasks for tender and layout teams. This thesis mainly concentrates to the development of layout team service content, output definitions and generally tender process harmonization.

Development of layout team tasks was started with a two-day kaizen task development bootcamp. In the bootcamp, multiple layout specialists defined the aims of service content development. After that, the content of tender layout drawings and the feasibility of layout development continued in different streams following modular kaizen principles.

Data collection for future process development continued simultaneously and all features from other development tasks were collected and analyzed. Lean methods and ideology were widely used in process development in which value stream mapping was particularly used.

With value stream mapping it was possible to demonstrate the slowness of the current tender process from the customers point of view. VSM was used to categorize process parts and find waste elements. Value stream mapping, specification quality, design assist and competences were the main drivers that affected development of the new desired tender layout process.

The largest single kaizen task for the layout team was to harmonize layout tender drawing content. In the harmonization process, drawing content was defined and piloting of it was carried out with 10 tender projects. Piloting feedback was analyzed, and changes were put into practice. Templates were partly taken into use in the most challenging MP projects and will be implemented for all tender drawings globally (excluding China and North America) when designing tools will produce the developed output.

In addition to this, the harmonized layout tender process was implemented for layout and tender engineers were trained. Also, layout team service content was defined and documented into official instructions and trainings was arranged before implementation. The most important result of this thesis was that a large study was made concerning further tender layout process development. The results of the research were presented to management.

2 INTRODUCTION OF KONE CORPORATION

KONE corporation is a global leading company in the escalator and elevator industry. The company also provides automatic building doors, solutions for maintenance and modernization. KONE company was founded in 1910. More than a century later (2018) KONE had annual net sales of EUR 9.1 billion, and at the end of the year 2018 over 57,000 employees (KONE 2019).

KONE has operations in more than 60 countries all over the world (FIGURE 1), serving more than 450 000 customers. KONE headquarters is situated in Helsinki, Finland. KONE has eight global R&D centers and seven global production centers. Business lines are separated into service business and new equipment business (KONE 2019).

KONE has the mission to improve flow of urban life and make cities better places to live. The direction and shape of industry is driven by two megatrends: urbanization and technological distribution. KONE vision is to deliver the best people flow experience (KONE 2019).

This thesis was conducted for Supply Operations Finland (SOF), Hyvinkää. Key functions of SOF focus mainly delivering, production and designing of special lift solutions and components. Special segments of SOF are the most demanding global infrastructure and high-rise projects (KONE 2019).

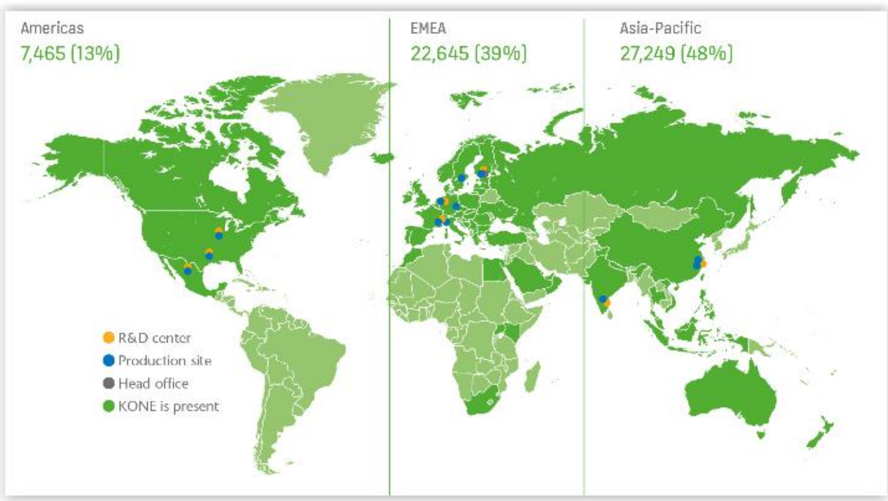


FIGURE 1. KONE locations globally (KONE 2019.)

3 THEORETICAL FRAMEWORK

This development project is conducted using means of qualitative research. It is put into practice with the means of constructive research. Team-based development tasks of this projects utilizes many features from operational research.

The goal of the constructive research is to find a new solution for a theoretically proven practical problem. In this process, high-quality data collection and documentation of different development phases is important. Data and documentation can be used in analysis and arguments during the later phase of the project (Ojasalo & Moilanen & Ritalahti 2009).

In operational research knowledge of (what)and ability to adopt practical changes are at focus. The aim is to change the way people and the organization work as in constructive research. The key element is to put the change into the practice and evaluate it. (Ojasalo & Moilanen & Ritalahti 2009).

Lean ideology is main principle of this thesis and lean techniques and tools are widely utilized during this development project. Lean offers many different tools for improving processes and process segments. In Lean, active involvement of people is also one of the fundamentals. By involving people, collecting data, visualizing the problems it was possible to run analyses and create the process, which followed frames of constructive research.

3.1 Lean Philosophy

Lean thinking is a managing philosophy. The basic idea of lean ideology is continuous evaluation and improvement of organization functions. Lean tools are used to shorten the time between an order from customer and a ready product handover. Time can be shortened if non-value adding (NVA) segments can be eliminated from functions (Netland & Powell 2016).

In practice, lean thinking has become one of the most successful approaches to business improvement of our generation. Different organizations are adopting lean all over the world. Lean managing methods are also widely used in large companies, especially in order to improve group performance. According to recent knowledge, best practices are based on lean thinking (Netland & Powell 2016).

Concepts of lean mainly originate from the Toyota Production System (TPS). In this concept lean is used to eliminate the waste and increasing speed and flow. The ultimate objective of lean is to eliminate waste from the whole process (Goldsby & Martichenko 2005).

Lean ideology has given Toyota an advantage to obtain superior performance by decreasing the launch time for new products and increasing product quality, using less money and human resources, hence lowering costs of production. Toyota continues to act as a powerful reference model for lean practitioners in taking the next step on their lean journeys (Netland & Powell 2016).

The roots of lean date to the time after World War II. At that time it was estimated that that work in Japan took 9 time as much resources than in America. Toyota started research to find out where the time was wasted. If waste could be eliminated, the productivity of the company would rise. This idea started the process called “Toyota Production System” and it is considered to be a starting point of lean thinking (Ohno 1988).

TPS became the basis of a management philosophy called lean manufacturing, in which the primary objective is the maximization of value for the customer through the elimination of production waste (Krafcik 1988; Womack & Jones 2003). Value can be described as the ability to provide products or services at the right time and at the appropriate price in order to satisfy customer’s needs. These needs can only be defined by the customer and therefore it should be the starting point of lean thinking (Womack & Jones & Roos 1990; Womack & Jones 2005).

3.2 Lean principles

Lean has some main principles which are summarized into six points: “Value”, “Map the Value Stream”, “Flow”, “Pull”, “Perfection” and “Respect for People”. The first five points are defined by Womak & Jones 1996. The last one is usually called “the second pillar of lean” and it plays an important role in lean (Oppenheim 2011). Explanations of these six points are listed below:

Value: In lean thinking, value is defined by a customer, which can be internal or external. The external customer pays the services and defines the final value of a product. Internal customers receive outputs inside a company. Value itself can be divided into two: value adding and non-value adding. Value adding function practically adds value to a product from a customer’s point of view. NVA segments increases lead time and operating time but doesn’t add value of product (Oppenheim 2011).

Map the Value Stream: Value stream includes all tasks, definitions, phases and links in a process. Categorizing different types of waste elements in the delivery process is the first step of eliminating waste. Waste elements can be divided into seven categories: Overproducing, *waiting, conveyance, processing, inventory, people motion and correction* (Oppenheim 2011).

The process mapping phase includes searching and removing all non-value adding elements. It is also for enabling the remaining value adding parts to flow without rework, waiting, backflow or stopping. The information flow between tasks and people need to be clear and understandable. In lean thinking this means detailed planning, common databases, rapid and pervasive communication and frequent interactive events. The important thing is to keep information flowing (Oppenheim 2011).

Flow: Flow describes the progression of a flow unit during the delivery process. This means that perfect flow can be achieved when a flow unit is only interacting with perfectly planned steps without stopping, waiting, unplanned rework or backflow (Oppenheim 2011).

Pull: The key element of pull is to understand customer needs and expectations in all process phases. This means that all process phases need to be in close communication with the customer, so that work can be coordinated correctly (Oppenheim 2011).

Perfection: Perfection is the ultimate goal of lean. The current state of the system is never perfect and in lean thinking functions are driven towards perfection by continuous improvement. Perfecting the work output in each task must be bounded by the overall value proposition, which defines the moment when an output is good enough (Oppenheim 2011).

Respect for people: People are the center of everything and the source of success in lean ideology. They are the most important resource for high performance of the company and its functions. Problem correction and development are run through brainstorming the root causes, corrective actions and effective solutions (Oppenheim 2011).

3.3 Flow efficiency in process

This development project doesn’t comment on any department resourcing methods, but the importance of flow efficiency is one of the main fundamentals in this development project. Process mapping in the kaizen event was described from frontlines to layout design. This means that the team was able to investigate process flow in Hyvinkää from the supply unit’s point of view. One consideration was to define how deficiency in early phases of the process causes problems in the end.

Main difference between flow- and resource efficiency is, that with resource efficiency the most important factor is to ensure that resources are used to the maximum level. With flow efficiency, which is considered with lean ideology, the main fundamental is to maximize the flow of material or information. This means that lead time will be minimized from the customer’s point of view and number of finalized tasks is maximized. Because of process variation it is almost impossible to utilize resource- and flow efficiency at the same time in a single organization (Torkkola 2015).

Variation in a process is a non-value adding segment according lean philosophy. Variation also has a clear impact on the organization's ability to combine good resource efficiency and flow efficiency. In processes there is always variation. A seemingly amount of reasons for variation can be divided into the three main reasons: *resources, flow units and external factors* (Ojasalo & Moilanen & Ritalahti 2009).

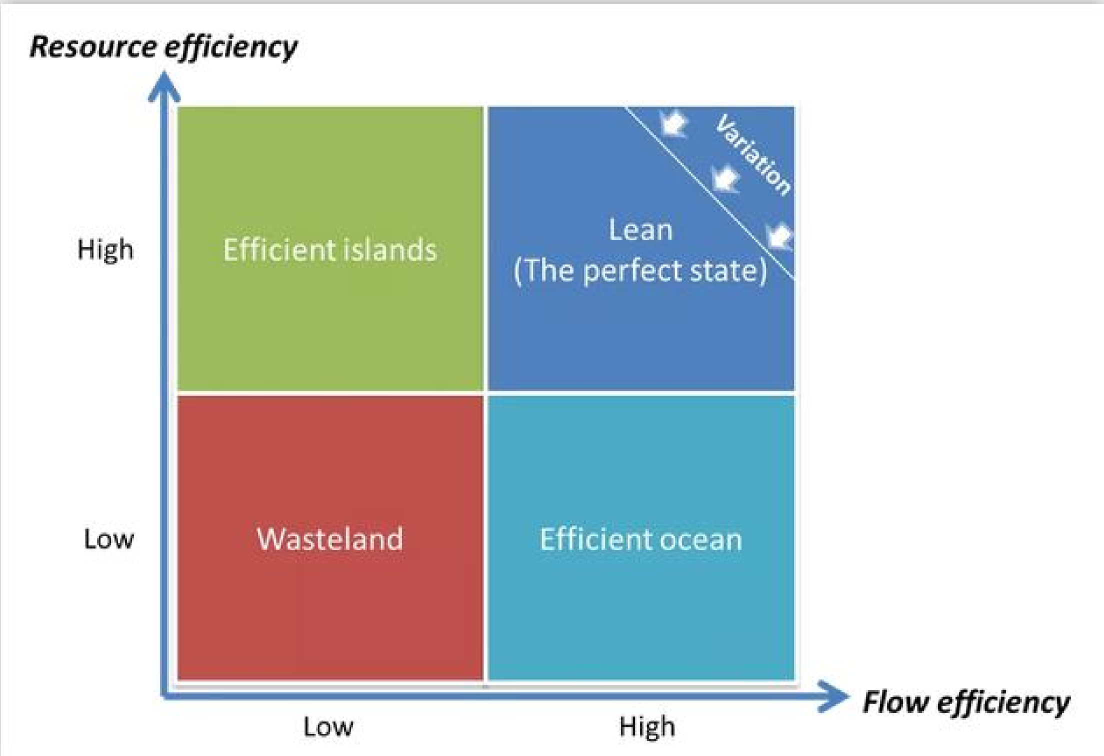


FIGURE 2. The Efficiency Matrix (Modig & Åhlström 2012.)

Variation in a process prevents the utilization of both efficiency streams. With more variation, the smaller is the area where it is possible to act (FIGURE 2). Because of resource efficiency maximizing, customers lead time will increase. Flow efficiency is governed by three laws of the nature and all of those can be proven mathematically. These three laws are:

Little's law: Average lead time is in direct relation to the amount of work in progress. Little's law states that the long-term average number of customers in a stable system L is equal to the long-term average effective arrival rate, λ, multiplied by the average time a customer spends in the system, W.

Expressed algebraically, little's law appears as: $L = \lambda W$

Law of the bottleneck: Every system, regardless of how well it works, has at least one constraint (a bottleneck) that limits performance.

Law of the variation: Variation occurs everywhere. With more variation, the longer is the lead time. Law of the variation can be explained with Kingsman's equation (Torkkola 2015).

3.4 Kingman's equation: effect of utilization and variation

According to Kingman's formula lead time will be increased if:

1. Average handling time increases
2. Variation increases
3. Utilization of resources increases

Kingman's formula describes: Affecting factors to the realized lead time (CT) are time that is consumed in work (t), variation (V) and Utilization (U)

$CT = V * U * t$

This means that cutting down waste that creates variation will decrease lead time. A large amount of variation occurs in process phases where many different types of tasks are taking place and always in a short period of time.

This equation (or more precisely, this *approximation*) shows the two factors that influence lead time and queue length. One important factor is the utilization. The higher the level of utilization, the longer queue (Chhajed & Love 2008). FIGURE 3 shows an example about waiting time for different levels of utilization for the example above.

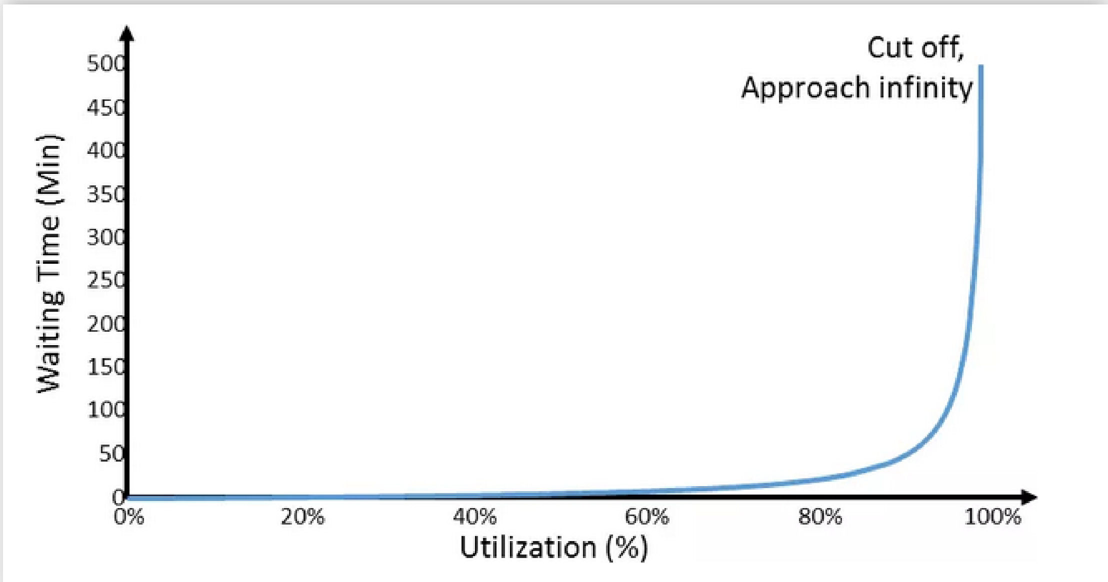


FIGURE 3. Utilization affect to lead time (Torkkola 2015).

The second factor is the variation. The higher variation is, the longer the queue. FIGURE 4 is an example how variation increases lead time.

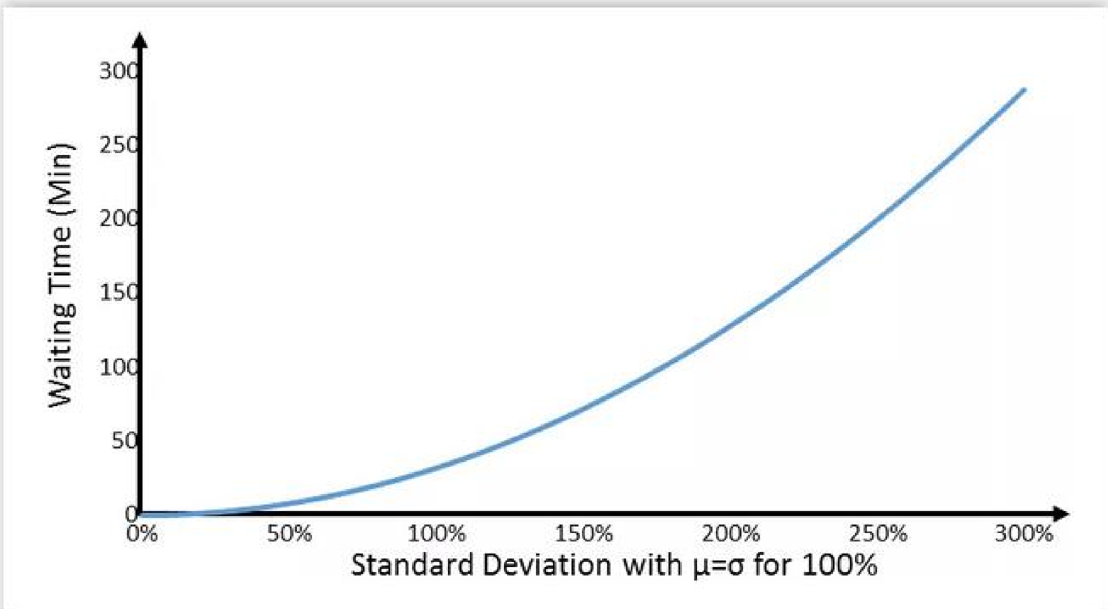


FIGURE 4. Variation effect on lead time (Torkkola 2015).

3.5 Visualize

Visualization is one of main fundamentals of lean thinking (*Jidoka* in Japanese). By visualizing a situation, process, or problem, a description of a situation that helps a team to create a common understanding can be created (Torkkola 2015).

An organization process flow can be compared to football, for example. Even if the team has a good technique, teamwork and individual skills it still does not guarantee goals or victory. These are only the main principles for the movement of the ball – i.e. a flow occurs (Torkkola 2015).

In *Jidoka* when a visualized organization is created: If there is anything that prevents good flow it can be noted immediately. The main principle how flow can be achieved in football happens when players are able, in every moment and from all places, to:

- See the football field, the football and goal(s)
- See teammates and opponent players
- See scoring changes and remaining gaming time
- hear referees' whistles
- hear teammates and the crowd

With all this, the player and the team can form an overall picture and make decisions how to make goals together (Torkkola 2015).

Visualization is the most efficient way to communicate. A picture creates quickly a common image of the situation. It can reveal in which process step the problem occurs and help to make the changes that have a desired effect (Torkkola 2015).

If there are a lot of specialist's and experts in the team who are working with certain things on a daily basis, visualization is the best way to create a wider understanding about the situation. When a team can see the big picture, they are able to make good decisions independently and quickly. Visualization also creates community and openness (Ojasalo & Moilanen & Ritalahti 2009).

Visualization is also a good tool to point out certain problems in a process. It can be utilized in workshops by using, for example, post it stamps categorized by different colors. Selecting categories wisely will create an opportunity to categorize problems or solutions. Visualization is also good tool to involve people in working groups.

3.6 Kaizen and kaizen event

The word “kaizen” comes from Japanese word “kai” which means ”change” and ”zen” which means ”good”. Organizations that want to implement kaizen must be willing to continually change and evolve toward ever-evolving excellence. In other words, kaizen is based on continuous improvement. It can focus on an existing process or to be the result of a major reorganization (Grace 2014).

Kaizen is a development approach that integrates quality methods for intensive working environment. All parts of an efficient kaizen must be designed and can be divided into modules that can be scheduled (Grace 2014).

A kaizen event provides the possibility to get experts from multiple teams into the same room at the same time in order to obtain the best available understanding about direction of the development quickly.

“The kaizen event” is an effective tool for moving past “analysis paralysis,” tying improvements to a larger strategy and involving all the necessary perspectives to create relevant, measurable and sustainable improvements. The kaizen event is a two- to five-day focused improvement activity during which a sequestered, cross-functional team design implements improvements to a defined process or work area. Normally kaizen consists of three different parts (Martin & Osterling 2007):

1. Planning: Normally 1-2 weeks before kaizen event. The goal needs to be defined in this phase and management commitment needs to be clear. Also resourcing during and after the kaizen needs to be agreed.
2. Kaizen event: Process analyzation, defining problems in process and specifying solution (tasks).
3. Kaizen task implementation: Implementation of created development tasks and continuous improvement.

A kaizen event is one of the traditional models to implement kaizen. It can be used for situation mapping, completing a project or as a project start up. A kaizen event is one of the most effective lean methods and the goal is to speed up a project or push it through quickly. In addition to quick solutions, the biggest benefits in this method are efficient time usage of participants and high commitment of experts and management (Grace 2014).

Kaizen involves breaking down a process and removing any unnecessary elements and waste. Finally, everything is put back together in a new and improved way. At the end, process should work more smoothly and fully utilize the skill sets of everyone involved. In a kaizen event, it is important that all required experts (different areas of process to be developed) are involved and everyone are committed to the goal (Grace 2014).

In a kaizen event, the team looks at the process targeted for improvement and identifies activities as value-adding, non-value adding, or necessary on-value-adding. The order of priority for improvement is to: 1) eliminate unnecessary non-value adding activities; 2) reduce necessary non-value adding activities; and 3) optimize value-adding activities (Grace 2014).

A common goal in kaizen events is to create flow through waste elimination. An essential activity is having the team view the process as though they were the material, data, or paperwork being passed through the system or person receiving a service and identifying all the stops along the way. After determining the reason for the stops, the team members can use relevant lean tools to improve flow (Martin & Osterling 2007).

At the end of a kaizen event a clear definition of development tasks needs to be created. Tasks need to be approved by the management and resourcing to complete these tasks needs to be agreed. Tasks need to be addressed to owners and schedules need to be clear. A project should have project manager who follows the progress of the project.

3.7 Modular kaizen

Modular kaizen is another form of kaizen. Unlike the kaizen event, the modular kaizen concept focuses on making progress alongside everyday work. Modular kaizen is an improvement approach that integrates quality techniques into the busy schedules of everyday activities (Grace 2014). Basically, that means that development is divided into smaller modules, which can be fitted into everyone's calendar.

The concept of modular kaizen offers different possibilities for leading methods of development. Unlike more traditional leading models, Toyota leading model with continuous kaizen offers the possibility to move part of the leading to a work group. By doing this it is possible to obtain the best possible result from the team and commit team members to reach the goal more enthusiastically (Liker & Convis 2012).

The modular kaizen approach is complementary to the Plan-Do-Check-Act (PCDA) and Define, Measure, Analyze, Improve, Control (DMAIC) models of quality improvement. Modular kaizen concept utilizes the basic problem-solving model which is divided into the seven steps. It is based on a clear understanding of the problem (Grace 2014). The seven steps are (FIGURE 5):

1. Understand and define the problem
2. Collect, analyze, and prioritize data about the problem symptoms, determine the root cause(s) of the most significant symptoms
3. Identify possible solutions
4. Select the best solution
5. Develop an action plan
6. Implement solution
7. Evaluate the effectiveness of the solution in solving the problem

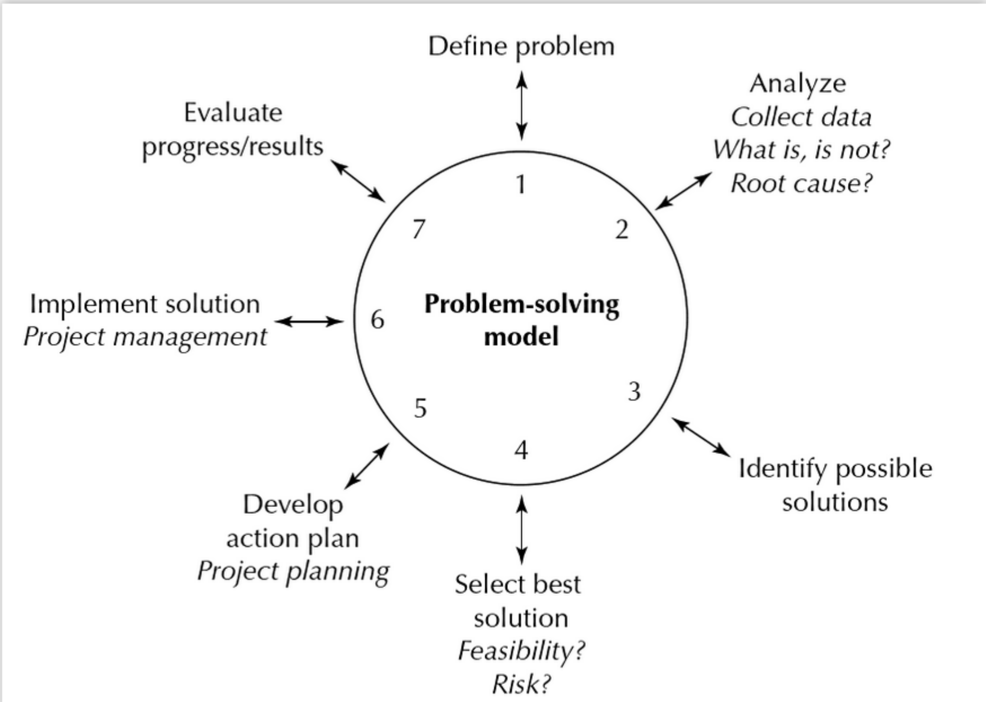


FIGURE 5. Problem solving model (Grace 2014)

Modular kaizen supports incremental and breakthrough improvement. In this development project both are utilized. When layout service model was in the development phase, the means of incremental development was used by utilizing terms of modular kaizen. On the other hand, layout drawing content can be categorized as a breakthrough improvement, once the drawing sheets are taken into use (Grace 2014).

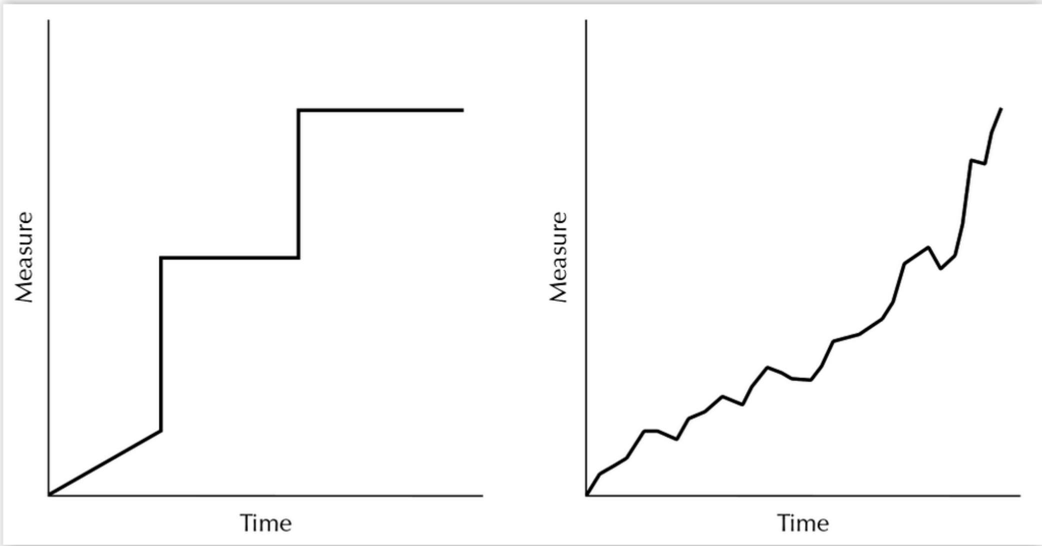


FIGURE 6. Breakthrough versus continuous improvement (Grace 2014)

FIGURE 6 illustrates the difference between continuous and breakthrough improvement. Continuous improvement is an evolutionary progression of improvement over time. Breakthrough improvement is characterized by large step improvements to meet higher measures of process performance expectations. Continuous improvement can be realized by making small changes to an existing process. Breakthrough improvement is usually obtained by rewriting significant activities of an existing process, thus creating a new process or subprocess as a result (Grace 2014).

3.8 Plan, Do, Study, Act

Every working process needs continuous improvement. Continues improvement, also referred as continuous quality improvement is one of the main fundamentals of kaizen. Plan, Do, Study, Act method (FIGURE 7) is used in this thesis, but it might have different forms, for example: check, act, plan, do/disrupt. Continuous improvement is also a management approach to improve and maintain quality (Grace 2014).

FIGURE 7. Plan, Act, Study, Do -cycle (Torkkola 2015.)

This method can be utilized for example in a situation where someone has an idea in the designing phase and testing of its eligibility needs to be assessed. At this stage “planning” means that the testing of the hypothesis of what will happen needs to be defined and the goal is to understand what will happen. According to this, it is important to plan how to recognize if a test is successful. In addition to these practical arrangements, tests need to be planned during this phase (Torkkola 2015).

PDSA-cycle can be used to solve small problems or to improve the entire value process in lean. The starting point is the planning stage phase where the correct situation is determined and analyzed. For example, in technical support, a common measurement of KPI is time resolution and what to accomplish. Data need to be collected to set up the base values and time to be followed during the PDSA (Provost & Murray 2011).

To make this possible, the actions need to be separated from conventional work and change needs to be handled only as a hypothesis, which needs to be proven to be correct in practice. Only after that it can be utilized and taken into regular use. The hypothesis describes the relationship of cause and effect. Either the test is successful or there will be new question (Torkkola 2015).

At the “Plan” -phase, goals for the lean process are set and correct questions need to be asked to find proper solutions. All phases need to be documented and re-estimated in each stage and every time when the cycle begins again (Provost & Murray 2011).

“Do” -phase of the cycle contains testing of the hypothesis in practice. Test / validation can be arranged in as small scale as possible. This is especially important if the work is done in different phases. The meaning of this is to prevent unnecessary costs from occurring (Torkkola 2015).

The reason of the “study” -phase is to decide if test is a success or not. Did we achieve the aimed results? Is there any new obstacles or problems and what went wrong? Statistical methods can be used to estimate she significance of the results. (Torkkola 2015).

At the final stage (act) it is time to decide will the change be implemented into widespread use. In practice, this means that test results are used to forecast the implementation of obtained change is reasonable. At this stage it is possible to decide if change of goal, methods or hypotheses and possibly even a new PASD cycle are needed (Torkkola 2015).

The PDSA -cycle shows a continuous search for answers to achieve a better resolution time (FIGURE 8). This requires continuous process improvement and following up the changes to make fast decisions. If significant improvements cannot be achieved, then it is important to do agile changes (Provost & Murray 2011).

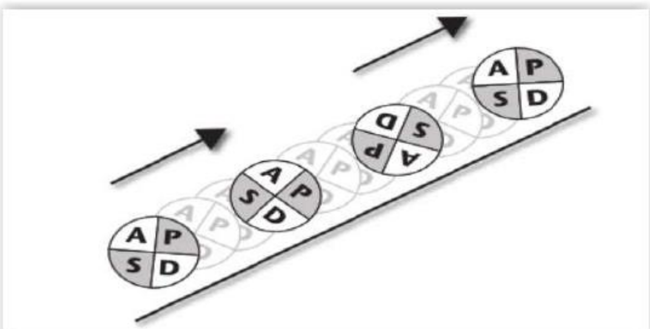


FIGURE 8. Sequential PDSA -cycle (Provost & Murray 2011.)

3.9 Value stream mapping

VSM is a part of lean managing philosophy and it is used to map current process functions and to design new states of series how process unit is moving through organization steps. Basically, it is a tool to identify waste. After a VSM is created, a process can be improved so that waste can be eliminated.

VSM is a powerful tool because it enables visualization of material or information flow through the value chain. It can give a global vision to the full chain of the process. Lower production costs, faster response time to the customer and higher quality of products (and information) are therefore outputs that can be expected when applying VSM to the process (Lacerda, Xambre & Alvelos 2015).

The participation of elements of key departments is required to obtain essential information of the process. After mapping the current state using the VSM and identifying the process waste, the mapping of a desired future state is possible (FIGURE 9). VSM presents value of each activity, process time and financial aspect; all of which are determinants of decision process (Jones & Womack 2002; Pavnaskar, Gerhenson & Jambekar 2003; Chen Ye & Shady 2010).

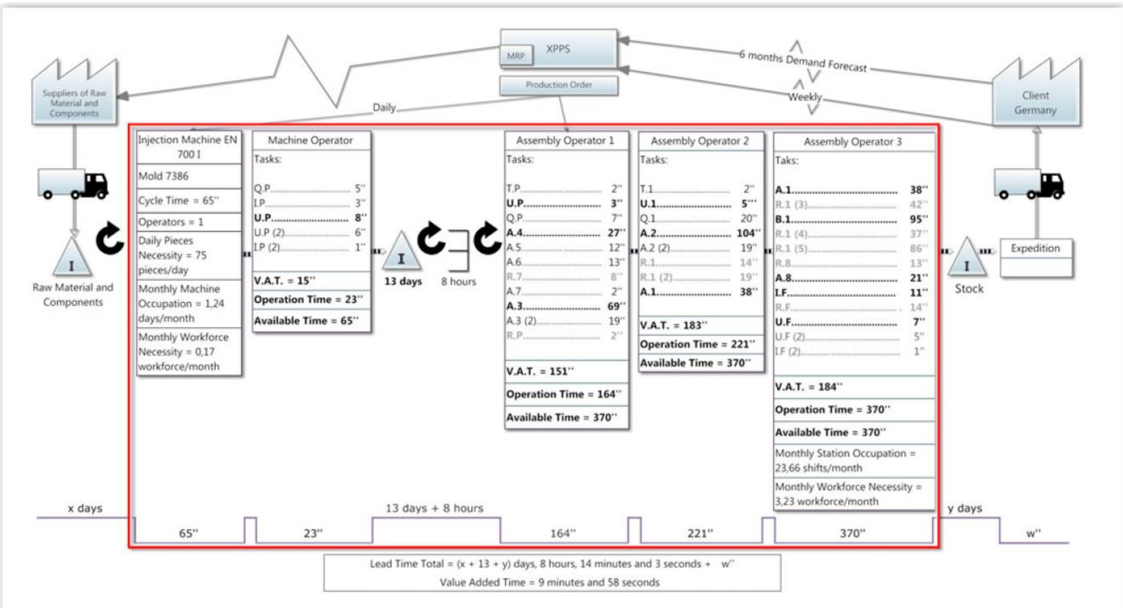


FIGURE 9. Example of a Value Stream MAP (Lacerda, Xambre & Alvelos 2015).

After analyzing the initial process state and considering the critical point, some solutions were presented in order to reduce waste and increase the quality and efficiency of the process. However, the selection of the final process should be based on the best trade-off between the performance and the ease of implementation (Lacerda, Xambre & Alvelos 2015).

Segments of a value stream can be divided into the three categories: value adding (VA), necessary but not-value adding (NNVA) and non-value adding (NVA). NNVA activities can be classified, for example, to stakeholder meetings or setting time of production machinery. All functions for which the customer is not willing to pay can be defined as NVA activities, such as: storing, information passing, rework, waiting, overproduction, transportation, processing, or under-utilization of knowhow (3.2). Because all process segments, including value adding parts, might include NVA and NNVA parts, it is crucial to determine in which accuracy level the process is examined (Torkkola 2015).

When a VSM is ready, a process can be separated into smaller segments. It is important to find all waste elements for elimination (FIGURE 10). There are different types of waste and determination which may vary in relation to industry area (McManus & Millard 2002).

	Waste	Description
1	Overproduction	too much detail, unnecessary information, redundant development, over-dissemination, pushing rather than pulling data
2	Transportation	information incompatibility, communication failure, multiple sources, security issues
3	Waiting	information created too early or unavailable, late delivery, suspect quality
4	Processing	unnecessary serial effort, too many iterations, unnecessary data conversions, excessive verification, unclear criteria
5	Inventory	too much information, poor configuration management, complicated retrieval
6	Unnecessary Movement	required manual intervention, lack of direct access, information pushed to wrong sources, reformatting
7	Defective Product	lacking quality, conversion errors, and incomplete, ambiguous, or inaccurate information, lacking required tests/verification

FIGURE 10. 7 waste elements (McManus & Millard 2002).

Considering that information flows and matures through the process: The tasks performed to add value to the information or transportation. This forms its initial state of raw data to the formation of completed task. However, all analyses derived from raw data doesn’t produce useful information (McManus & Millard 2002). If waste is detected, it is still important to avoid over processing during the process.

When analyzing a VSM process, it is mandatory to understand the direction of development. Lean philosophy is a great guide, but still it is important to understand the idea behind the rules, especially when information or engineering work is considered. This is because there are inherent differences between manufacturing and engineering in terms of lean principles (FIGURE 11).

Lean Principle	**Manufacturing/production**	**Engineering**
Value	Visible at each step, defined goal	Harder to see, emergent goals
Value stream	Parts and material	Information and knowledge
Flow	Iterations are waste	Planned iterations must be efficient
Pull	Driven by takt time	Driven by needs of enterprise
Perfection	Process repeatable without errors	Enables enterprise improvement

FIGURE 11. Lean Principles in Engineering (McManus 2005).

In order to improve a process after value stream mapping and analyses, the goal must be clear. How these principles (3.2) can be achieved, how quality can be improved, how waste can be reduced and how the lead time to the customer can be shortened. VSM can provide a view for all this, after process parts are categorized and analyzed.

Current state maps provide a view to find waste elements in the process and provide tools for an action plan on how to eliminate all of these to reach a better future state. However, brainstorming sessions should be preferred during future state design, after VSM and related analyses are completed (Tyagi, Satish, Choudhary, Cai & Yang 2019).

3.10 Competences in the process

Respect on people and correct use of talent is one of the lean fundamentals. The waste of human potential can lead to missed improvement opportunities, considering that lean philosophy advocates that every individual is a thinker and can contribute with positive outcomes (Ohno 1988).

When it comes to the tender environment in KONE, there are many different phases before engineering starts to process the information (lift technical specification) for use in engineering. Lift solutions are remarkably vulnerable to defects in specification and it is quite common that filling or changing individual items in the specification, can make remarkable changes in the solution. Because of this, the correct usage of layout competences during the process is important in the means of lean.

Mapping the competences inside the layout team is one phase of current state analyses, similar to VSM. The first stage of understanding the system (process) is to map its limits. Input from sales and marketing departments are crucial when designing a new product. This means that sales and marketing is also the main customer for engineering. This doesn't need to be noted when it comes to process value stream and competences, because they are also the supplier of preliminary design ideas (Serdar, Durmusoglu & Cinar 2017).

When a company is dealing with highly demanding solutions, lack of competence might cause defects in the process. Statistical analyses may be used to map the competences of critical functions. A critical function can be for example in sales, marketing or design team (Serdar, Durmusoglu & Cinar 2017).

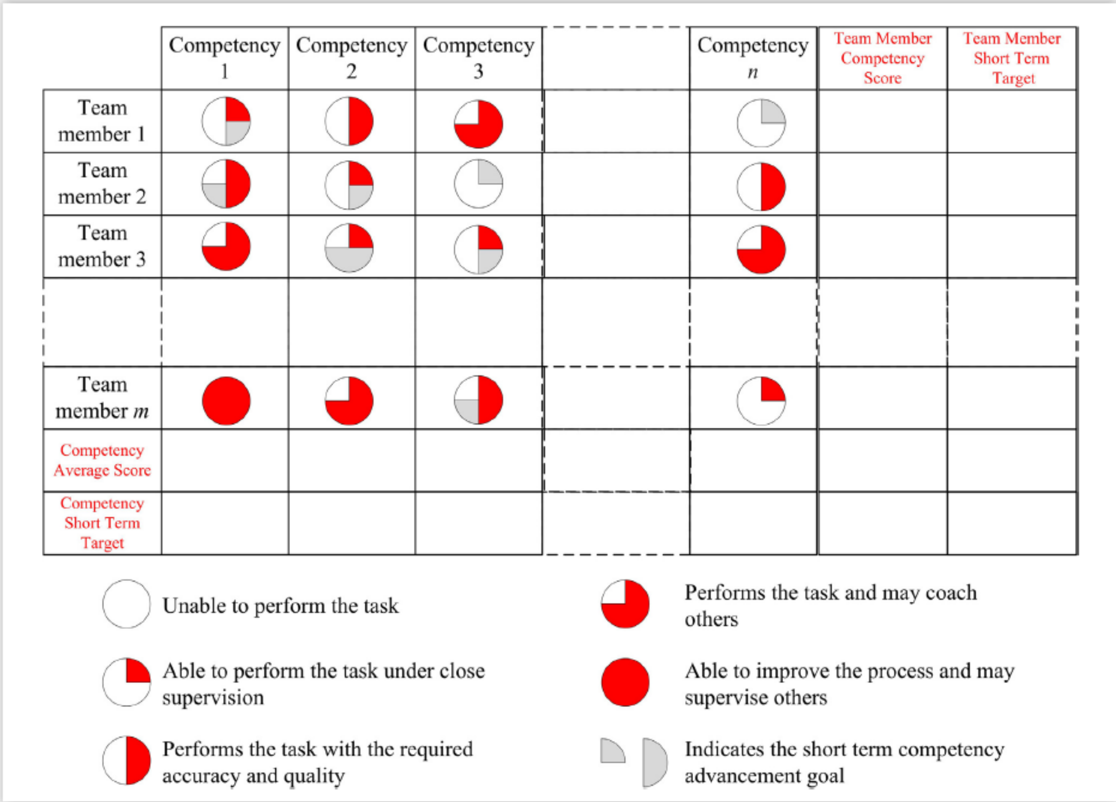


FIGURE 12. Example competence matrix (Serdar, Durmusoglu & Cinar 2017).

Mapping team competence into the matrix makes it easier to have an overview of the current competence situation in the team (FIGURE 12). It also gives insight to corresponding processes (Serdar, Durmusoglu & Cinar 2017). Basically, this also helps to inform and understand requirements of the process steps and possible bottlenecks.

4 WORK PLAN

Lean methods were widely used during the timeline of this development project. According to lean ideology, it is important that everything can be measured and planned properly. The aim of this thesis was to create a long-term development action plan and to define external factors affecting the process and schedules during the lifespan of the project. The form of this project was defined to follow the steps described below:

1. Project mapping: Defining problem and data collection
2. Kaizen event: Presenting problem and creating project plan and tasks
3. Modular kaizen: Project was divided into sections and scheduled
4. Piloting: Piloting and feedback analyses
5. Implementation and further development
6. Continuous improvement

4.1 Research methods

This development project has been influenced by constructive research, yet it utilizes features from operational research. Lean thinking is the main fundamental behind the development segments, but the structure of the development process follow the methods of constructive research.

Development around the layout tender service offering and the tender layout content utilizes a form of operational research that is a part of constructive research (FIGURE 13). Lean methods and analyses are widely used during the project. The first stage of the project was the kaizen event. The next stage was kaizen task list development which started with a 2-day layout bootcamp. In these stages, phases 1-3 of modular kaizen definitions were followed (FIGURE 5). After this, the teams continued task development during everyday work as described in the principles of modular kaizen.

Regular meetings were arranged to ensure that every task was going forward. Results and the direction of development were estimated in these meetings. Action plans were followed, results were estimated, and testing were arranged for the most important development segments. Data collection and analyses for tender layout process development continued during the whole project.

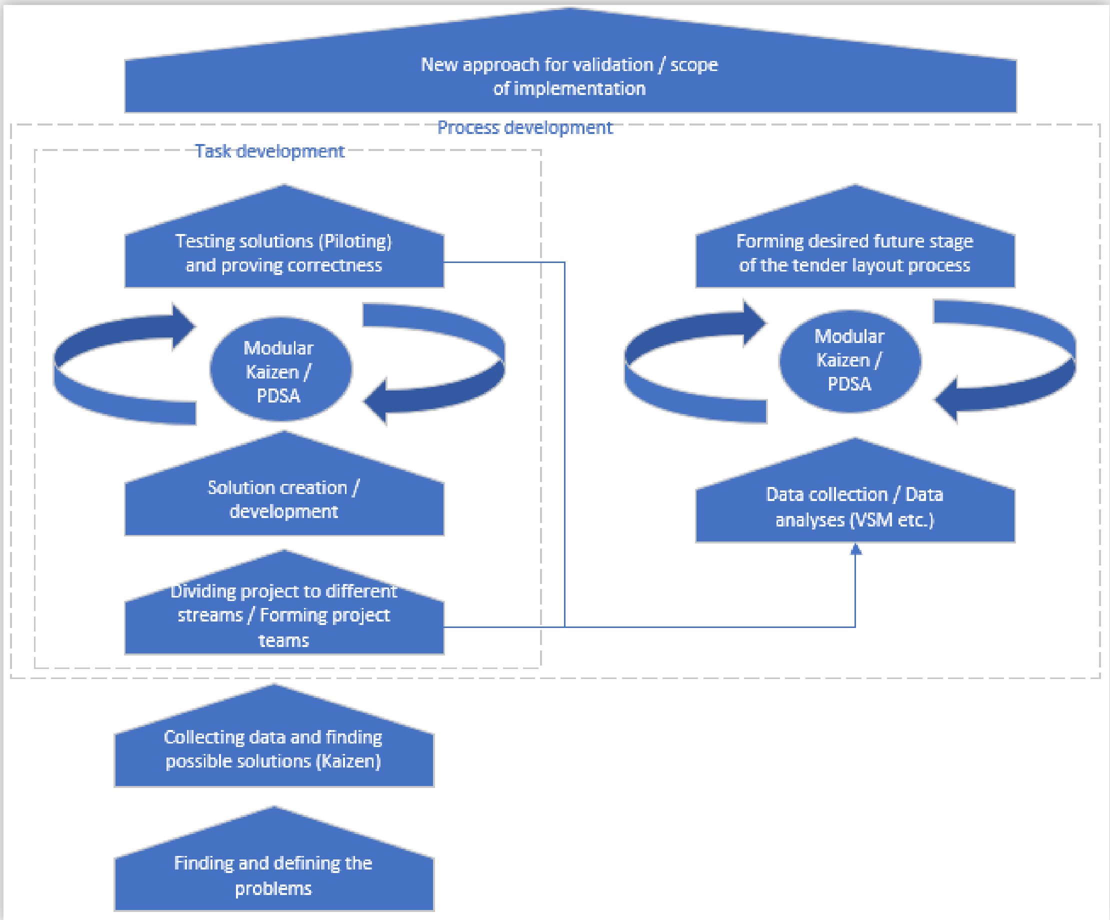


FIGURE 13. Process map drawn for this development project in planning phase

The first stage of the process was to find and determine problems in the tender layout process. The form and the goal of the kaizen event was defined in this process. In the kaizen event the team defined problems, ran analyses and created solution proposals. As one of the results of the event, a “kaizen task list” was created to be the base for future development.

The development project was divided into the subprojects at a later phase. The focus of the project aimed toward process development. The main individual actions were tender layout service offering definitions and tender layout drawing content definitions. These definitions were part of the kaizen task development.

The tasks included several actions which all were related to the tender layout process development.

All development phases of the project increased data for process analyses. In addition to this there was a separate data collection and analysis phase for future process development including value stream mapping, competence matrix and process definitions. Also, activity data collected by the systems was analyzed and the findings were noted in further development definitions.

Finally, all data was collected, analyzed and the desired harmonized next stage layout process was formed. At the end of the project the process implementation plan was created, and the tasks were addressed to the correct functions. All required parties inside the supply unit were trained in the renewed tender layout process, layout service content and tender layout output. Still the most important part of the project is the study concerning desired the future process stage. This means that development around the process continues but outcome is considered to be out of the scope of this thesis.

4.2 The goal and the purpose

The goal of this development project was to unify tender processes as well as the content and functions produced by the layout team at the tender phase. The main segments were divided into the tender layout process itself and layout service content and function definitions. The tender process needs to be mapped by defining the whole supply line process stream, from frontline units to designing functions.

By unfirming the earlier described functions the process flow can be improved and amount of waste can be decreased. The goal is to investigate the tender layout process from many different angles, to form the best possible solutions and to map possibilities for future development. When considering lean methods (3.2), variation can be divided into three main segments: *Resources, flow units and external factors:*

Resources in this case means layout- and tender engineers who are working for SOF. Engineers have variation in expertise and knowledge because they have worked with different tender teams and frontlines in the past.

As a part of an organization change, several layout pools were unified. Changes in day routines and working methods was suspected to reduce the motivation of some layout engineers. This caused a lot of variation and waste and improving this situation is one of the goals of this project.

Flow units are in this case layout drawings, technical calculations and other layout documents, which are delivered to tender engineers, frontlines or customers. Different layout outputs, layout and tender, may cause confusion among engineers. By creating one clear tender layout content, it is possible to achieve better resource- and flow efficiency at the same time.

External factors in this case are different expectations that different tender teams and frontlines had. The largest amount of variation segments derives from historical background, because tender teams were located in different organizations with separate working methods. By creating uniform processes and offering which serves each party, it is possible to reduce variation of external factors.

When unifying layout team functions and determining the future service content it is important to map the best working practices. It is also crucial to map service content to include all (and only) the necessary functions and services. To achieve this, it is also mandatory to visualize the current situation and use best expertise from different teams.

The result of this project is the harmonized tender layout process. Layout output needs to be harmonized to improve clarity from the customer point of view. New, defined tender layout service content needs to serve the new harmonized process. The uniformed process and layout service content needs to be documented as a part of KONE official documents. Maintenance of drawings needs to be implemented and responsibilities documented within the layout team.

This development project focuses on the viewpoint of a customer and frontlines in terms of lean (3.2). Development needs to be customer centric and gains need to be visible for customers. Due to this, the entire process chain needs to be inspected. Also, substantial quality benefits can be obtained by implementing these actions. It is possible to decrease tender lead times and reduce actual working hours in different functions during the process by removing waste elements and determining needed functions clearly (3.3).

Uniform, well-designed and harmonized layout tender drawing content serves the layout team, tender teams, frontline units and customers. Uniform content leaves less ambiguity, improves quality and the visual look of the drawings. All these changes help layout engineers to work more efficiently. The customer viewpoint needs to be at the center of the development. To achieve this a survey was commissioned for FL units. By doing this, external feedback could be noted during the development (appendix 1).

4.3 Action plan, schedule and resources

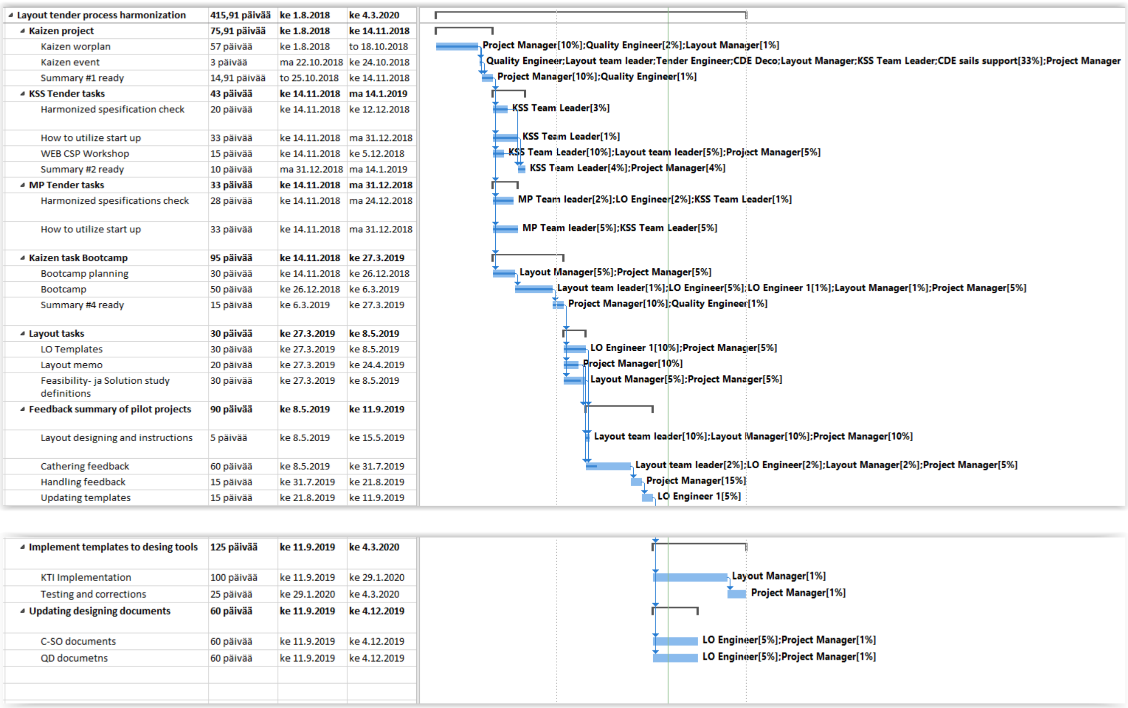
KONE is a large company and a huge amount of development is taking place in different development streams simultaneously. Content of this thesis needs to be aligned with other development projects. Because of this, a thorough planning phase is crucial to optimize results to be practical for implementation and simultaneously to serve optimally the needs of the company.

At the beginning the situation was quite chaotic. There were multiple ways to handle tender projects, deliver input data for engineering and design tender layout drawings. In addition to this layout services that are offered for tender teams contained a lot of variation. For this reason, the process and layout services where unclear for all parties.

A kaizen event was selected to be the first stage of this development project, as kaizen events are a useful way to implement development tasks for different teams. It also enables the gathering of experts from different departments into same space for a longer time at once. It also allows the mapping quickly, to find new ideas and to define the project scope (3.6).

The structure of this development project was created in the kaizen event. The sponsors of the event were the layout team manager and both tender team leaders. The first stage of harmonized process and the task list for variation reduction was created. The task list was created to contain elements which need to be developed by the layout team and the tender teams before harmonized process could be implemented. A 2-day bootcamp inside the layout team was arranged after the kaizen event to launch and plan tasks creation. After this a project plan was designed.

It was agreed that the project doesn't have any fixed resources, but layout engineers can be involved by the means of modular kaizen (3.7). Final planning was designed in this phase because all the relevant definitions concerning service content were ready at that time. External factors caused some delays to the project schedule (FIGURE 14).



Layout tender process harmonization	**415,91 päivää**	**ke 1.8.2018**	**ke 4.3.2020**
Kaizen project	**75,91 päivää**	**ke 1.8.2018**	**ke 14.11.2018**
Kaizen worplan	57 päivää	ke 1.8.2018	to 18.10.2018
Kaizen event	3 päivää	ma 22.10.2018	ke 24.10.2018
Summary #1 ready	14,91 päivää	to 25.10.2018	ke 14.11.2018
KSS Tender tasks	**43 päivää**	**ke 14.11.2018**	**ma 14.1.2019**
Harmonized spesification check	20 päivää	ke 14.11.2018	ke 12.12.2018
How to utilize start up	33 päivää	ke 14.11.2018	ma 31.12.2018
WEB CSP Workshop	15 päivää	ke 14.11.2018	ke 5.12.2018
Summary #2 ready	10 päivää	ma 31.12.2018	ma 14.1.2019
MP Tender tasks	**33 päivää**	**ke 14.11.2018**	**ma 31.12.2018**
Harmonized spesifications check	28 päivää	ke 14.11.2018	ma 24.12.2018
How to utilize start up	33 päivää	ke 14.11.2018	ma 31.12.2018
Kaizen task Bootcamp	**95 päivää**	**ke 14.11.2018**	**ke 27.3.2019**
Bootcamp planning	30 päivää	ke 14.11.2018	ke 26.12.2018
Bootcamp	50 päivää	ke 26.12.2018	ke 6.3.2019
Summary #4 ready	15 päivää	ke 6.3.2019	ke 27.3.2019
Layout tasks	**30 päivää**	**ke 27.3.2019**	**ke 8.5.2019**
LO Templates	30 päivää	ke 27.3.2019	ke 8.5.2019
Layout memo	20 päivää	ke 27.3.2019	ke 24.4.2019
Feasibility- ja Solution study definitions	30 päivää	ke 27.3.2019	ke 8.5.2019
Feedback summary of pilot projects	**90 päivää**	**ke 8.5.2019**	**ke 11.9.2019**
Layout designing and instructions	5 päivää	ke 8.5.2019	ke 15.5.2019
Cathering feedback	60 päivää	ke 8.5.2019	ke 31.7.2019
Handling feedback	15 päivää	ke 31.7.2019	ke 21.8.2019
Updating templates	15 päivää	ke 21.8.2019	ke 11.9.2019
Implement templates to desing tools	**125 päivää**	**ke 11.9.2019**	**ke 4.3.2020**
KTI Implementation	100 päivää	ke 11.9.2019	ke 29.1.2020
Testing and corrections	25 päivää	ke 29.1.2020	ke 4.3.2020
Updating designing documents	**60 päivää**	**ke 11.9.2019**	**ke 4.12.2019**
C-SO documents	60 päivää	ke 11.9.2019	ke 4.12.2019
QD documetns	60 päivää	ke 11.9.2019	ke 4.12.2019

FIGURE 14. The schedule of the main development tasks

5 KAIZEN PROJECT

As described in the theory section (3.2), kaizen is a lean method for implementing a change. A kaizen event is one of the forms of implementing kaizen and it was selected to be the first research method for this project.

Before the actual kaizen event, the first stage was to map the situation and to create the action plan for the event. After the event was planned, the schedule could be formed. Proper planning was the key for a successful event and its fluent progress (3.6).

5.1 Kaizen plan and approval

Planning of the kaizen event started approximately two months before the event. Planning was started early because of the extent and complexity of the subject. It was also considered important to properly understand the expectations and the workflow of the kaizen event.

It was clear already during the planning phase, that defining the problems and features that cause waste, will have a positive effect on different phases of development. By analyzing the collected data, it is possible to define development tasks and to understand the biggest problems in the process (3.6).

A kaizen project planning team was gathered by including representatives from the SOF-Quality- and Layout engineering team. The planning of the kaizen event was started by mapping the problems that the different tender processes were causing at the time (FIGURE 15). At the same time, the team considered how these differences affect the work of designers and tender engineers and what is the impact on customers. These differences can be classified as a variation in the process. The harmonization of these process parts helps to decrease lead time and designing hours (3.3).

FIGURE 15. Variation modules of the current process

At the planning phase the main differences where categorized into seven main process parts (FIGURE 15).

1. Different content in layout drawings
2. Different engineering lead times
3. Different input data for engineering
4. Different activities for engineering
5. Differences in feasibility process
6. Different instructions and documentation
7. Different design tools

The form of the kaizen event should be (3.6): Process analysis, problem definitions in process and solution specification (tasks). Process mapping was set as the starting point of kaizen event. With this selection, the team could trace root causes of variation in the process for further data analysis.

All team members participated in the process mapping. In this way all process parts could be modelled with a high level of quality. Usage of post-it -stickers was selected to utilize every team member's expertise for the use of proper process mapping. Usage of stickers also gives a possibility to visualize and categorize the problems (3.5).

When common understanding of the problems in the current process was collected, the planning team estimated the business impact for variation reduction. This business case was based to the amount of first tender layouts, which was created during weeks 1-40 in 2018. Estimation was based on annual volume.

The savings potential and estimated actual reduction was calculated. Price per hour was determined as an average of Indian and Finnish layout engineer costs. Because of this limitation, savings outside layout team were removed from this business case calculation, even if the saving potential in other teams was obvious. The business case also consisted of savings separately for MP and KSS organizations. These costs were combined as follows:

- Estimated amount of confusion and hassle
  - 5800 hours (Total: MP, KSS, Feasibility)
  - 215 000 € / year
- Estimated reduction
  - 3400 hours
  - ~140 000 € / year

This calculation shows that it is possible to obtain ~140 000€ annual savings, only by removing waste from the process. Possibilities to improve quality and decrease lead-time were dropped out when making savings calculation. In addition to this, the following benefits were listed:

- Possibility to achieve better lead times
- More accurate data from activities -> benefit for management
- Better quality -> possibility to avoid revisions
- More efficient usage of resources in layout team

Business case was presented to managers before kaizen, and it was approved by them with the kaizen approval form. When the form was accepted, the schedule of the kaizen event was decided and provided to the kaizen team members.

5.2 The kaizen event

The three-day kaizen event was arranged in October 2018. At the first stage, business case results and the following reasons of kaizen plan was presented to sponsors (Managers of Layout, KSS and MP):

Why are we here?

- What?
  - Main goal of this kaizen is to form one harmonized process and procedures for tender layouts / feasibility checks and content of tender layout drawings.
- Why?
  - After organization change in the layout team there has been several processes for tender layout creation. Because of this, there is unnecessary waste and other problems in process.
    - Designers don’t know how to act
    - Long lead times
    - Inefficient usage of resources
  - Because of this:
    - Content of layout drawings are different
    - Customer don’t receive drawings in time
    - Revisions are needed
    - Overproduction exists
    - Quality is decreased

Agenda of the kaizen event:

Day1:

- Introduction
- Management introduction
- “As is” -situation process mapping
- Improve and defining, fishbone -model

Day2:

- Summary of Day1
- Selection of development tasks
- “To be” -process description
- Further defining of the main development tasks

Day3:

- Summary of day1 and day2 and presenting the development actions to the sponsors
- Action plan approval by sponsors
- Action plan / task list creation

5.2.1 ”As is” -situation mapping

The first stage of kaizen event was to map MP tender layout process with post-it -stickers. The next stage was the description of the KSS tender process and feasibility processes. In process analysis all process phases were described with post-it -stickers on the whiteboard. Each team member was involved, and the team was able to map all process phases (3.5). Detected problems were categorized with different colored post-it -stickers:

- Orange: tool / document
- Pink: problem / waste
- Bright yellow / question
- Big yellow sticker (process phase)

A kaizen event involves breaking down the process, removing any unnecessary elements and waste (“as is” -situation mapping and problem definitions). At the end, everything was put back together in a new, improved way (“to be” -situation mapping) (3.6).

The process mapping phase in the kaizen event covers KONE Hyvinkää supply line unit layout tender processes. In this approach frontlines are first input givers in the process, but frontline process is not drawn out at this stage. The process contained frontline (as input giver), CSM (customer solution manager), tender engineering, layout engineering and component engineering departments.

The outcome of the mapped process was presented from the supply line point of view: Confirmed tender with price (transfer price with engineering feasibility, with or without layout). Engineers from different departments are acting as supporting functions in the tender engineering processes.

The engineering task is to create layouts or give technical support to tender engineers so that the technical feasibility of tendered elevator solutions can be confirmed. In the tendering phase, component engineering task is mainly to give component level support for layout engineers.

5.2.2 MP as is process mapping

The major project tender organization handles the most challenging projects and most complex solutions in KONE. Because of that, the MP tender process is more complex compared to KSS tender process. For this reason, process mapping started with MP tender process. The process was drawn out as a swim lane diagram similarly to PICTURE 1. Swim lanes were:

- FL = Frontline
- CSM = Customer Solution Manager
- TE = Tender Engineering
- LO = Layout Engineering
- COMP = Component Engineering

PICTURE 1. MP “as is” -process mapped in the kaizen event

The team realized, that there was a lot of documentations and instructions in the early process phases (orange stickers). Having multiple documents may be confusing for tender engineers. This causes problems in the process (pink stickers) and mainly at the end process phases (engineering). All problems in the engineering might cause uncertainty and a need for clarifications which causes an increase in the tender lead-times.

5.2.3 KSS – and FEASIBILITY “as is” -process mapping

KSS Tender team is working with mainly high-volume product tenders and their tender process is lighter than MP tender process. Also, projects handled in KSS are simpler than in the MP unit. Because of these factors, the KSS -process contains less problems than the MP -process (PICTURE 2).

The feasibility check process was also mapped during this session (PICTURE 2). Some new issues were found out during the process mapping. The main problem in this phase was the lack of proper process description.

If the work and the content of the study are not defined, misunderstanding possibilities will occur between the layout and the tender engineer. As a result, the checked solution may not be feasible. There were also differences in working methods and activity terms when comparing KSS and MP tender teams.

PICTURE 2. KSS “as is” -process / Feasibility check “as is” -process mapped in the kaizen event

5.3 Problem definitions

In this phase, the kaizen team analyzed the features, which causes waste and problems in the process. SIPOC- and fishbone (FIGURE 16) – models were used in analyses. In the next phase, the team analyzed which specific actions or features are the most effective and which elements of waste can be eliminated (3.6).

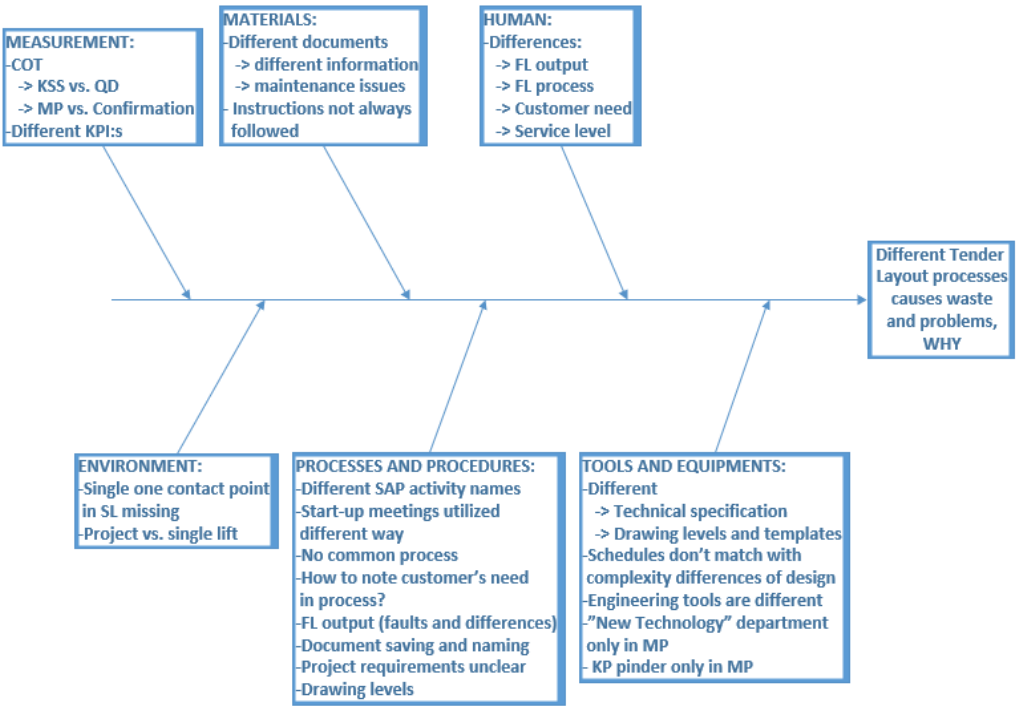


FIGURE 16. Fishbone -model created in the kaizen event

After Fishbone analyses all post-it -stickers were classified to describe the main categories of problems. The most important categories in the order were:

1. SAP / Tender process
2. Feasibility check process
3. Layout output
4. Inputs for layout

TABLE 1. SIPOC analysis created in the kaizen event

Supplier	Inputs	Process	Outputs	Customer
MP FL MP / KSS FL KSS FL	KP-Binder WEB CSP Building Drawings Architect Drawings KTOC	Specification To Supplyline	Information storage Filled specifications Drawings in PDM Drawings in PDM SAP notifications / filled spesification	MP TE TE KSS TE
MP TE KSS TE	Categories in WEB CSP QD-22.710 QD-20.550	Open SAP Activities	Mail to Eng service Longtext in SAP SAP Activity	Layout
LO Engineer	KP Pinder Start up Email from TE SAP PDM	LO Engineering	LFD Schedule Layout Memo Onefile Custom sheets Design assists Engineered tender Clarifications via mail Single/ multi-sheet layout Feasibility result in SAP	MP TE KSS TE

A SIPOC analysis was conducted to detect differences in the three main process phases (TABLE 1). These process phases were “specification to supply line”, “open SAP activities” and “LO Engineering”. Red color in TABLE 1 stated MP, Orange contains both tender teams and green stands for KSS tender team. This analysis highlighted differences in the outputs and inputs and confirmed that differences in tender processes and inputs causes a lot of variation in the layout work phase.

5.4 ”To be” -situation mapping

“To be” -situation process mapping was conducted in days 2 and 3 of the kaizen event. By analyzing the problems, the team had formed a vision that uniform and clear common process would improve flow in the process and decrease process-related variation. It would also help to remove most of the process related variation that affects effective work.

The team took the results of earlier analyses into consideration while forming a new “to be” -process. The goal was to form a harmonized tender layout process which would be common for both teams. It would also be leaner, and engineering would be involved in at an earlier stage of the project. This would bring engineering expertise closer to tender engineer and would also help to reduce input-relating problems in engineering work.

Problems and stops at the end of the process causes a lot of delays for the whole process. The focus would be to understand, which type of engineering assist is needed in each individual process phase to improve process accuracy. The following process was formed during the kaizen event (FIGURE 17):

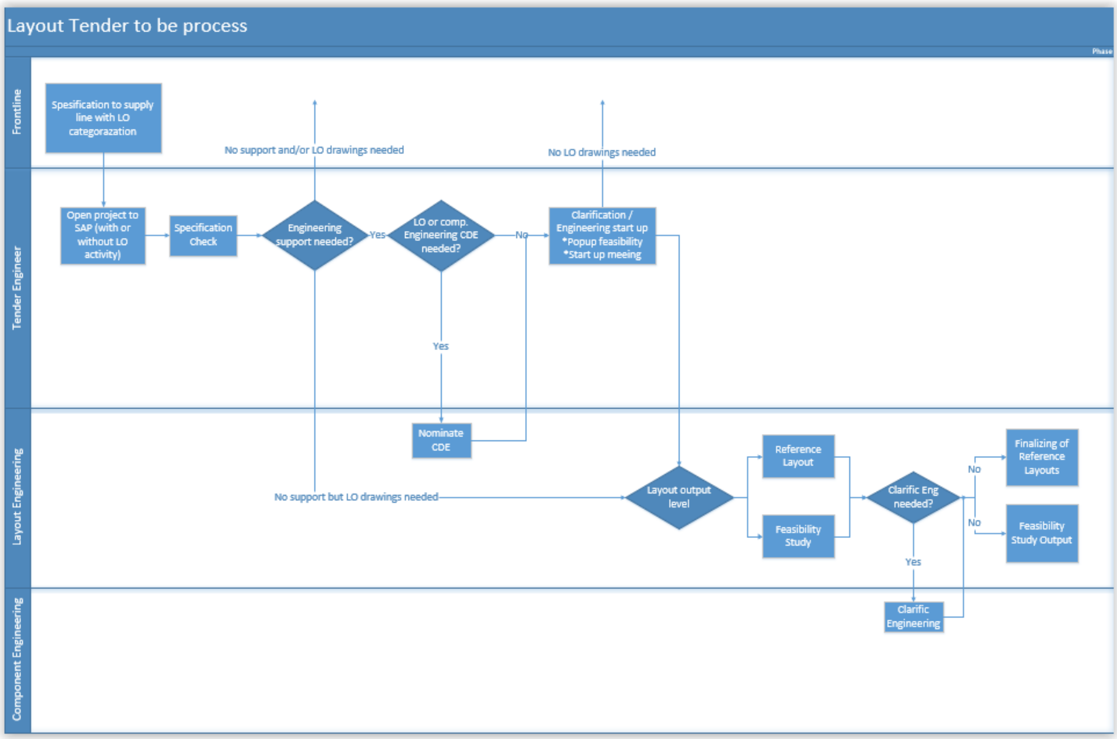


FIGURE 17. Tender process formed in the kaizen event

5.5 Kaizen summary

The formed “to be” -process was defined to be the basis for the development process created earlier. The kaizen team agreed that a common process would be the goal of the development and new development tasks need to be utilized, so that process can be implemented. This was also approved by the sponsors at the end of kaizen event.

The kaizen team formed a list of actions that need to be taken care of after the event. These items were the content of the kaizen task list. These development tasks were directed to tender and layout teams.

5.6 Kaizen task list

The tasks were addressed to tender, and layout teams and the responsible person and preliminary finish date were agreed for each task. Layout team tasks were quite large and demanding and those were later transformed into their own development projects. The list of tender team tasks is as follows (TABLE 2):

TABLE 2. Tender team task list

Action	Team	Responsibility	to be started	to be finished
Tender Engineering Steps:				
Harmonized specification check form	KSS/MP	Sara / Haksu	Q4 / 2018	Q1 / 2019
Definition when start up is needed	KSS/MP	Sara / Haksu	Q4 / 2018	Q4 / 2018
Definition when Enginering support is needed	KSS/MP	Sara / Haksu	Q4 / 2018	Q4 / 2018
WEB CSP Workshop -to be defined needs from Engineering -Automation to tool for specification check	KSS/MP	Sara	November / 2018	Q4 / 2018
KP-binder usage in KSS	KSS	Sara	November / 2019	Q4 / 2019

Most of the actions were addressed to the layout team. This is because there was a lot of variation in the engineering work. By harmonizing engineering output and service content, the new common process would be possible. At this point it was already known that this would require a huge effort and a lot of resources from the layout team.

TABLE 3. Layout team task list

Action	Team	Responsibility	to be started	to be finished
Layout Engineering Steps:				
Update QD-23.020 -Harmonized LO Tender Process -Feasibility studies proces (QD-04084 terminated if possible) -layout levels to be noted -Feasibility activity (FEASIBILITY)	Layout	Mikko	November / 2018	Q2 /2019
Update QD-22.710 Long texts -Feasibility study	Layout	Ville	Q4 / 2018	Q1 / 2019
Feasibility study development -Input-work-output - description -Whole solution visibility to be checked (always?) -Design memo to be used for output documentation -LO internal outputs and saving -Information for TE to be defined	Layout	Ville	Q4 / 2018	Q1 / 2019
Design memo form and development -Process development and instruction creation -PDM saving of memo -Form to be developed more guiding -> all relevant features to be considered	Layout	Ville	Q4 / 2018	Q4 / 2018
Reference Layout definition development -Layout out put levels to be defined (1343849) 1: Basic -Original definition 1343849 -Whole template need to be updated -Machine room forces to be included -Possibility to use one file and same sections than approval drawings to be studied 2: Customized -Basic + customer request -LEAD time TBC separately -Always charged? 3. Full set of layout drawings -Definitions according KONE standards (same as Formal layout) -Always charged?	Layout	Ville	November / 2018	Q1 / 2019
Update QD.20.550 -Lead time / default hour -definitions for each level	Layout	Mikko	LAST ONE	Q2 /2019
Reference layout template creation -Clarify which templates need to be updated according tender levels -Jump lift template creation -Other template definitions	Layout	Ville	November / 2018	Q4 / 2018
Tool output definitons -Definition for which LO tools layout levels are affecting (EPT etc.) -Change request for each LO tool	Layout	Mikko	November / 2018	Q1 / 2019

The most prominent kaizen tasks were tender (reference) layout content development and design memo development, which was relating to the layouts. The other major entity was the feasibility study development. Other tasks were related to these main activities (TABLE 3).

6 KAIZEN TASKS

Kaizen tasks were divided into two categories: “Tender team tasks” and “layout team tasks”. These categories were separated based on the responsibility of task management. Tasks where led independently and separately by both teams. This thesis mainly focuses on the content of layout team tasks.

6.1 Tender team tasks

First task for tender teams was to develop a “harmonized specification check form”. This development task was harmonized with another major development project, the “Supply Quality Plan”. This meant that this task was not included to be a part of this project, but inputs were noted in a different development stream. Also, task “definition when start up is needed” was moved to be a part of another development project.

The task called “definition when engineering support is needed” was divided into smaller segments. Tender teams created instructions concerning features that trigger the use of “pop up feasibility” which is a form of “engineering service desk” function for tender engineers. This list was later connected to be a part of Supply Quality Plan.

Web CSP is one ordering tool that is used by both tender teams. A workshop was arranged to gather all inputs (including engineering), which need to be noted and automatized in a tool. In this workshop also new development tasks were created. All these actions were addressed to KSS tender manager.

KP-Binder was not implemented into the use of KSS projects at the end due to resistance of KSS management. The goal was to unify the naming and storing procedure of layout drawings. KSS volume tenders includes lot of projects which don’t require layouts at all. The creation of KP-Binder for each tender would increase manual work. This task will be cut out from this development project at this stage.

6.2 Layout team tasks

Layout teams' tasks were handled as individual parts even though all parts were connected to each other. The task development started with a two-day boot camp where the whole layout team participated. The team was separated into two separate groups. The reason was that there were multiple views and working methods inside the layout team. This was the only way to take everyone's view into account and to form common understanding.

The form of task development was guided by using a problem-solving model and it is seven segments (3.8). In the model, bootcamps and task teams were presented as segments of this circle. In the bootcamp the team was divided into a group, that worked within the layout output content definition and another group concentrating on the tender feasibility check development.

6.3 Layout content definition

Defining the tender layout output was the biggest single action to reduce variation in this project. This is particularly important because the data created in the designing phase by a layout engineer is widely used and visible for customers. Having different content in drawings is far from ideal. Without preventing actions, the customer may even receive different types of drawings even within the same project.

KONE uses many of different types of platform level elevator solutions. Some of these are supported by current designing tools but others are not. This means that tool outputs guide the form of a part of the tender drawings. Other solutions are "built from scratch" by using component blocks. There are also old design tool outputs that some designers still prefer. Also, organizational background affects quite much the "habits" of designers and the ways they are used to present solutions in the tender phase layouts.

The starting point of this development was a bootcamp that was arranged soon after the kaizen event. Later, the team gathered together several times to improve developed tender layout output and to analyze collected data of pilot projects as segments of modular kaizen (3.8).

Template content of the three most relevant platforms were developed during the first phase. These platforms would cover most of the solutions. MR and MRL templates were selected because these two platforms are the most common elevator platforms in C-process. JUMP platform was selected because it requires a different presentation method than other platforms.

The main principle in the template development was to present only the dimensions that are interesting for the customer. Still all relevant data should be available for other stakeholders. Output needs to be technically visible and designed with high quality. First stage was to analyze "to who we are doing tender layouts for" (which departments are using layout output):

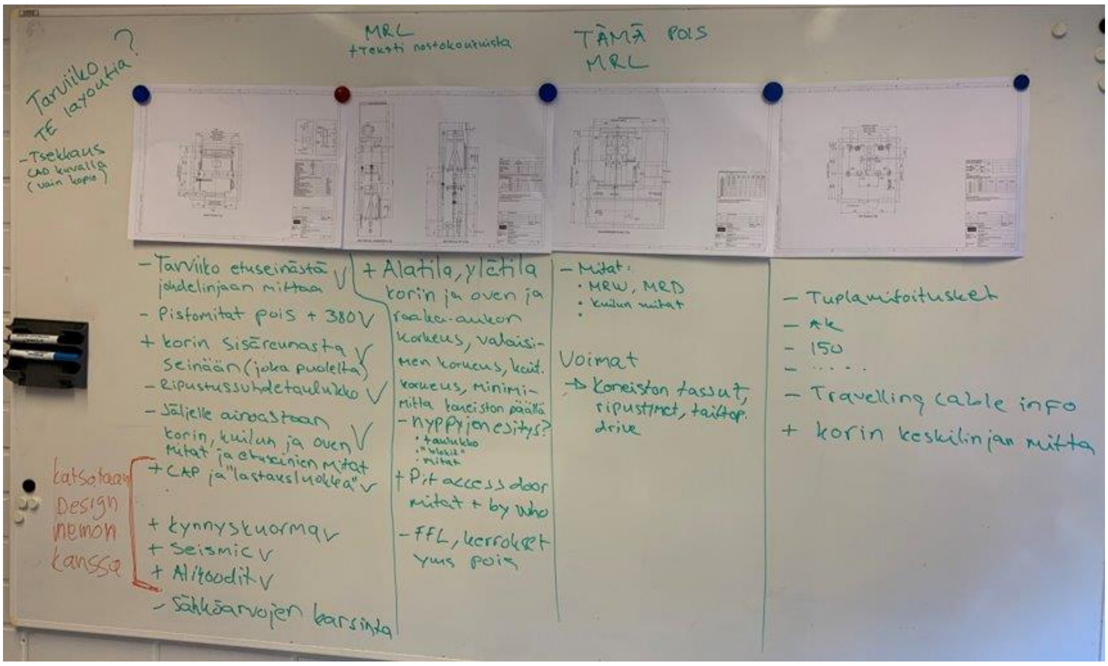
1. Final customer
2. Builder
3. Architect
4. Front line (CSE, sales, marketing)
5. Tender engineers (price calculation)
6. Layout engineers (technical feasibility, for checking)

It is important to understand who is using which data from engineering. The goal was to simplify drawings and present only content that are relating to points 1-4. Other content can be delivered with other formats. The objective was to make drawings more customer centric. Drawing content was determined to be:

1. Tender layout drawing
2. Tender layout memo (TLM)
3. Technical calculation summary

Documents were divided in a way that tender layout drawings are the only official documents that layout provides directly to frontlines. Information that is used by the tender and layout engineers is not relevant in the drawings. Piloting period was handled with TLM, but before “go live” it was combined with calculation tool outputs.

After content definitions, the team went through all the dimensions of the tender layout drawings, all the tables and technical calculations. The purpose was to cut down duplicate data from outputs (PICTURE 3). The result was a highly simplified tender layout output without free text fields and with less dimensions (FIGURE 18).



PICTURE 3. Layout content definition in the bootcamp

A pre-pilot project was selected after the first stage of definition was ready. The project contained eight highly demanding lift solutions to London. After drawings were sent to the frontline, the customer solution manager (CSM) visited Finland to give feedback about templates. The team received good feedback, and CSM separately mentioned how impressed they are about customer centricity and simplicity of the drawings. (As a good addition to this: Customer issued an order for all units of this project).

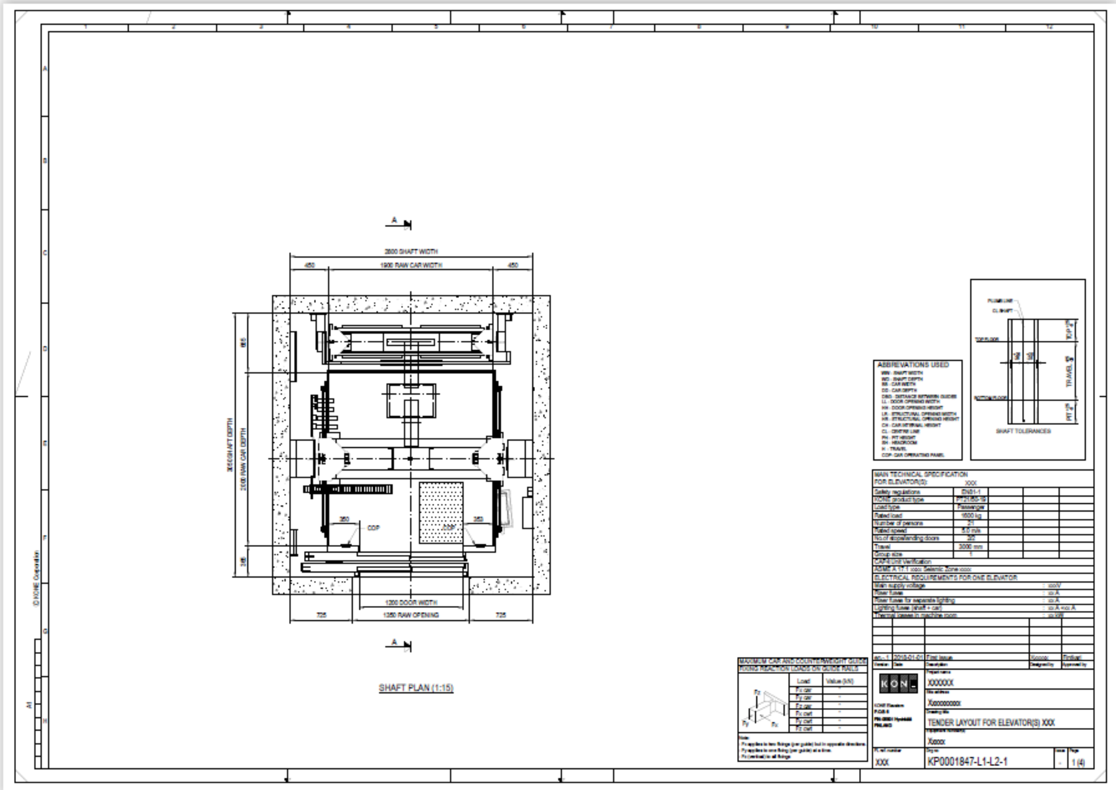


FIGURE 18. First page of the renewed MR tender layout set

Feedback analyses were done, templates were updated according to analyses and the piloting period was started. A survey was made for Tender engineers - (appendix 2) and for Front line persons (Appendix 1), who were handling the pilot projects. After this all feedback was analyzed and corrections were implemented.

Feedback from FL was positive. TE questionnaire shows that examining data from different locations is not preferred by everyone. As a response to this, Eng-calc main data list (MDL) replaces TLM, so that all information from layouts is stored only in the drawings and MDL.

6.4 Feasibility of the tenders

One task for layout team was to determine how to check solution feasibility without creating tender layouts (TLO). Feasibility of the elevator solution needs to be checked by a layout engineer, in case frontline and tender team competence is not enough for verifying it. Definition of working process was required, so that good quality could be obtained, and all parties can understand requirements of work assignments in a similar way.

Checking of the actions was divided into two parts. The first one was “Feasibility Check” (FC) and the other one was “Solution Study” (SS). These two different actions were decided to be developed. The main idea was that there is a need for quick specific checks (FC) as well as full studies of lift solutions (SS) and the lead time benefits could be separately estimated for these.

Feasibility check was defined as a check that is done for specific feature in a limited scope. The input for layout engineer is in the SAP system and the required check is defined within SAP. As an output, the layout engineer gives specific answer to a specific question. This option is used when it is clear for the tender engineer that the work amount is between 2-4 hours. This way, the layout department can commit to a shorter lead-time (2 days).

The solution study was defined to be used when the whole lift solution feasibility needs to be confirmed by the layout engineer. It can be done also for challenging solutions which have the same lead time as a tender layout. Since the solution can be completed without fully finalized tender drawings, it can be produced with a lower number of design hours.

6.5 Layout Service content

Defining and documenting the layout service content was an important objective of this thesis. Definitions of all layout tender phase services for tender teams were documented in a new QD document. Service content definitions are important for each party to understand what kind of services layout team can offer and how the services should be used.

Definition work was separated into different development streams. Popup Feasibility content was compiled by the tender teams. Feasibility check and Solution study development was one subproject inside the layout team. Content of the tender layout content remained the same, even though the layout content itself was renewed (7.1). The need of a CDE (Chief Design Engineer) was also developed to serve also tender phase but it was done separately outside of this development project.

TABLE 4. Tender layout service content

TASK	Scope	Input	SAP activity	Work	Output	Lead time	Hours
PopUp Feasibillity	- Quick questions - Specification review - Technical support -Defined in SQPlan	Specific question	N / A	Technical support	Documented by TE/PE/SM	N / A	up to 1h
Feasibility check	- Limited exact inputs - Specific KTOC MUC checks - Feasibilities of changes to existing tender layouts - Defined in 51655145D01	- KTOC + limited MUC - Existing Tender layouts - Project checks (Excels) - Other clear limited spesification	FEASIBILITY	- Check feasibility of requested feature	- Answer to specific question	2 day / single unit TBC / project level check	2 - 4
Solution study	-Defined in 51655145D01	- KTOC + MUC - WEB CSP	SOLUTION	- Full specification and solution study - Outputs saved and verified	- Sketch (ND) - EngCalc (ND) - List of main hoisting components (PDM)	Same than Tender LO	(4~30h) QD-20.550
Tender Layout	All	All	LAYOUT	Tender LO process	-Tender layout (PDM) -EngCalc (PDM) -List of main hoisting components (PDM)	QD-20.550	(4~40h) QD-20.550
CDE / LDE	Separately requested if needed QD-25.150	Project spesific QD-25.150	LDE LAYOUT / CDE LAYOUT	QD-25.150	QD-25.150	Project spesific QD-25.150	Project spesific QD-25.150

TABLE 4 is a collection of new layout services. Content was taken into the use and training for tender- and layout teams were planned and organized before implementation. The goal is that all tender and layout engineers can be aware of different layout services and the activities are automated in the SAP system. These definitions decrease the amount of variation and hassle in the tender layout process.

7 PROCESS DEFINITION

It is important to understand all process functions and how they are related to each other. In this section the process phases are defined and described. Value stream mapping is used as a tool to understand how the process chain is working. VSM is also used to highlight the limiting factors in the current process and how they can be avoided in the future state process design.

7.1 Process phase definitions

The work during the process can be separated into the value adding (VA) and the non-value adding parts (NVA) (3.9). In this project, process parts were defined to be VA, pre work (for specification), NVA and rework. Finding and removing NVA parts and rework from the process, enables the decrease in lead times and the number of actual working hours in the tender layout process (TABLE 5).

TABLE 5. Process phase definitions

Process	Actual work (min)	Lead time (h)	Definition
Specification Creation (FL)			Pre work
Open Project to SAP (TE)	15	24	Non value adding
Work Allocation (TE)	15	24	Non value adding
Acknowledgement (TE)	66	44	Pre work
Layout Allocation (LO)	15	24	Pre work
Layout Creation (LO)	449	161	Value adding
NORM		*6,2 d*	
STOP		*0,8 d*	
UNCLEAR		*0,7 d*	
Clarific Eng (Eng)	462	48	Value adding
Prizing (TE)	220	357	Value adding
Tender Send	5	1	Non value adding
REVISIONS			
Specification Update (FL)			Re work
Open SAP Activities (TE)	15	24	Re work
Work Allocation (TE)	15	24	Re work
Acknowledgement REV (TE)	48	34	Re work
Layout Allocation (LO)	15	24	Re work
Layout REV Creation (LO)	492	96	Re work
NORM		*3,9 d*	
STOP		*0,6 d*	
UNCLEAR		*0,5 d*	
Clarific Eng REV (Eng)	444	48	Re work
Prizing REV (TE)	77	346	Re work
Tender Send	5	1	Re work
More revision rounds...			Re work

Values in TABLE 5 are based on raw data and contains average values from both tendering organization activities. Numbers are not official and contains inaccuracy because of process variation. Values are needed for VSM to demonstrate trends in the old tender process.

When comparing work phase definitions and competences in a layout team (8.1), increasing quality of pre work would allow the possibility to decrease the amount of rework and need of clarifications in the process. This means that if an elevator solution definition phase could be considered carefully during the specification phase in the frontlines, the quality of input data for tender -and layout engineers would be improved.

Better understanding of the voice of the customer in the frontline units would make it possible for KONE to sell the correct solutions to customers. Offering the solution is a combination of understanding the customer’s needs and understanding the possible elevator platforms and solutions.

Making available the expertise of the layout engineers for use by the frontlines (and in the tender teams) would increase the quality of specification and solution creation. An improved state of solution creation would increase the capability of frontlines to suggest “correct” solutions for the customers in the first place. Direct contacts and closer communication between the CSE organization in the frontlines and SL tender / layout teams would make this possible.

7.1 Value stream map

When process stages are defined and divided into segments it is possible to calculate the lead time and actual work for each step. In this phase value stream mapping is a powerful tool to visualize and understand the full process chain. VSM also shows the efficiency of the information flow chain and the relationship between lead times versus actual working hours (3.9).

The study was made of process phase definitions (7.1) and concerning lead times and actual working hours of different activities. Data analysis was the main research method in this phase. This means that the data in the value stream maps are mainly based on the data that the system has collected from actual tender projects between 2018 and 2020.

When considering these VSM figures it is important to understand that these are average values from the system (KSS and MP). Data are not 100% correct process wise because in some of the projects, the actual process might have some variation when compared to the presented process model. The main reason for this VSM is to visualize the problem, find development areas and demonstrate the trends in the current process. Actual numerical values should be considered in this light and should not be considered directly.

7.1.1 First tender

The first tender value stream map shows process (information) flow with average lead times and amount of work that has been done for each activity. Based on this study, the average amount of effective work is under 5% of the total time when the tender is inside a supply line. This means that when FL sends a tender to SL it takes approximately ~26 days (635h) to be completed (when layout drawings are required) and effective time of work is approximately 21h (FIGURE 19).

This VSM demonstrates the “longest” tender process chain in a case, where the layouts are requested. Normally layouts have been required only for the most challenging cases in the tender phase. With a more standard-like tender projects, the tender engineer can give a transfer price for the frontline without opening layout activities. In this way the lead time will be dramatically shorter. Because of this, also the average lead time for a tender is shorter.

Still this shows a weakness in the current process when it comes to lead times. Lean guides process developers to consider parallel activities whenever it is possible to obtain better lead times. It also suggests cutting down non-value adding process parts. All these factors would be benefits from the customer’s point of view and can also help to reduce working hours of the process. These points are considered in chapter 10.

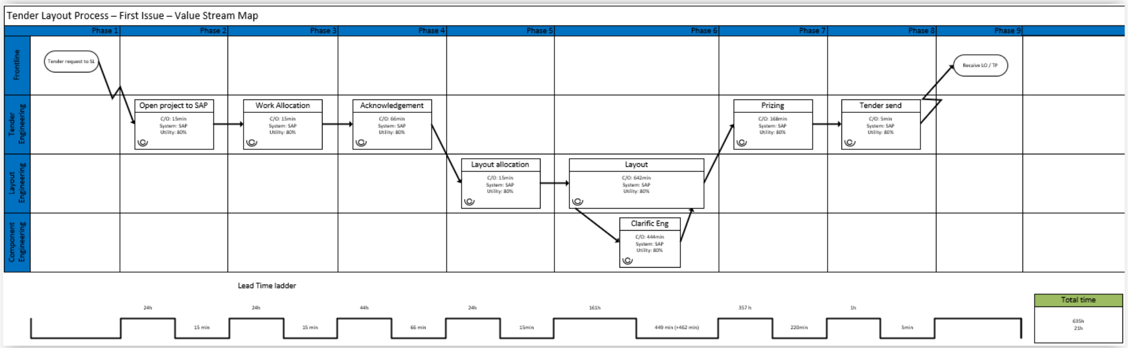


FIGURE 19. Tender phase VSM for first issue

7.1.2 Revision

Revisions are defined as rework, while revisions might be caused by many different factors. Sometimes a request might come from the customer and then the only preventing factor from the supply line point of view is to make available the expertise of engineers for use in the frontline units.

According to the tender revision VSM figures lead time for tenders is approximately ~23 days (549h) (when layout is requested). During this time there is ~19h of effective work in the process (FIGURE 20). The revision VSM has similar types of consideration requirements that are mentioned in first tender VSM section (7.1.1).

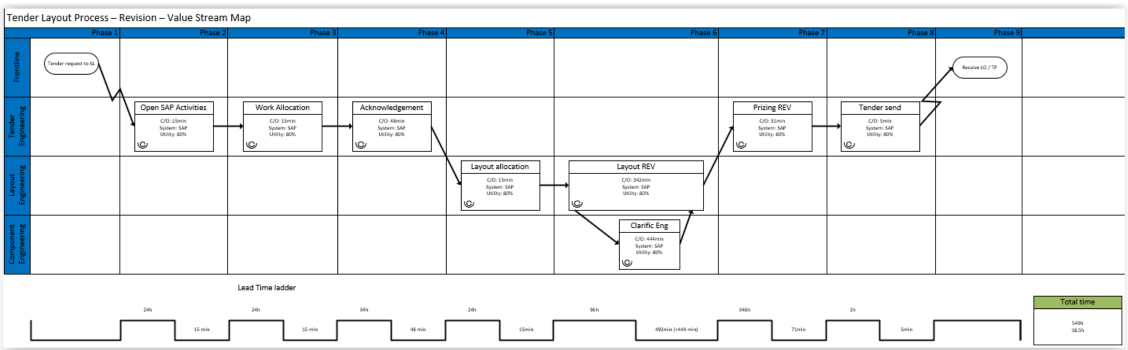


FIGURE 20. Tender phase VSM for revision

7.1.3 Revisions and lead time

When examining these value stream maps, the biggest issue how to improve lead times is to prevent revisions. Several revision rounds may occur for the same tender which might cause a lot of delay for tender projects. Still all revisions are not caused by mistakes and not all revisions can be prevented. Cutting down revisions would decrease lead times, but also makes it possible to move designer working hours to the value adding phases (11).

When one is considering customer satisfaction, it is important that the correct attitude is implemented to processes initially. Conditions to succeed the first time must be created and the process must support tender engineers and designers to make correct decisions first time.

When one understands how revisions add to workload and how they slow process, actions are needed to improve the situation. This really needs more actions also at a higher level. This factor was presented to the engineering management and a business case needs to be built, as well as further actions are required.

8 PROCESS DEVELOPMENT

The process development phase was continuing simultaneously with the other development phases from the beginning, being also the final stage of the project (FIGURE 13). The reason for this is that all research results aim towards the final process development phase. When all of the research methods and layout service content were ready, it was possible to tie all information together and finalize a new harmonized tender layout process.

This project aims separately towards two process phases. First one is the supply line process (8.4), which contains all of the new layout services, and which needs to be implemented into use as a timeline of this thesis. The next phase is to define the direction for further process development. The goal for future development needs to be shorter lead times and a better flow efficiency in the process (10).

8.1 Competences in layout team

Hyvinkää layout team has core a competence in highly demanding elevator level solutions in KONE. Designers are highly experienced, and they can support other teams in elevator level engineering. Still there is a lot of different types of solutions and it is impossible for one designer to maintain high competence level on all possible solutions.

Competence of layout designers working in the Hyvinkää facility is mapped and described in SOF a layout competence matrix. On a team level, it is important to have all competences available. The matrix shows how widely competences are divided in the layout team. One point is also to highlight how important it is to address correct competences to serve correct action points in the process. Practically this means offering the expertise of layout engineers for the use in other units (3.10).

1. Beginner (Little or no experience)
2. Practitioner (Needs support or guidance from others)
3. Advanced (Able to perform independently and capable to guide others)
4. Experienced (Ability to lead and tutor others)
5. Expert (Seen as a Subject Matter Expert)

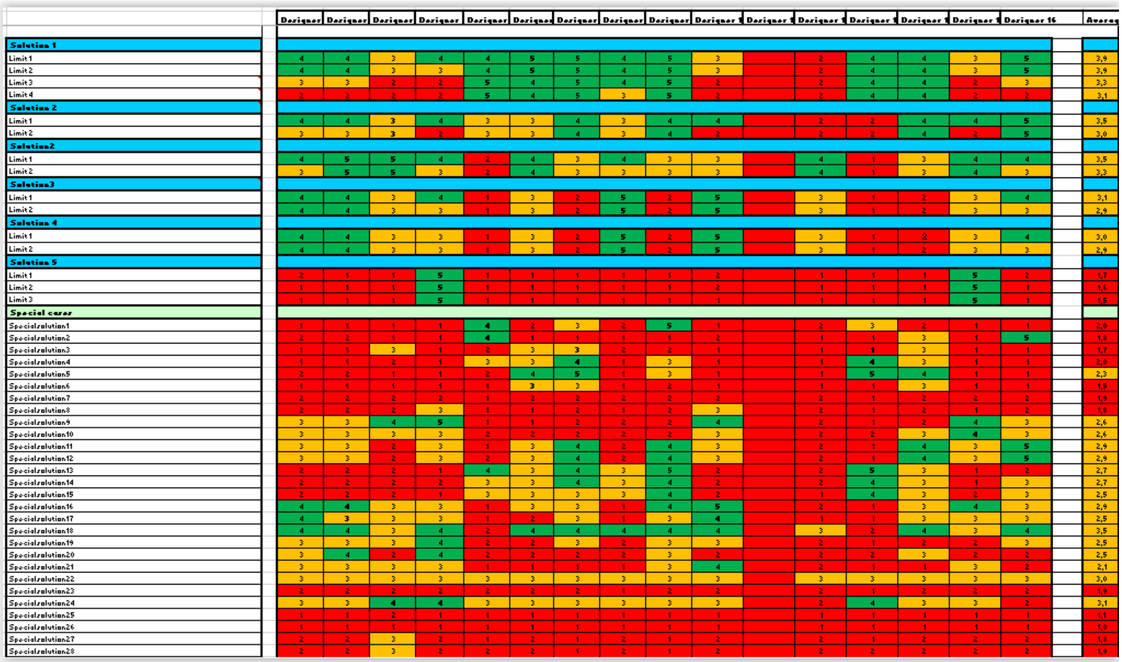


FIGURE 21. View of the SOF layout competence matrix

In this context it is easy to understand that even the most experienced experts cannot learn all the competences inside the team (FIGURE 21). For this reason, it is challenging for the tender and frontline engineers to have the required level of understanding of all the different solutions, especially with the more complex elevator designs.

8.2 Specification quality

When thinking about process improvement and smooth process flow in KONE; probably the most important things are the quality and content of lift technical specification. Improving specification quality not only serves tender and layout engineering but can be also considered as a benefit for marketing. It is important that correct lift solutions can be offered in the very beginning of the process (3.10). Also lead times and actual working hours can be reduced from supply lines when specification quality is increased.

Increasing technical competence in the frontlines (CSE) is one of the key factors. Still providing engineering expertise for the use of frontline units is something that can easily be done directly from the supply line. This close collaboration would bring correct knowhow to the correct place but also increase both FL and SL competence. By offering SL engineering expertise for the use of frontlines indeed bounds resources to the front end of the process but it also gives possibility to reduce need of clarifications and revisions.

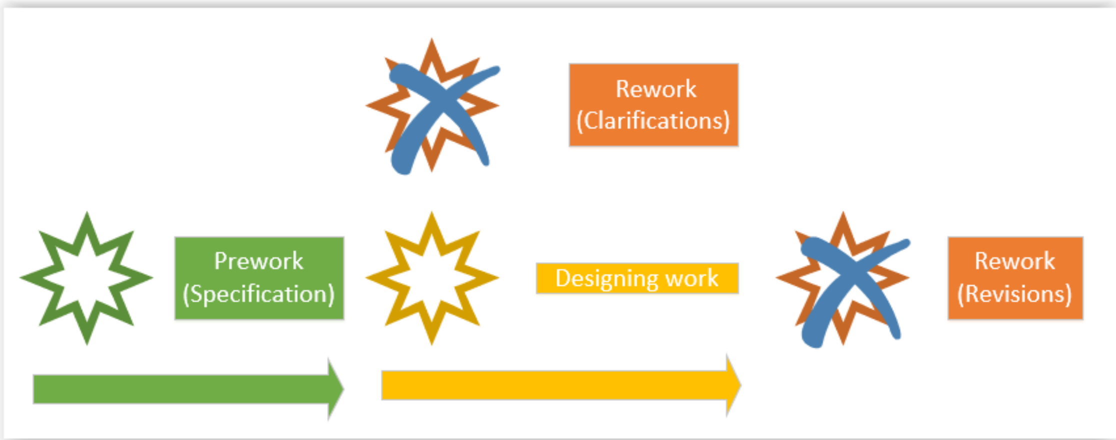


FIGURE 22. Rework in process

Cutting down all the rework from a challenging working environment is not completely possible at once. Concentrating on improving the quality of the specification would be a possibility to reduce amount of rework (FIGURE 22). In theory, if the specification is perfect before engineering has started, it is possible to go forward without clarifications and specification related revisions.

This is an ideal situation that should be the targeted with process development. In the real life there will always be something that needs to be clarified or corrected. Still there are substantial possibilities to improve the current state with these considerations. It is good to remind that lean guides to aim for perfection and it should be the goal in process development as well (3.2).

With the current process, multiple departments are wasting a lot of time for specification checking. First, the frontline creates and checks the lift specification. After that the tender engineer checks specification before layout allocation person and layout engineer check the specification.

Offering technical expertise for use in earlier process phases would decrease STOP and UNCLEAR status changes and the amount of revisions and clarifications. By defining this more clearly the amount of duplicate work phases in the process would also decrease. Still it is important that all parties are following the process and that process discipline is at a good level.

8.3 Design assist

It is important that the required support is available in all process phases when considering all research phases and aiming for good flow efficiency. This enables the possibility to make things right at the first attempt, helps to reduce variation and clarifications during the process steps. Reduction of “stops” during the designing work would also be a substantial benefit.

Frontline units are responsible for the content and quality of technical specifications in KONE. This is an important phase when thinking of the full chain and customer satisfaction. Because of this, all possible assistance needs to be available in this process phase.

Design assistance is the key function to get the best out of experienced designers. Defining layout service content (6.5) is one important factor in the process development to implement the design assistance features. The features in this thesis are mainly concerning the supply line internal service. While understanding how this affects to specification quality, this factor needs to be noted in future process development (10). Offering similar kinds of services for the use of frontlines would significantly improve specification creation process in the future.

8.4 Harmonized layout tender process

Finalizing the harmonized layout process was the final part of this thesis. It was possible to re-estimate the process when all of the harmonized design functions and layout service content were finalized. This process now contains all of the developed and harmonized layout services. All the following points were noted when this process was finalized:

1. Defining service content decreases variation in process
2. Redefining layout drawing output decreases hassle and improves quality, visual look and clarity in the drawings
3. Doing prework with specification ensures quality and decreases lead times and actual working hours
4. Offering layout competence for use in earlier process phases increases quality and effectiveness of prework
5. Describing harmonized tender layout process
6. Instructions were created to keep process steady
7. Training was arranged so that every process segment knows how to act
8. Continuous improvement is needed to keep layout service content in good shape also in the future

Main changes to the tender layout process after the kaizen event were: SAP activity-based layout services were divided into three (Layout, Solution Study, Feasibility Check). Layout service desk was designed to be established for the use of FL units (change will be implemented later).

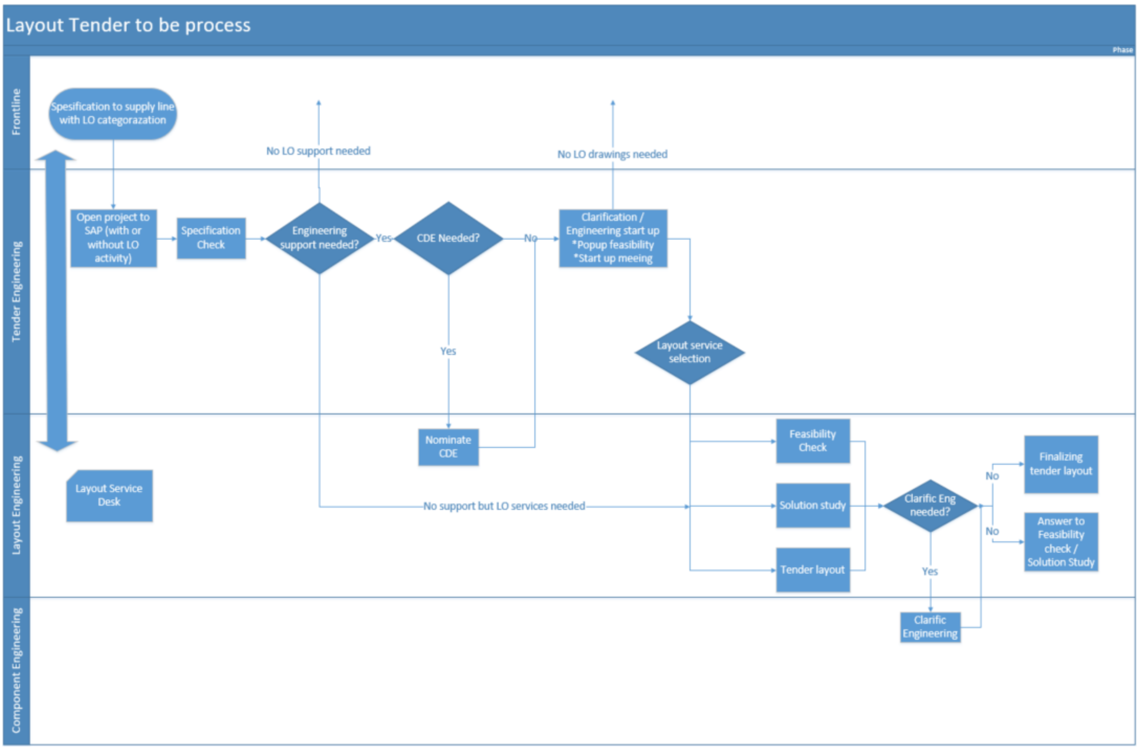


FIGURE 23. Process map of the harmonized tender layout process

The new process contains developed layout functions and new services that can be presented as pre work from the design unit's point of view (FIGURE 23). This is also one result of this thesis from a research point of view. The aim is to reduce rework in the process. Giving engineering support to frontlines is just the first stage. There are several possibilities how to increase specification quality and decrease the amount of clarifications and revisions in the future.

According to Kingman's equation, lead time of work increases if variation, handling time or utilization increases (3.4). A lot of variation effects have now been cut out from the process. This gives the possibility to shorten lead times and gives advantages for further process development. Utilization also affected by variation; it is impossible to estimate the amount of work when there is a lot of variation in the process. This affects also work planning and utilization. Cutting down the variation is also one key for more predictable utilization in engineering.

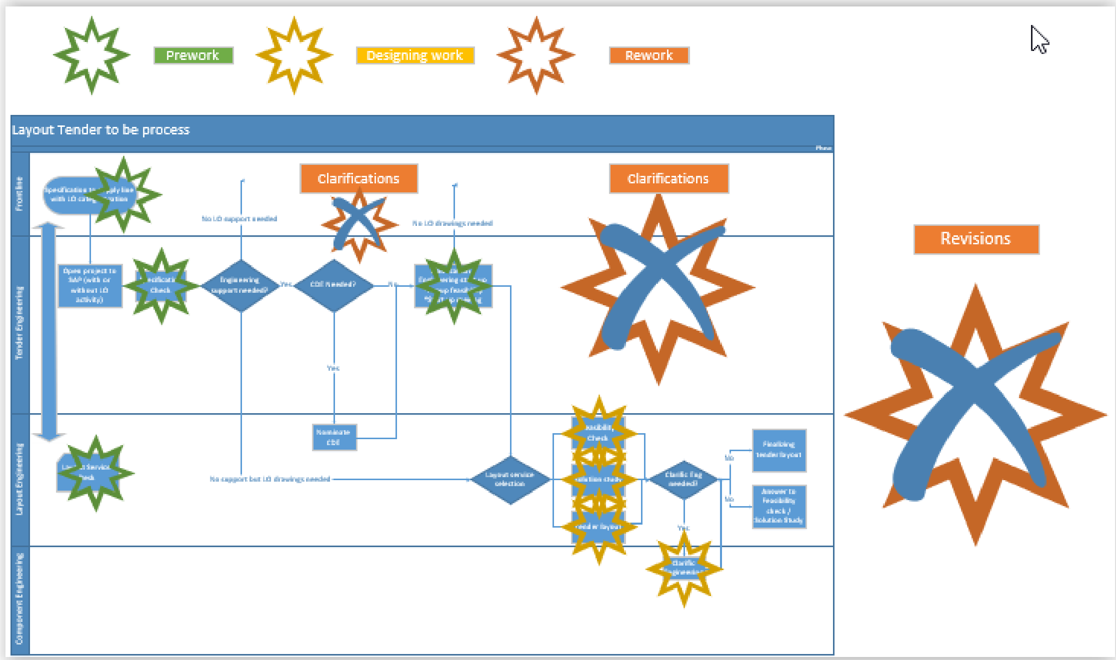


FIGURE 24. Description of prework in the renewed process

FIGURE 24 presents functions, which contain a specification improvement option, and which can be shown as prework from an engineering point of view. Removing all clarifications and revisions is not possible because all defects are not related to poor quality of specifications. Despite of this, it can show the way in future process development (10).

It is important to notice is that all process phases can be divided into smaller segments. For example, layout phase may contain waiting, input data validation, clarification, effective work, (more clarifications and waiting), checking and so on (FIGURE 25).

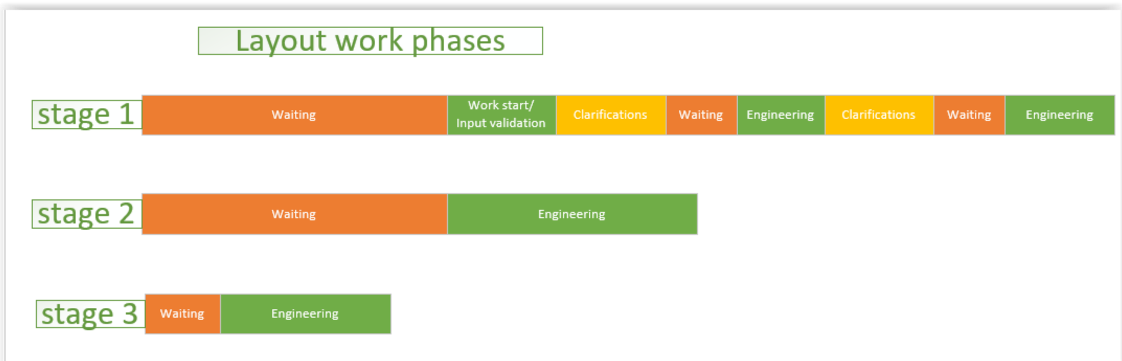


FIGURE 25. Segments of layout work

When opening layout work segments, it is possible to define different work phases inside engineering. The idea of FIGURE 25 is that different variables affect layout lead time. The waste inside the engineering phase not only increases the amount of work but can remarkably increase lead times as well. This is closely related to the fact that value adding parts of the process might include NVA and NNVA features (3.10).

Stage 1: First “waiting” phase occurs every time between allocation and engineering phases. This waiting time is related to resource efficiency in engineering. A flow efficient process would improve this in the future. Reducing waste elements, such as clarifications, waiting and revisions, is the focus of this development project.

Stage 2: In this stage a situation, where unnecessary clarifications are cut out from the process is presented. Also, the amount of variation and total engineering time is decreased. This will automatically improve lead time as well.

Stage 3: Future development should aim towards this stage. Lean offers promising possibilities when considering flow efficiency and shorter queues. When all engineering output definitions and engineering tool implementations are ready engineering work hours can be cut down.

9 CONTINUOUS IMPROVEMENT PROCEDURE

This development project focuses on tender layout process harmonization and process development. It contains research which aims to contribute to further process development. Yet one important factor is to ensure, that benefits already gained will be retained in good shape and further that development will happen. PDSA and continuous improvement are excellent tools for this.

One of the purposes of this development project is to put change into practice. PDSA cycle can be used to solve small problems or to improve the entire value process in Lean (3.8). This method can be used to keep implemented process parts up to date in the terms of time.

When layout service content, tender layout content and harmonized tender layout processes are all taken into use, breakthrough -type of improvement take place (3.7) in different phases of implementation. Basically, training and documentations will enhance the implementation and PDSA helps with maintenance.

When content of this thesis is implemented in practice, the means of continuous improvement will continue. This development was divided into segments and continuous improvement was independently planned for each segment. A responsible person was named for each function, and this person will be the main contact for future improvement ideas.

It was also agreed that the responsible person collects feedback from different teams and regularly arranges a walkthrough and updates around specific topics. The parts were defined as below:

- POPUP Feasibility
- FC & SS scope document
- Layout service content document
- Tender layout drawing content
- Tender layout process

There are still some major challenges concerning rework and clarifications that also serve as tips for managers in the future. There are numerous possible actions that could remove waste from processes and functions. Most likely, three biggest issues for future development are:

1. Resource- versus flow efficiency in engineering
2. How to improve specification quality
3. How to shorten clarification time while also reducing their number

These main fundamentals give multiple smaller options for improvement. Involving engineers more frequently in development would utilize of the best possible know-how in the development process. Giving the possibility for engineers to make a difference would also be an easy way to increase motivation in the team.

10 CONSIDERATION

The content of this thesis can be divided into two main segments. Sections 4-7 are mainly focusing on harmonization, variation reduction and correct usage of engineering assist inside the supply line. These sections are presented in a practical level and the development segments were completed and implemented during the timeline of this thesis. The results of these segments and further investigations (from chapter 7 to 9) have been used to define future development steps.

The continuation of project development is a result of a need to decrease SL tender lead times. VSM shows the relation between sequential activities with non-value adding parts and long lead times (7.1). This consideration section will collect the results of this research and give guidelines for further process development. This work is already ongoing, but end results are not included of the scope of this thesis because of long lasting segments of the development.

The project was closed within its scope when all planned actions were accomplished. The timeline of the project was long, and data was collected and analyzed during many phases (3.7). During the closing phase it is important to understand what has been accomplished and what results need to be considered in the future state process design. In TABLE 6 all project parts and status of the actions in the closing phase are presented.

TABLE 6. The goals reached in this thesis

Action	Status	Implementation
Harmonized TE spesification check form	Completed	Implemented
Definition when start up is needed	Completed	Implemented
Definition when enginering support is needed	Completed	Implemented
WEB CSP workshop	Completed	Ready
KP-pinder usage in KSS	Rejected	Will be considered later
Update process documetation QD-23.020	Completed	Implemented
Update QD-22.710 long texts	Completed	Inputs forwarded
Feasibility study development	Completed	Implemented
Design memo form and development	Completed	Implemented
Update default hour QD.20.550	Completed	Implemented
Redefine layout tender drawing content	Completed	Implemented
Piloting of renewed tender layout drawings	Completed	Implemented
Tool output definitons	Completed	Waiting actions from KTI
Define layout sercice content	Completed	Implemented
Define and train harmonized layout tender process	Completed	Implemented
Future stage tender layout process conciderations	Completed	Presented to management

The new harmonized tender layout process was implemented at the end of this project. Renewed tender layout content and improved tender layout service content definitions were the most important layout work phase related achievements of this project. These activities affect directly to engineering work and can reduce uncertainly and variation from the process.

This project also reduced variation in working methods and outputs by different engineers and teams. The development improved co-operation as everyone was able to participate and share best practices for the use of others. Also, different ideas were shared between teams. Although this project was completed, development of the tender layout process will continue with on the base of this project.

This project confirmed, that multiple benefits can be achieved via harmonization of process and its functions. Harmonization itself opens possibilities to reduce waste and variation from the tender layout process. It also gave the opportunity to define engineering assist functions and make sure that those are utilized in the correct phase of the process. Eventually this will also help with lead time reduction. Still, flow efficiency of tenders needs to be developed further. Reduction of variation creates completely different possibilities for future process development.

Speed and price are the principles that are currently driving the industry. Making the full chain process faster and removing unnecessary work, makes a huge difference in the tender phase. Lean offers a lot of tools to improve the “new” current state.

Further process improvement is possible by using lean philosophy and analyses such as VSM. When it comes to lead times, it is crucial to understand that each small process step increases waiting time in the process. For example, a 15-30 min allocation work might increase lead time of the tender by 1-2 days (3.9). This is crucial when these steps will accumulate in the process. Lean ideology also suggests considering running process parts in parallel, if possible (3.2).

This research contains a lot of similarities to earlier research. For example, prevention of unnecessary movement of flow units, finding the correct work order, mapping team competences, defining defects and rework and including them in the process and finding ways to do process parts in parallel (Serdar, Durmusoglu & Cinar 2017; Dirk & Hendrik 2003).

Correct usage of engineering assistance in the different phases of the process can smoothen the process dramatically. One key factor in the future development is the creation of an environment that allows more efficient collecting of data for the tracking of the *full chain* process. This would require a common tool for front-lines and supply lines for the tracking and launching of activities. This opens a possibility to detect problems in the process and develop it further. In FIGURE 26, a high-level process map, which can guide future development is presented.

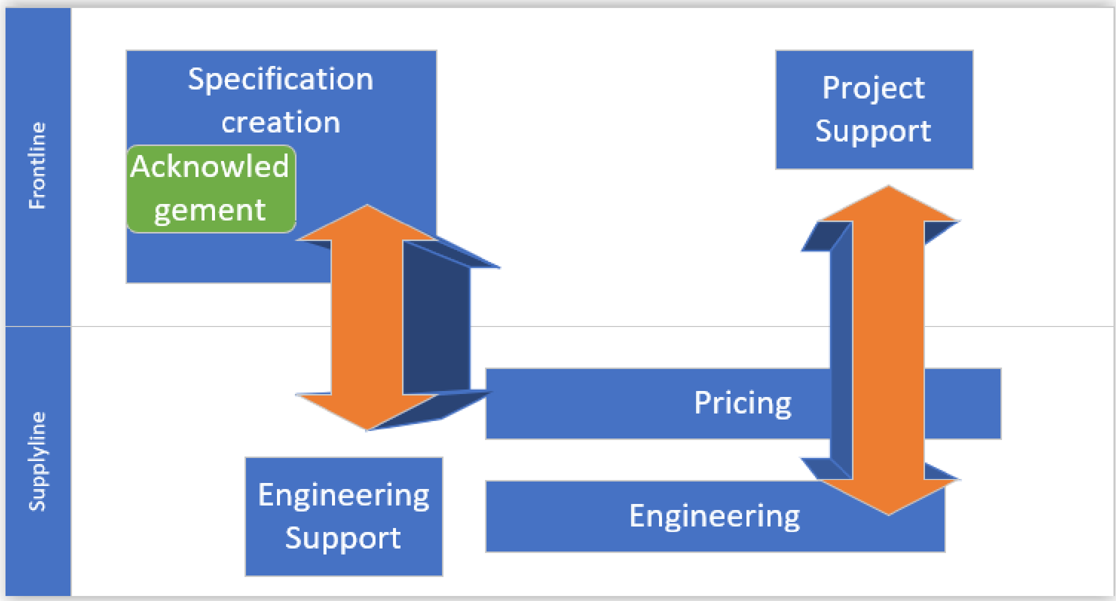


FIGURE 26. Further process considerations

The key of the process map can be found in simplification and collaboration. The most important phase of this process is specification and solution creation. At this point it is important to remember, that selecting the correct elevator level solution for the customer is one of the main fundamentals of specification creation. It is crucial to understand that all shortcomings at the beginning of the process will continue and multiply to the end (3.10).

In the current process, the acknowledgement phase is presented as a check phase for the created specification. The phase may take one week to accomplish after a tender request has been sent to supply line. One should note, that difficult and unclear solutions will increase this time.

Time loss is further amplified by different non-value adding handling phases (allocation, activity creation etc.) and the high workload of tender engineers (acknowledgment). Due to this, the acknowledgment phase is not conducted properly in most of cases. The specification is also checked in the designing phase, and in various allocation phases. All of this is applicable also in tender revisions.

One possible solution presented in FIGURE 26 is to define acknowledgement phase to be a part of the specification creation in frontlines. This could be done effectively with direct support from the tender and layout teams. For this, direct communication is crucial between frontlines and the supply line specialist. This would save time, help to offer the correct solution for the customer and increase the quality of specifications. Basically, by offering direct engineering and tendering assistance for the use of frontlines, non-value adding parts can be removed from the process and the lead time of the full chain tender process can be improved.

With this efficient collaboration, frontlines (when this is enabled from a tool point of view) can directly open engineering and tender activities from the supply line. This would result in a huge lead time reduction. By applying this, development of parallel engineering and pricing can be started. To obtain the best result, it would require a direct support function to CSE, for the use of layout and tender engineers (FIGURE 26).

Running tendering (TP) and layout (LO) activities in parallel would lead to a remarkable lead time benefit. It would also help to avoid unnecessary work in engineering. The key to promote this development, would be to separate the most challenging projects from simpler ones. By categorizing activities, running straightforward activities through parallel processes and highly demanding solutions through sequenced processes would be possible (at least at the beginning). The key to separate processes must be complexity, not the relation to organizations.

This approach requires a similar type of engineering support definition for the use of frontline units that has now been done for the tender teams (tender layout service content definitions). Eventually this would improve the lead time and actual hours used for tenders. Cutting down clarifications and revisions would enable the movement of these resources to the frontend of the process. However, a common tool for activities and clarifications between FL and SL would be beneficial.

A future state process proposal in FIGURE 26 is a result of analyzing lean methods using lean ideology in relation to the KONE environment. Non-value adding parts have been deleted, correct competences are collaborating directly and actions that can be done in parallel are presented. This is one form of a simplification that opens possibilities to increase flow dramatically. This enables a possibility to decrease clarifications and revisions at the same time (3.8 and 3.10).

All the possibilities cannot be noted in the scope of this project, but the results can be considered in forthcoming process development projects. Considerations and future state process plans have been presented to the engineering management and their message was clear – "This will be worth investigating further". At the end of this project this work is already started.

Still it is important to note that when an organization is starting to adopt lean methods, it is not only about processes and functions. It is important to train lean to the whole personnel and provide them with the proper means and tools. Working in a new environment requires that new skills and new ways of thinking must be adopted. Employees need to understand processes that are relating to lean thinking and how their own work is relating to them. It is important to ensure that all personnel have enough information and knowhow, so that they can succeed in their work (Earley 2016).

11 Comparing the results of the research with previous research

The first segment of this project mainly concentrates on reduction of variation. Tender layout drawing content development and tender layout service content development was a part of this segment. This was the starting point of this thesis and it was related to process harmonization, but it is nevertheless handled as its own entity.

Another significant and theoretically broader entity was the tender layout process development. It was divided into two parts. The first one was the improvement of the current supply line tender layout process to include developed services and functions. During the process, while results were compared to earlier research, it was revealed that further process development is needed. Research in further process development and practical work were run in parallel during the project.

When this development project started, the main idea was to utilize lean methods by removing waste elements from the tender layout process and to develop one leaner and uniform tender layout process. The theoretical background of this study is based Lean ideology. The project was started by utilizing a kaizen event, expertise of the people and lean methods, like Kingman's equation (3.4). According to Kingman's equation, lead time will be increased if:

1. Average handling time increases
2. Variation increases
3. Utilization of resources increases

The connection was clear when everyday work in the layout team was analyzed. Variation increases the amount of work and causes clarifications and rework in the process. This increases handling time and increases utilization by itself, leading to further delays on designing work. The tender lead times in KONE would also be affected by removing waste from the process. This entity formed boundaries for research modules, which are described in chapters 5-6 of this thesis.

This development project was followed the principles of Lean (see Chapter 3.8) were: The modular kaizen approach is complementary with the Plan-Do-Check-Act (PCDA) and Define, Measure, Analyze, Improve, Control (DMAIC) models of quality improvement. The concept of modular kaizen utilizes the basic problem-solving model which is divided into seven steps. It is based on a clear understanding of the problem (Grace 2014). The seven steps of the cycle are listed below:

1. Understand and define the problem
2. Collect, analyze, and prioritize data about the problem symptoms, determine the root cause(s) of the most significant symptoms
3. Identify possible solutions
4. Select the best solution
5. Develop an action plan
6. Implement solution
7. Evaluate the effectiveness of the solution in solving the problem

The data collected of each cycle must be analyzed before the new cycle can be started (3.7). In this project the cycle was completed when all the above presented modular kaizen steps were completed and the service content and the initial process definition were developed. During the process, a large amount experiences and data was collected and analyzed. The developed process definition matched the assignment that was framed for this development project.

When this goal was achieved, it was possible to re-estimate the goals. Evaluation of the situation started from the first principles: Understand and define the problem (3.7). This was possible, since the theoretical background was clear, and the collected data were analyzed. When all iterations of the cycle were completed and all collected data analyzed the, results were compared to earlier research. This was the crucial phase of this project because the realization of results and the consideration of further development process took place in this phase.

While comparing results to other research, where process and lead times improvement were considered became clear, that radical improvements are needed. The realization occurred while comparing the results of this project to the work of Lacerda, Xambre & Alvelos (2015).

Their study has a lot of similarities with this work and it provided inspiration to apply value stream mapping also to this project (see also section 3.10). This is despite the fact, that the subject of these research differed.

As Ohno (1988) presented, that in order to reduce the duration of a timeline, the timeline between a customer's order and the production delivery should be examined and the related waste should be eliminated. Ohno (1988) also identified seven common forms of waste in an industrial environment, which are briefly described below:

- Defects – Quality problems that can often result in complaints from customers or be previously detected by inspection or maintenance teams. These problems are typically related to the lack of standard procedures and quality control systems, or to human failure, and have a negative impact on both production costs and productivity.
- Inventory – The surplus of inventory usually derives from the existence of production bottlenecks, slow changeovers or unbalanced processes. As a consequence, larger inventory holding areas and more handling operations are needed.
- Motion – Workers movement that does not add value to the product. This is often related to the placing of tools and components within the station or to ergonomic aspects that demand bigger efforts from the workers than it should.
- Overprocessing – Any operation or process that does not add value to the company can be considered a production waste and it can potentially increase the incidence of defects in the products
- Overproduction – Production of more items than required by the customer. As a consequence, resources are used without financial return, stock and necessary warehouse space increase and production planning becomes less flexible
- Transportation – Moving products and materials within a factory requires transportation systems that might be expensive, need maintenance, increase the Lead Time and sometimes damage parts
- Waiting periods – Time wasted waiting for people, materials or equipment. It can happen due to flow obstructions, problems in stations' layout, delays in the delivery of components or lack of balanced production processes. An additional waste has more recently been pointed out as important (Liker & Meier 2006) and, should therefore, be considered in the list
- Talent – The waste of human potential can lead to missed improvement opportunities, considering that lean philosophy advocates that every individual is a thinker and can contribute with positive outcomes.

By comparing this list, it was possible to identify many similarities in this research and the new process-related development areas. A lot of revisions (defects) in layout tender phase occurred. “Motion” and “transportation” is not physical in our environment, but the same principle can also be applied to information flow. Flow efficiency of a flow unit (3.3) was not perfect, and many NVA (7.1) phases occurred in the “current” tender process. In addition to this there occurs “overprocessing”, “transportation”, “waiting periods” and lose of “talent” in the processes.

These were the four main factors which caused challenges in KONE’s tender environment. To better understand the process, value stream mapping (7.1) was applied as a research method. VMS showed the need for further development clearly, as also perceived by Lacerda, Xambre & Alvelos (2015).

The next phase was to improve the efficiency of talent usage of layout experts. Technical specification plays a very important role in the process (8.2). In addition to this we are handling really challenging technical solutions in KONE (8.1). Because shortcomings at the beginning of the process will reflect and multiply to the end (3.10) design assist functions would be beneficial in the solution creation phase in the frontline *(talent).*

Lean principles also guide the developers to focus the correct competences closer to customer. In KONE, this practically means improving the collaboration between layout engineers and CSE. This would ensure that technical expertise in SOF layout could be utilized more efficiently in the future.

In order to overcome this problem, other studies were examined and compared to those of the KONE tender environment. The goal was to find solutions to simplify the process and increase the process flow.

One important realization in this context was, that this process entity should be considered as a service organization (Stadnicka & Ratnayake 2017). This basically means that we are not only doing engineering, we are offering different types of engineering services. This approach would require much more investigation and will open huge possibilities for supply line engineering in the future. This also applies to the engineering assistance definitions for the use of FL units mentioned in chapter 10.

The primary motive to use Lean principles for service enhancement is to optimize process and services by offering more efficient services with less resources: Doing more with less (Zhao, Rasovska & Rose 2016) simultaneously through professionalization of work functions, as well as supporting personnel to adapt to the change (Cervone 2015; Ratnayake & Chandry 2017). A significant number of the research and development tasks in the service sector are related to lean practices (Suarez-Barraza, Smith & Dahlgaard-Park 2012).

It has been a long-term challenge to discover how to operate with productivity-enhancement-related challenges in services (Carlborg, Kindsröm & Kowalkowski 2013; Radnor & Johanson 2013; Dobrzykowski, McFadden & Vonderembse 2016) and especially, how lean principles can improve service processes (Lee, Olson, Lee, Hwang & Shin 2008; Carter, Danford, Howcroft, Richardson, Smith & Taylor 2011; Bortolotti & Romano 2012). The principles are particularly vital in purely service-oriented industrial organizations.

This was also carefully considered in the future state process design (FIGURE 26). How to enhance tender layout process so that is allows the service mindset into the process. Naturally, this would also require a lot of development in the engineers' attitudes as well.

Two studies had a principle role in defining the context of this thesis. These studies were:

- Study made by Belgian Armed Forces Using Value Stream Mapping to Redesign Engineering Project Work (Dirk & Hendrik 2003)
- Team based labor assignment mythology for new product development projects (Serdar, Durmusoglu & Cinar 2017).

The basic idea of this thesis can be considered as a mixture of these two studies. The beginning for all development projects was to map current process state. Process development was utilized using lean tools and analyzes. For example, value stream mapping was used to show defects in the current process. This was done in order to find waste, categorize process steps and to improve process flow.

There are a lot of similarities, as for example the prevention of unnecessary movement of flow units, finding the correct work order, mapping team competences, defining defects and rework in the process and finding ways to run process parts in parallel (Serdar, Durmusoglu & Cinar 2017; Dirk & Hendrik 2003). Studies were made by using data analyses, and by expertise of the project management and experts utilizing lean methods. The goal is to put the correct competences in the correct location in the process and improve the flow.

The relation between the end results of these studies were markedly similar. Process improvement needs team-based work after these analyses. Results of the studies need to be published and workshops need to be arranged to achieve the desired future state process. As a result, remarkably improved lead times with less resources can be obtained. Efforts must continue to obtain the state where it is possible to do more with less.

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APPENDIX

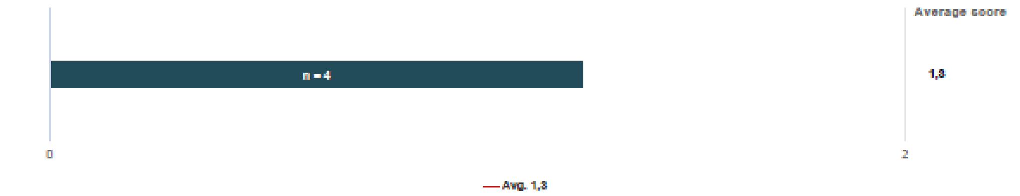
Appendix 1. Frontline Questionnaire 1 (2)

Tender layout harmonization: Frontline questionnarie

Total number of respondents: 4

1. Is it important to show reaction forces in layout tender drawings?

Number of respondents: 4



	Yes	No	Average	Median
	75%	25%	1,25	1

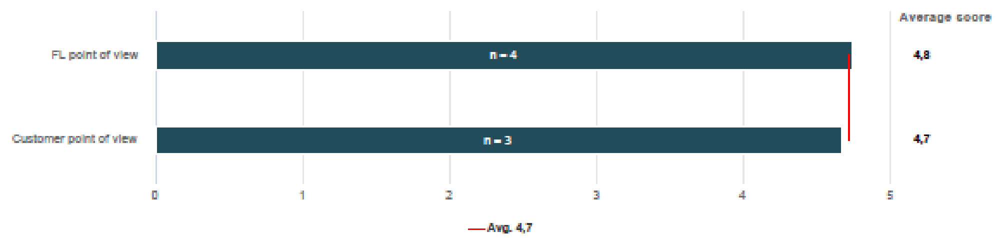
2. Please give your arguments to first question

Number of respondents: 3

Responses
Usually we need the hooks placement
Reaction forces are first thing what construction/engineering companies ask from layouts.
Placement of hooks is needed quite often and reaction forces - case by case

3. Is there all relevant dimensions in tender layout drawings? (1 = Not at all , 5 = all relevant)

Number of respondents: 4



	1	2	3	4	5	Average	Median
FL point of view	0%	0%	0%	25%	75%	4,75	5
Customer point of view	0%	0%	0%	33,33%	66,67%	4,67	5

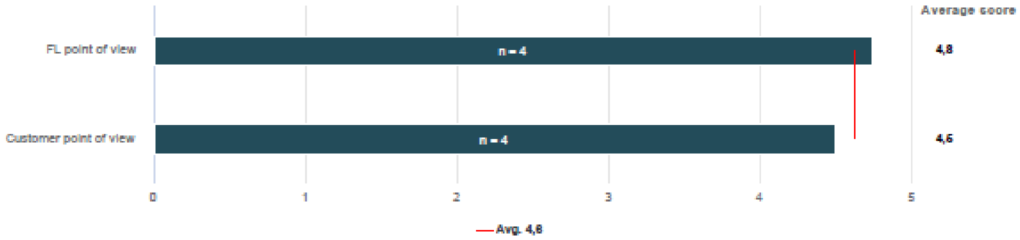
4. Please give your arguments to question three

Number of respondents: 1

Responses
MP-Fin tender drawings most times includes all relevant drawings. MP-Chn are not that good, they should learn from MP-Fin tender drawings .

5. Is the detail level of tender layout drawings sufficient? (1 = Not at all , 5 = really good)

Number of respondents: 4



	1	2	3	4	5	Average	Median
FL point of view	0%	0%	0%	25%	75%	4,75	5
Customer point of view	0%	0%	0%	50%	50%	4,5	4,5

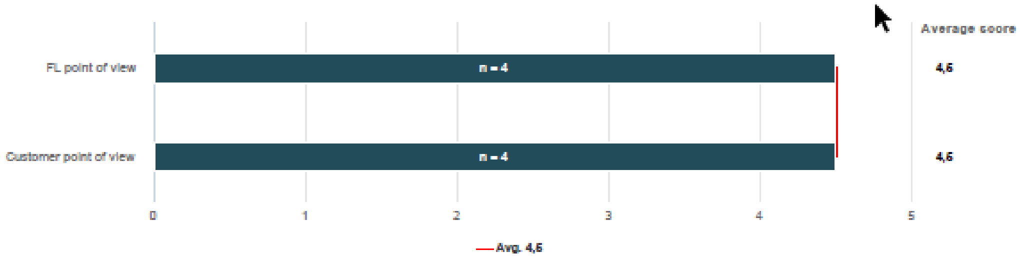
6. Please give your arguments to question five

Number of respondents: 1

Responses
Again MP-Fin drawings are overall better looking. Sometimes e.g. MP-Chn drawings make Monospace lift small plan view 1:20 scale in big sheet which do not look.

7. How sufficient is the information in the tables? (1 = poor, 5= really good)

Number of respondents: 4



	1	2	3	4	5	Average	Median
FL point of view	0%	0%	0%	50%	50%	4,5	4,5
Customer point of view	0%	0%	0%	50%	50%	4,5	4,5

8. Please give your arguments to question seven

Number of respondents: 1

Responses
MP-Fin drawings are good , there is typically all needed information. MP-Chn drawings not that good , often they don't even put forces and electrical values even asked.

9. General feedback. Here you can give any feedback about pilot tender layout drawings. Please consider also what should be added or removed from drawings.

Number of respondents: 2

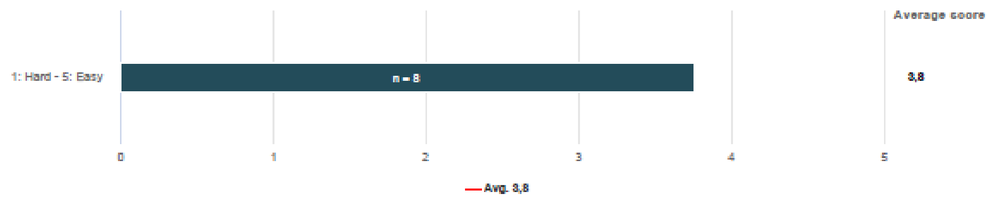
Responses
Please add hooks placement. Holes placement.
1.) Focus that drawings generally look good, view scales looks nice in drawing sheet. 2.) Early tender drawings should have perhaps min headroom height , min MR size , min pit height , even we draw as shown in client drawings. This item should be discussed with FL. 3.) If we draw something like the Rope Hole Silencer or similar , name them and that they by KONE, sometimes client might thing they belong to their scope and they are not happy.

Tender team questionarie

Total number of respondents: 8

1. How easy it is to find information from tender layout memo and Engcalc raport?

Number of respondents: 8



	1	2	3	4	5	Average	Median
1: Hard - 5: Easy	0%	25%	0%	50%	25%	3,75	4

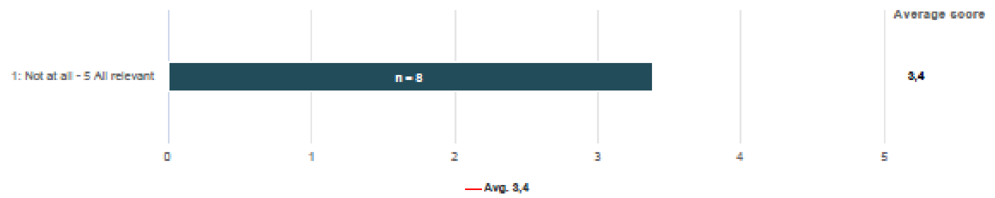
2. Open comments to qustion one

Number of respondents: 6

Responses
We need data sheet where all the basic hoisting function is listed and can be read quickly
EngCalc is very detailed and it therefore not always easy to find what you are looking for. Just need to get familiar with the layout. The new memo form is very B-process focussed e.g. "Deviations to KTOC". But otherwise very clear.
Ottaa aikaa kaivaa tieto moneita lehdeitä ja aikaa meillä ei ole
Elizabeth House: Layout memo looks good and easy to follow. It is a different and better format than for 8 Bishopsgate. EngCalc is comprehensive and sometimes difficult to find things. But it is there - just need to go through it!
Engcalc comments in Design Notesnot clear at all! Memo is good.
L/O easy , EngCalc diffic.

3. Is there all relevant dimensions in tender layout drawings?

Number of respondents: 8



	1	2	3	4	5	Average	Median
1: Not at all - 5 All relevant	12,5%	25%	0%	37,5%	25%	3,38	4

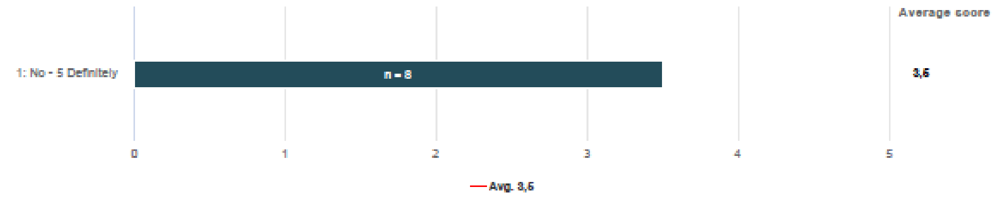
4. Open comments to question three

Number of respondents: 4

Responses
No problems. I don't remember needing to dig into the AutoCad file to get dimensions. But it is essential that the AutoCad files are stored in the KP binder - just in case you need to check some dimensions.
Need to check that the the guide bracket L dimension is shown and also the divider beam thickness are shjown. Also Landing door centre to centre lines are shown for the lobby set out.
L-dimension of guide fixing brackets missing.... Everything is missing, orderbound componets, no describtion, without Memo pricing is impossible. And still it needs to have good imagination for pricing engineer.
Shaft dims are most important

5. Is the detail level of tender layout drawings sufficient?

Number of respondents: 8



	1	2	3	4	5	Average	Median
1: No - 5 Definitely	12,5%	12,5%	12,5%	37,5%	25%	3,5	4

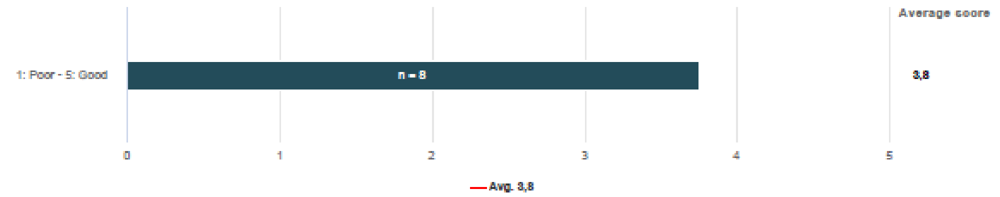
6. Open comments to question five

Number of respondents: 3

Responses
Yes, good as I remember.
See comment for question 4.
Drawings well done but , no describtions for special components!

7. How sufficient is the information in the tender layout tables?

Number of respondents: 8



	1	2	3	4	5	Average	Median
1: Poor - 5: Good	0%	25%	0%	50%	25%	3,75	4

8. Open comments to qustion seven

Number of respondents: 3

Responses
OK. With the drawings, memo and the EngCalc files then all the information is available.
Yes, these look fine.
Ok

9. General feedback (What you want to add or remove from tender layout drawings)

Number of respondents: 7

Responses
Tender engineer needs on sheet where the important hoisting data is listed.
Generally: make sure that the door centre lines are shown on the lobby plan view. Also that the EngCalc fiels are stored in the KP binder in pdf format as not everyone has the EngCalc programme.
Kaikkien leiskasuunnitteljoiden pitäisi tallettaa molemmat TC fileet tai sitten latoa deviation listaan samat tiedot mitä oli alemmin piirustuksessa. Nyt pitää etsiä tietoa sieltä sun täältä ja joskus toinen TC filee puuttuu kokonaan. Laittakaa tarjousinssiä varten oma lappu, jossa kaikki oleellinen yhdellä A4sella. En nyt kerkiä speksata mikä on oleellista, mutta ainakin perusmitat, painot, komponenttityypit ja se mikä poikkeaa normaalista, esim. IP asiat.
These layouts look quite good. As said earlier some bracket, beam and lobby layout drawings were missing. Not relevant in this case, but some times loadings and minimum possible / minimum required dimensions are needed.
It would be good if we could copy the texts from tender layout.
Add describtions!
unnecessary dimensions ; only shaft dims are needed + BB,DD,LL,CH,HH