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Elevator Floor Extension Process Improvement

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<p>This thesis concerns process improvement on an elevator floor extension process. The main goal was to study and find a way to improve one of the KONE modernization processes and to make a comprehensive documentation about it.</p> <p>From a theory viewpoint, different process improvement methods were examined to find the most suitable method for solving the practical problems in the studied process. The thesis was done by using one of the best-known process improvement methods called DMAIC. DMAIC is a problem-solving method based on Lean Six Sigma.</p> <p>In the practical phase, the problem areas were analyzed and prioritized. The priority with existing problems was examined with the modernization team and the improvement for the problems was planned. After the correction plan was clear, the improvements were carried out and feedback was asked from the technical team and pricing and frontline unit. With these improvements, the technical team will significantly save working hours.</p> <p>The main results gained during the practical part of the thesis work were: extended scope for the simplified elevator floor extension process, new more accurate pricelist and thoroughly documented work instructions. The tests made by the involved modernization team personnel indicate that the prices calculated with the new pricelist are accurate and valid. With the help of the created guideline documentation and work instructions, the new pricelist is easy to expand by adding more elevator types or options based on future needs.</p>	
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<p>Tämä insinöörityö käsittelee prosessin kehitystä sovellettuna hissien kerrospäivitysprosessiin. Työn päätarkoituksena on tutkia ja löytää tapoja parantaa yhtä KONE:n modernisointi prosessia ja lisäksi tehdä selkokielineen ja ymmärrettävä dokumentointi ja ohjeistus prosessin eri vaiheista.</p> <p>Erilaisia prosessi kehitysmenetelmiä tutkittiin teoreettisesta näkökulmasta, jotta tutkitun työn kannalta sopivin menetelmä löytyisi. Insinöörityö tehtiin käyttämällä yhtä tunnetuimmista prosessin kehitysmenetelmistä nimeltään DMAIC. DMAIC perustuu Lean Six Sigma prosessin kehitysmenetelmään.</p> <p>Työvaiheen alussa prosessin ongelmakohdat analysoitiin ja priorisoitiin. Havaittujen ongelmien prioriteetti määriteltiin ja suunnitelma ongelmien korjaamiseksi laadittiin hissimodernisaatio-tiimin kanssa. Kun suunnitelma oli selvä muutokset voitiin toteuttaa ja tämän jälkeen pyytää palautetta tekniseltä-, hinnoittelu- sekä asiakas tiimiltä. Testauksen sekä positiivisen palautteen perusteella voidaan todeta, että tehdyt muutokset auttavat vähentämään merkittävästi teknisen tiimin työkuormaa.</p> <p>Keskeisimmät tulokset insinöörityön työvaiheessa olivat: laajennettu yksinkertaistetun hissien kerroslisäysprosessin tarjonta, uusi entistä tarkempi hintalista ja perusteellisesti dokumentoidut työohjeet. Modernisointi tiimin jäsenten kanssa tehdyt testit osoittivat, että uudella hintalistalla lasketut hinnat olivat tarkkoja ja päteviä. Ohjeasiakirjojen ja työohjeiden avulla uuteen hintalistaan on helppo lisätä uusia hissityyppejä tai lisätä optioita, riippuen tulevista tarpeista.</p>	
Avainsanat	Prosessi, kehitys, hissi, modernisointi

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List of Abbreviations

SSE	Service Supply Engineering.
REN	ReNova. Door model for MonoSpace elevators.
BOM	Bill of material, found in SAP.
MAP	Maintenance Access Panel. Access panel that contains needed electronics for maintenance. Located next to landing door, usually at top floor.
TOC	Theory of Constraints, process development method.
SAP	Systeme, Anwendungen und Produkte in der Datenverarbeitung Aktiengesellschaft. Software to manage business operations and customer relations.
VC	Variant Configuration, abbreviation used in SAP.
FL	Frontline, country-specific customer service unit.
SOF	Sales Organization Finland.

1 Introduction

It is important for a company to improve and renew its processes. Process improvements may remove unwanted bottlenecks, reduce delays, improve efficiency and most importantly increase the company's competitiveness. On an organization level, efficient process helps personnel to avoid delays and perform specific work tasks without feeling hesitation about the quality of the outcome. Properly documented processes help both new and old personnel to follow the defined guideline and reach similar final results in organization.

The purpose of this thesis is to study one of KONE's processes and make it more streamlined and fast flowing. The main problems that are targeted to be solved are delays and misunderstandings in an elevator floor extension ordering process and removing the bottlenecks in the existing ordering tools.

In chapter 2 the reader is acquainted with KONE and one of its organizations in which the study is done. The organization handles elevator modernization orders and gives technical support for customer frontlines across the world. The organization consists of different elevator material specialists, like mechanical, electrification, doors and signalization.

Chapter 3 introduces different kind of process improvements methods in theory level. Processes can be examined from many different viewpoints and there are many different ways to develop a process to make it more reliable and quicker. Some process development methods can even be combined to maximize the efficiency of new improved process.

Main objectives, identified challenges and problems in process are specified and analyzed in chapter 4. Challenges and problems are mainly identified with the help of SSE technical team, but also other teams are interviewed about the existing problems in the elevator modernization process. The thesis research process and end results are displayed in chapter 5. The results for the process development task and the whole study is evaluated and reviewed in chapter 6 against set objectives.

2 Environment and Background

This section gives an overview to KONE, its' operating environment and customer segments. As part of KONE's portfolio, elevator modernization is offered. The elevator modernization options are described to give background information about the factors that are taken in account, when making the modernization option selection.

2.1 KONE as a Company

KONE is over a hundred-year-old company, which was founded 1910 in Finland. It is one of the world's largest elevator and escalator companies. KONE has produced also many other types of machines during last century, for example from hydraulic pumps to harbor cranes. Nowadays KONE focuses on providing customers with industry-leading elevators, escalators and automatic building doors, as well as maintenance and modernization solutions for own and other manufacturer's products. The company's mission is to make people's movement and working comfortable, safe and effortless in constantly growing cities and in tall buildings. [1]

KONE's net sales continued to rise between 2010 and 2016 from almost 5 billion to 8.8 billion. The number of employees has increased from 33 500 to 52 000 in the same period. The company's class B shares are quoted on the NASDAQ OMX Helsinki Ltd in Finland. [2]

KONE operates in 60 different countries. Operations are divided into six different geographical areas which include: North America (ENA), Southern Europe (SEMA), Central and Northern Europe (CNE), Asia (APA), Russia (RUS) and China (GCN). KONE has seven manufacturing plants and a global research and development (R&D) center, which are located in all main market areas. Locations are shown in figure 1. [2]

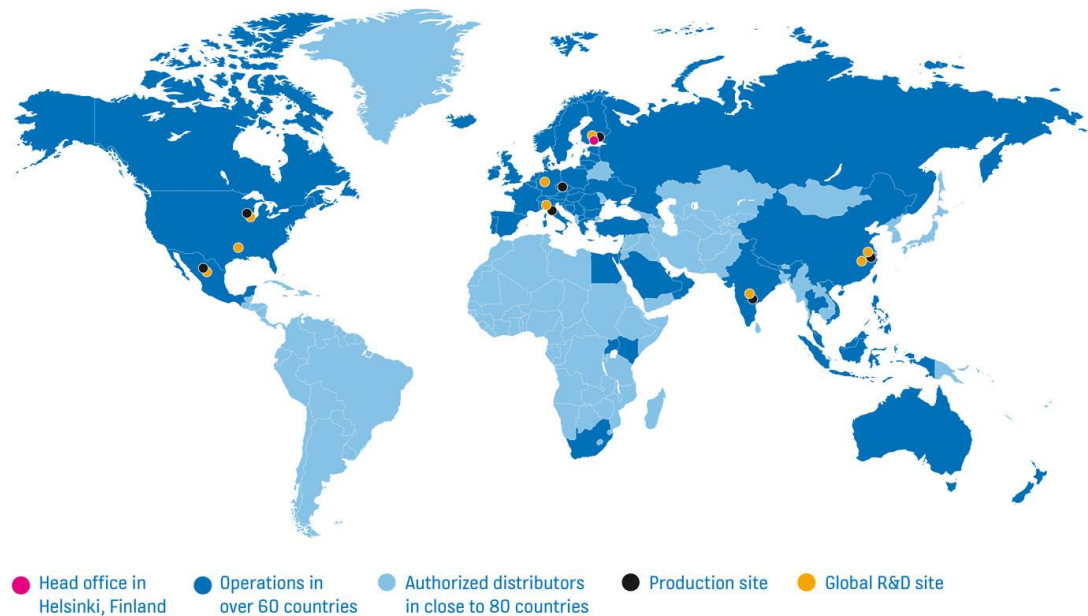


Figure 1. KONE locations worldwide. Copied from KONE in Brief (2016) [2]

KONE offers a wide range of products to meet the needs of the diverse types of real estates, residential buildings, office buildings, public transportation, hospitals, business centers and as well as for a number of other special structures such as large cruise ships. The key customers include building owners, building contractors and real estate companies. Also, authorities, architects and consultants have a key role in the purchasing process of elevators, escalators and special solutions. [3]

KONE has approximately 400 000 customers worldwide. Most of them are maintenance customers. The maintenance agreements range from one year contract of one lift housing company to large international customers with multi-year service agreements. Consequently, one of KONE's largest business area is the modernization and maintenance of elevators. [4 p. 2.]

2.2 Elevator Modernization Alternatives

Modernization of an elevator means either a full replacement or a partial modernization of an old elevator.

The full replacement often means installation of a new elevator to replace the old one. Reasons for the complete renovation include the higher reliability and security of the new

lift, as well as larger size of the new elevator and door opening. Often automatic doors, elegant furnishing and operation silence are very important features for the users. In addition, floor extensions to the basement and the attic are enabled. Floor extension means that the length of elevator shaft is increased to top or bottom floors and new stops are added. Also, existing "blind" non-served floor can be added to serve users by adding new landing station doors and other needed material. It is also possible to install through type car, which means that there are doors at both ends of elevator car.

The partial reform is a good option when the original design and outward appearance of the lift is to be maintained or a complete renovation is not financially justified. In older more esteemed buildings it is usual to preserve the old traditional elevator. In such case the viable solution is just to partially reform the elevator. In partial reforming only the key parts of the elevator are changed either all at once, or one part at a time. By doing so, the residents will incur only little disturbance during the process. The partial reform may include e.g. renewal of the hoisting equipment, restoration or renewal of the doors, refurbishment or renewal of the elevator surfaces. The partial reform also improves safety, accessibility and energy efficiency. However, the elevator car does not naturally gain more space, because the elevator car frame is not changed as it would be in a complete renovation. [5]

3 Process Development Process and Methods

Regeneration of a process has various levels of ambition in general: business reconfiguration, radical re-design of company's core processes and continuous improvement of processes. Usually the main emphasis at organizational level is on continuous improvement of processes as in this thesis. [6 pp. 99—105.]

The starting points for the continuous improvement are the already existing organization structures and processes. The scope is restricted to functional sub-processes and the improvement is usually part of a comprehensive quality program covering the whole organization. Also, improvement of one specific process or sub-process is possible. The typical characteristics of such continuous process development are that the approach to process improvement is "bottom up" and whole personnel is involved in it. The ambition level is moderate with cumulative saving benefit target of 10-30%. Process development is done in small steps so that the evolution of the process is phased and the impacts of the change are predictable. The trigger for the improvement is typically based on common sense and development suggestions from personnel. [6 pp. 99—105.]

3.1 Goals and Phases of Process Development

The main goals with a process improvement are improvement of efficiency, measurability of the process, improving the sustainability of production, improving the quality of production, improving the reliability of production, problem management and usability of the process. [7 p. 3]

Process improvement can be divided into three main phases [6 p. 121]:

1. The company discovers a need for a change in business based on external or internal factors and thus old business models become outdated.
2. The company creates a vision of target state, specifies the necessary steps and implements them.
3. The company establishes new practices in accordance with the new business model into part of their normal operations.

The above phases are applicable for any process development, regardless of the set ambition level. Therefore, e.g. when a sub-process which is being used in an organization is required to be modified based on development suggestions received from the organization to improve the process efficiency and reliability, it contains the phases for change discovery, target planning and improvement step execution, and taking the new process as part of the daily operations in the organization.

In the following figure 2 a generic process change process is shown:

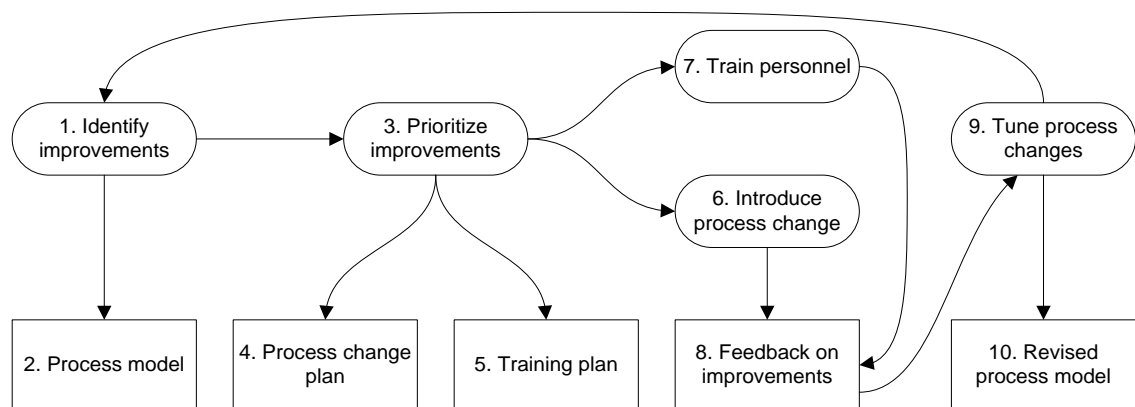


Figure 2. Generic process change process. Copied from Sommerville (2009) [8 p. 15]

The process change process consists of following steps and deliverables [8 pp. 14—15]:

1. Identify improvements

First part of process change is to identify and specify the required improvements. Improvements can be identified by reviewing the old process model and discovering problem areas.

2. (Old) Process model

Old process model serves as a basis for the new process model when continuous improvement approach is being used.

3. Prioritize improvements

Improvements must be prioritized because not everything can be done at the same time. Changes must be done from the most important to less important improvements.

4. Process change plan

In a process change plan it is defined how the change is going to be implemented and what changes are more important than others.

5. Training plan

Training plan describes how the upcoming change is going to be trained to personnel. Without proper training the new process may even lower the efficiency and quality of the process.

6. Introduce process change

New process model is introduced to the personnel. In this step, feedback on improvements is collected (see step 8).

7. Train personnel

Personnel must be trained to use the new process without difficulties. Usually this is done by making proper documentation and instructions, and by giving a presentation about the changes in the process. During the training, feedback on improvements is collected (see step 8).

8. Feedback on improvements

The received feedback gained during the process introduction and process training is collected. Also, while engineers work with the new process they gather valuable information about improvements and give feedback about process.

9. Tune process changes

Feedback is used to fine-tune and improve the process so that it would be as good as possible.

10. Revised process model

After the feedback has been analyzed, the revised process model can be made. Next time when improvements are needed, the newest process model is used as basis and the process is again started from identifying the new process improvements.

3.2 Process Development Methods

There are many different methods for process development. Depending on the needs, certain development method may be more optimal than another to the given process development problem. Consequently, it is very important to recognize which method is right for the specific process. Some development methods can complement other methods and together they may provide much bigger benefit on conclusive results. In the following chapters couple of the most important and well-known process development methods are introduced.

3.2.1 Six Sigma and DMAIC

Six Sigma is a group of methods and practices which can be used to systematically improve a process. It is not an improvement program, but a performance improvement method. Six Sigma is based on a scientific approach, which utilizes statistical thinking and methods. Six Sigma focuses on minimizing process variation. The use of Six Sigma methodologies is expanded to reduction of errors and failures according to the company's product marketing and strategic targets. [9]

DMAIC is a problem-solving method which provides a systematic way to solve problems and develop ways to improve business strategies. In Six Sigma, systematic improvement

is implemented with DMAIC –process. First problem or improvement opportunity is limited to breakthrough point and then that problem is solved. DMAIC can be divided to five different steps as shown in figure 3 [10]:

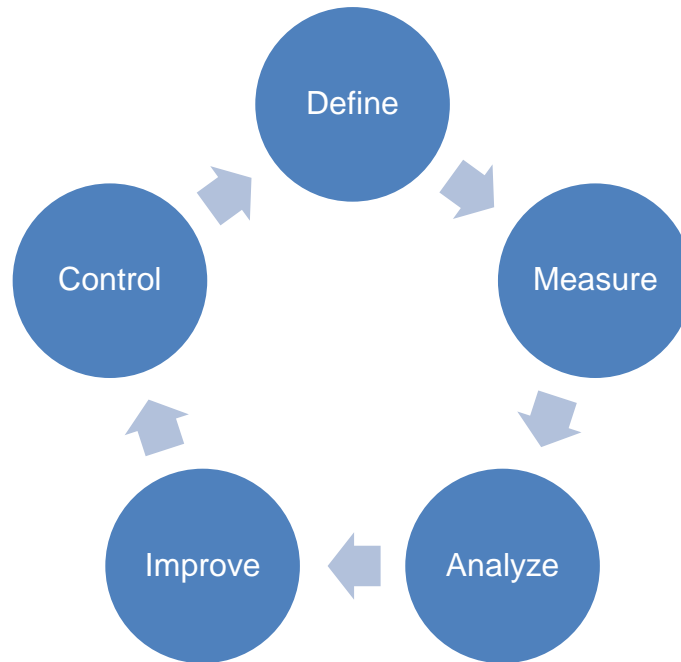


Figure 3. DMAIC problem-solving method. Copied from Six Sigma [10].

1. Define

First step is to define the problem, the requirements and to set a goal for process improvement.

2. Measure

Next step is to validate and finalize the problem and collect data about process efficiency.

3. Analyze

Cause and effect hypothesis is created. The main root causes and the best practice are recognized. In the same time the defining of requirements is finished.

4. Improve

Idea of how to remove main reasons of problem is created, tested and standardized. New process is designed and created.

5. Control

Standard measurements are created to maintain performance of the new process. If new problems arise, they will be corrected.

3.2.2 Lean

Lean production is known from book *The Machine that Changed the World*. Lean is originally based on Toyota Production System, which means Toyota's internal production philosophy that has been evolved nearly 100 years. The principle of Lean is to apply the principles of quality management to production. Lean focuses on optimizing the whole process instead of just focusing on a particular part of the process. The main idea of lean is to minimize and eliminate the non-value added time and maximize the value-added time in the production process. Value added time means the time which benefits value for both the customer and the company. Many kinds of production related problems can be solved with proper use of Lean. [11]

3.2.3 Theory of Constraints

Theory of Constraints is a more specific approach to decide where to use Six Sigma and Lean. Main idea is that every process has at least one problem and only one problem that most limits the performance of process. It is also known as the "bottleneck" of process. The bottleneck increases the turnaround time of process and as a result the performance of the process is decreased. The idea is to recognize what is the limiting factor in the turnaround time and how is it limiting process. The basic concept of TOC is that once you eliminate a restriction another restriction takes its place, and this cycle continues to improve the process. With focused use of Lean, Six Sigma and TOC it is possible to have much greater benefit for process improvements. [12;13]

4 Current State Analysis and the Scope of the Study

In this section the alternatives for the floor extension process are described. As the study focuses on A-process optimization, detailed current state analysis for the A-process is carried out. Based on the analysis, the A-process problems that are required to be solved are identified and prioritized. These together form the goals for the study, as shown in section 4.2.

4.1 Current Floor Extension A-process and Problems

Floor extension process can be divided into two main categories. One of these is more demanding C-process which requires special engineering. Regularly more special lifts such as scenic lifts require hardware, software and layout engineering. Layout engineering means basic level elevator engineering including mechanical feasibility, code compliance and safety spaces etc. In this case, frontline personnel open a new ticket for SSE technical team in SEB Issue Tool. It is also very important that frontline personnel include old layout drawings and other needed information about lift that is going to be modernized. The role of SSE Technical team is to acquire the information and prices about the needed parts and special engineering, and ultimately prepare a tender for the frontline. It is up to the customer to accept it or not. For the volume elevators, there is A-process in which frontline can calculate price for floor extension without help of technical team. Frontline uses an existing pricelist to calculate price for floor extension. In this case, special engineering is not needed or even allowed.

In the following figure 4, A-process flow is shown.

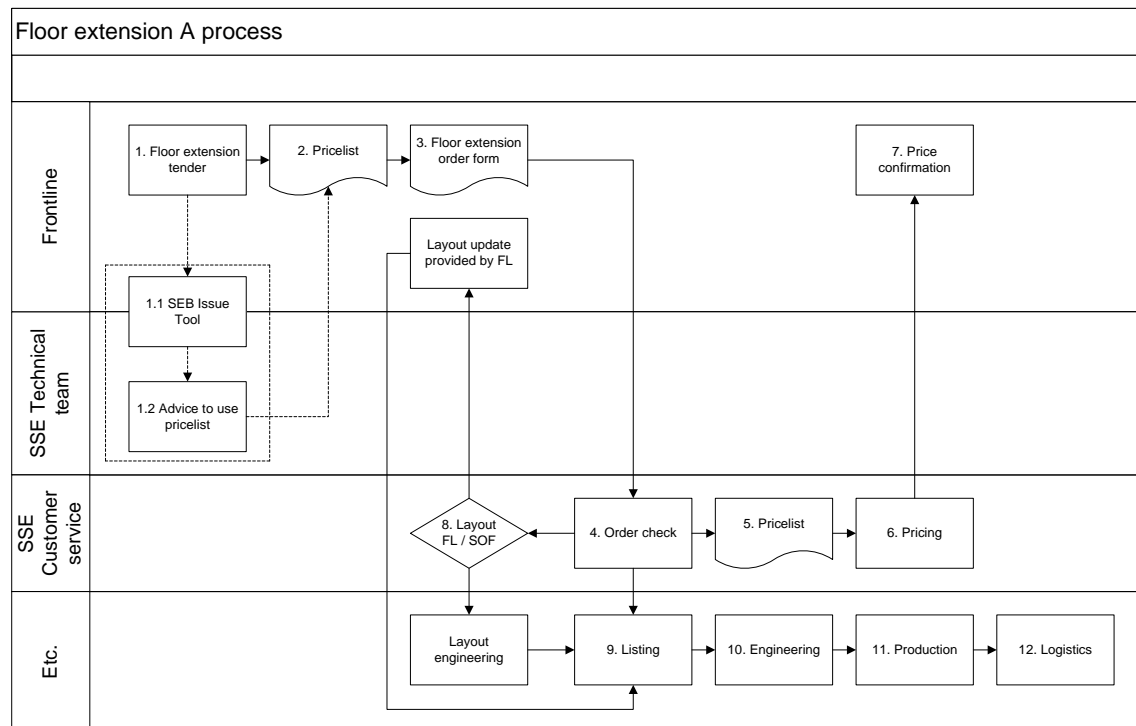


Figure 4. Floor extension A-process diagram.

A-process consists of the following steps:

1. Floor extension tender

When A-process floor extension for elevator is needed, frontline uses pricelist to calculate price for extension. If the pricelist scope doesn't match with customer needs, extension is C-process and must be continued by contacting SSE Modernization Technical team through SEB Issue Tool.

Frontline must always provide reference numbers, KEN (KONE Elevator Number) and/or sales order number for elevator. This helps the personnel to find information from specific elevator through SAP and PDM. It is very important to have these reference numbers because without them it is impossible to find any information about elevators.

When ordering a floor extension frontline must also attach a filled floor extension order form. If new layout diagram is needed it needs to be provided in .dwg form available in PDM.

In some cases, the frontline contacts SSE technical team through SEB Issue Tool. Because this is A-process technical team only advises to use the existing pricelist to calculate right price, if price list is suitable for needed extension.

In case a tender needs to be done:

SEB Issue Tool ticket must contain filled floor extension order form or it needs to be available in PDM. Frontline must also provide elevator reference numbers. If some information is missing ticket is turned back to frontline to fill in missing information.

Depending on case special engineering must be contacted via email and SAP to gain prices for needed material. If special engineering is not needed pricelist shall be used to calculate the price. The price list scope does not cover all possible cases but technical team can calculate prices by accommodating the pricelist.

2. Pricelist

Frontline uses the A-process MonoSpace floor extension pricelist to calculate price for floor extension. Price consists of basic price depending on which hoisting motor is installed on elevator, shaft materials which are calculated by shaft length, MAP position, doors and signalization.

3. Floor extension form

Floor extension form must be filled with elevator information. The needed information is: basic elevator information, background information, electrification type, type of update, shaft info for old and new travel, needed materials, old and new floor chart. Also, extra remarks can be added to clarify some information.

4. Order check

SSE Customer service performs order check for floor extension orders. Order form is always required for each elevator and it needs to be saved in PDM.

Order check consist of following operations: check consistence of initial information, fill relevant information to SAP VC, ensure that following process steps get sufficient information: layout, listing, engineering.

5. Pricelist

Customer service uses the pricelist to calculate price for frontline. If the price matches with the given price from the frontline, the customer service will move forward to the pricing phase. If not, the frontline will be contacted to discuss the given price.

6. Pricing

When the price is correct, the customer service adds the given price to SAP order and adds in the price for the freight cost.

7. Price confirmation

Price confirmation will be sent to frontline trough SAP and order will be proceeded to factory.

8. Layout FL / SOF

Source for layout update will be determined by elevator type. Some volume elevator types can be updated only by using FL tools. C-process cases need usually supply line special engineering.

9. Listing

Listing fills SAP with correct information so the engineering and factories know which materials must be shipped to the customer.

10. Engineering

Engineering prepares more detailed material list and creates manufacturing drawings if needed.

11. Production

Right materials are produced, gathered and packed for delivery.

12. Logistics

Floor extension materials are delivered from one of KONE's logistic centers to the site for installation.

The problem is that in too many A –process floor extension cases frontline contacts technical team for help with floor extension ordering. This causes extra workload for the technical team. By rescaling and reforming the existing pricelist the frontline personnel could be more independent when ordering a floor extension. This leads to more accurate prices, more extensive ordering selection and faster order processing. One of the largest existing problems are difficulties when customer wants to order floor extension with adding more than one floor.

When a ticket arrives to modernization inbox in SEB Issue Tool, a predetermined specialist assigns it for the subject matter specialists which can be electric, signalization, mechanics, doors, car or floor extension specialist. Ticket is always either technical question or invitation to modernization tender. When ordering floor extension frontline personnel must always provide additional floor extension form for SSE. Order form contains specific information about the elevator such as back ground information, electrification type, shaft information, information of needed materials, floor chart for existing and new floor layout and remarks field for additional information.

If the ticket contains some contradictory information or something relevant is missing, the ticket can be turned back to frontline. Main reasons for turn backs are missing elevator reference numbers, documents or cases the where frontline personnel can check price for needed material from existing pricelist. Missing reference numbers and documents cause delays in the ordering process and because more communication between frontline and technical team is required, it leads to wasted working hours.

The pricelist for floor extensions contain certain criteria that indicate whether the floor extension is possible for specific elevator. For example, elevator must be a standard A process elevator delivered from Italy's factory and it must not have low pit room feature. Also, delivery content for different kind of upgrades are mentioned.

If the pricelist scope matches with an elevator being upgraded, the frontline personnel can choose from three different kind of tables depending which extension type elevator needs, extension for top-, bottom-, or intermediate floor. Each of these tables contains basic price for update depending on which hoisting motor lift has. Shaft materials such as electrification will be calculated based on which hoisting motor does elevator have installed and by shaft length in full meters. After that has been done, the frontline personnel choose which kind of doors they want to new floors. Now, the pricelist has three different options for new doors REN200, REN600 and REN800. Price for doors is very inaccurate because it is calculated as an average price. Many elevator doors have fire protection but some don't. If the pricing for doors is done with the floor extension pricing list, customers may be billed more or less than they really should.

In top floor updates the maintenance access panel can be left to existing top floor and additional price for longer cables needs to be attached to the total price. This option has caused confusion in frontline because it is not displayed clearly enough in pricelist.

KSS370, KSS420, KSS470 and D-series signalization can also be ordered using the current price list. For others, a specific price list for signalization is displayed in bottom of the price list.

There is not much documentation and instructions existing currently about the floor extension process. Lack of proper documentation causes delays and confusion also in SSE technical team. Engineers have done many notes for themselves and everybody has little bit unique way to calculate the tenders.

The current identified problems in the A-process and in the pricelist, are:

- Too complex pricelist
 - Sometimes frontline finds hard to calculate right price for floor extension. They don't know what basic price consist of and there is no guide how to calculate price correctly.
- Inaccurate and old prices for doors and signalization in pricelist
 - Price list consist of average price for that reason prices don't often match with material prices.
- Notes missing in pricelist
 - Some machineries for example NMX and MX20 are missing from pricelist. Also, there is no mention of compensation rope. Compensation rope is added when travel increases over specific point depending on elevator type, speed and load.
- No defined price for more than one floor extension
 - In many cases frontline wants to add more than one floor. Current price list doesn't support multiple floor extensions.
- Extra workload for SSE technical team
 - As some machineries and multiple floor extensions are missing from price list frontline cannot calculate price for all A-process floor extensions and they need to open a ticket in SEB Issue Tool.
- The lack of guideline documentation and proper instructions
 - SSE Modernization does not have guideline documentation on how to use price list. For that reason, floor extension calculations prices may vary depending on who does them.

4.2 Goals of the Study

The goal of this study was to make A-process floor extension orders more extensive and simpler to pull through. Current problems with A-process are introduced in chapter 4.1 and in table 1 below. Improvements will be done with ambition level of continuous improvement as described in chapter 3 and with help of DMAIC method described in chapter 3.2.1.

Table 1. Current A -process problems.

Problem	Area	Priority
SSE Technical team extra workload	SSE Technical team	1
Inaccurate and old prices for doors and signalization in pricelist	Price list	2
Guideline notes missing in pricelist	Price list	3
No defined price for more than one floor extension	Price list	4
Complex pricelist	Price list	5
The lack of guideline documentation and proper instructions	SSE Modernization	6

Most extensive part of this process is to make more accurate pricelist that contains wider range of elevators and extension options with proper instructions. This will help to decrease SSE Technical team workload and make it easier to calculate prices correctly in frontline. While updating existing pricelist also new guideline documentation needs to be done.

5 Process Improvement

This thesis was done in co-operation with SSE Modernization technical team engineers who are familiar with floor extension product. They are specialized also in other products such as signalization, doors, electrifications and mechanics.

The first objective, aligned with DMAIC method phase “Define”, was to get familiar with the floor extension product and A-process elevators. The practical work during the familiarization process consisted of tendering the floor extension orders and pricing the orders with the help of the technical team and the customer service. A-process and C-process order flows were clarified with the help of SSE Technical team, SSE Customer service, as well as with the listing and engineering. This analysis is presented in section 4.1. At the same time notes and development ideas were gathered about A-process floor extension orders. As a result, the prioritized list of the A-process problems was created (Table 1).

Before any changes were made to the processes or to the pricelist, it was important to study the amount of completed A-process floor extension orders to understand the magnitude of the expected impacts. This phase corresponds to “Measure” in DMAIC method. The completed orders are available in SAP, from where they were transformed to a more readable Excel format. In total 482 completed A-process floor extension were found between January 2012 and January 2017. Out of the total amount, 236 of floor extensions were tendered and 110 of them were more than one floor extension. Tendering A-process floor extension takes about 1-2 hours’ time of SSE technical team personnel. In year 2016, total of 109 floor extensions were delivered and 53 of them were tendered. In reality much more floor extension tenders were made but they were not ordered or they are still waiting to be ordered. If tendered floor extension orders can be decreased even to half of what it is now, weeks of work hours can be saved. With this information, a conclusion can be made to make a new pricelist to speed up the process.

After meetings and discussions with the experts about the identified A-process problems, the conclusion was made that the best way to improve the A-process is to create a new more accurate and simpler price list to cover more elevator types and multiple floor extensions. Also, guideline documentation and manual for using the renewed price list is required for frontline personnel and for SSE. Restriction is that the pricelist can support only basic elevators made in Italy’s factory and new openings needs to be in same side

of elevator as old ones. The identification of these actions are covered in the DMAIC process in phase “Analyze” and further described in the below subsections from the DMAIC “Improve” phase viewpoint.

To complete the DMAIC process cycle, “Control” phase is realized in practice by collecting feedback for the improvements from the involved personnel and from the front-line, as well as by auditing the created work instructions. For further information, see section 6 about the result evaluation and potential future development topics.

5.1 Process

The main improvements in the A-process was that it shall be utilized for a wider product scope with the renewed floor extension pricelist. The new pricelist covers also other elevator types than standard MonoSpace elevators only. With the wider elevator type selection, the SSE technical team personnel do not need to calculate the prices for A-process MonoSpace 500, MonoSpace 700 and TranSys elevator floor extensions.

The process flow itself remains the same as shown in section 4.1, but it will be utilized for more elevator types than earlier. The old process had issues when frontline needed to order floor extension for other than standard MonoSpace elevator or more than one floor extension. Also with only average prices some special features were not listed in pricelist. Usually this lead frontline to contact SSE Technical team and frontline needed to wait answer depending on how busy technical team were at that point. With wider selection of elevator types and more options it is much easier and quicker for frontline personnel to order floor extension. It is also easier for SSE Customer service to perform order check and pricing because all needed material and options are visible in the new pricelist. Guideline documentation helps new personnel to understand floor extension process and it will also help old personnel to make floor extension tenders more similar.

5.2 Pricelist

New pricelist was made from a scratch and now it supports all A-process standard MonoSpace, MonoSpace 500, MonoSpace 700 and TranSys elevators. Main idea is, that

only the prices for the supported elevator types can be calculated. If pricelist does not contain the needed elevator type it most probably is C-process. The prices for the new pricelist are calculated material by material, instead of using average prices as earlier. The material prices and calculations were gathered with the help of the technical team and electrical engineering. With the accurate and visible material prices, the pricelist is easier to use, and the frontline can see which materials they are going to receive. This helps the frontline to order other needed material, in case elevator has some unique features which are not mentioned in pricelist.

The new pricelist does not support doors or signalization. A conclusion was reached in the team, that it is more accurate for the frontline to see the prices for doors and signalization from dedicated pricelists. The pricelist contains sheets described in following subsections:

5.2.1 Info & Requirements

In Info & Requirements sheet version information, scope, requirements, delivery content, other pricelists and ordering information are described. Scope describes for which purposes this pricelist can be used and what kind of elevators can be updated. If the elevator being updated matches the requirements, the pricelist can be used and the price will be valid. Delivery content describes which material is going to be delivered with the update. Basic delivery content is: guiderails, guiderail brackets and fixings, fish plates and fixings, hoisting ropes, over speed governor ropes, shaft electrification, traveling cables. Also brake release wire, LWD cable and lay out update is delivered if needed. Pricelists for different type of doors and signalization is displayed for frontline so they can be quickly obtained from PDM. Ordering information contains SSE customer service email and order form number. Also freight pricelists are mentioned in ordering information.

5.2.2 Elevator Information

Elevator information sheets contains the pricing tool. Pricing is started by first choosing the elevator type, load and speed. If needed elevator type, load or speed is not displayed in the list, it most probably is a C-process elevator and SSE Modernization technical support must be contacted to proceed with the floor extension.

After elevator type, load and speed is chosen, currently installed machinery is shown in first red cell. Next the frontline needs to fill in existing travel, new travel, new headroom height and new pit height. These cells are needed for rope length and guiderail calculations.

In the following step, the type of extension is chosen. Top/Bottom is chosen when the travel of elevator is increased. Intermediate is chosen when the travel increase is not needed and only new openings are needed in between already existing floors. Choosing intermediate extension redundant price cells hides automatically. After type of extension is chosen the frontline personnel adds the number of existing landings and the amount of new landings. These are needed for electrification calculations. When all needed information is filled, additional options can be chosen. Additional options cover extra travelling cables for intercoms. Different kind of other attachment such as maintenance access panel or electrification cabinet can be left to the second uppermost floor and so longer cables are needed, which brings extra price. Also shaft lighting and layout update bring extra price.

In mechanical materials, the price is shown for the varied materials. Counter weight guiderails with CWT safety gear can be chosen if needed. Type of compensation chain/rope is shown in price section. Compensation rope/chain is added automatically to the total price if travel is long enough. If compensation chain/rope is needed but travel is not over the limit described in compensation chain/rope type box, frontline personnel can check compensation chain/rope box in options. Electrification materials contains calculated price for floor electrification, travelling cables and for chosen additional options.

More information about materials used in A-process elevators pricing logic can be found in MonoSpace, MonoSpace 500, MonoSpace 700 and TranSys sheets. Actual materials will be delivered according to existing lift details in SAP.

At the bottom of the elevator information sheet, price for engineering, ordering fee and total price for extension are shown. Complete price for extension is obtained when this total price, price for doors, signalization and freight is added to SAP. After the frontline has sent the pricelist and order form to SSE Customer service, they will perform order check and pricing check, in order to make sure that the given price is correct and all needed material is chosen. Because the prices of the pricelist are confidential information, picture of price calculator without prices is shown below in figure 5:

Elevator information:		Description:
ESU Elevator number:		
KONE Equipment number:		
Elevator type	MonoSpace	Choose elevator type
Load [kg]	320-480	Choose elevator load
Speed [m/s]	0,63	Choose elevator speed
Machinery	MX05	Currently installed machinery
Existing travel [m]	20	Give existing travel height
New travel [m]	23,5	Give new travel height
Added travel [m]	3,5	Added travel for elevator
New head room height [m]	0	Give new head room height
New pit height [m]	0	Give new pit height
Floor information:		
Extension type	Top/Bottom (Travel incre	Please choose type of extension
Existing landings	3	Give number of served landings according to current floor layout
New landings	1	Give amount of added new served landings
Landings after extension	4	New total amount of served landings after extension
Options:		
Travelling cable, LOC E	<input type="checkbox"/> Check	LOC E option installed
Travelling cable, Optional intercom	<input type="checkbox"/> Check	ISI, CTVI, TEL N or LSC installed
Travelling cable, DOM/SSA**	<input type="checkbox"/> Check	SSA**D, SSA**E, SSA**F or DOM CS installed
MAP will become TOP-1	<input type="checkbox"/> Check	MAP will be located at TOP-1 in new floor layout
Cabinet will become TOP-1	<input type="checkbox"/> Check	Cabinet will be located at TOP-1 in new floor layout
SHL	<input type="checkbox"/> Check	SHL needed
NGSE	<input type="checkbox"/> Check	electrification type is NGSE New shaft bundle will be delivered
FOB	<input type="checkbox"/> Check	LOL, PRL or FET/FEB currently installed
RBO	<input type="checkbox"/> Check	elevator has over TOP-1
Layout update	<input type="checkbox"/> Check	New layout is needed. Please provide .dwg file. MonoSpace 500 layout update not available.
Compensation chain/rope	<input type="checkbox"/> Check	Compensation chain/rope is needed.
Mechanical materials:		
	Price: [€]	Material description:
Hoisting ropes		
OSG rope		
Car guide rails and fishplates		
Counter weight guiderails and fishplates		No CWT safety gear
Brackets		
Compensation chain/rope type	1 x QL10 (travel > 40m)	Type of compensation chain/rope. Please check if needed.
Compensation chain/rope		
Electrification materials:		
Floor electrification		Magnets/oscillator plates + fixings, floor FCB + node cable, shaft trunking and cable for landing door lock
Travelling cable standard 1		
Travelling cable standard 2		No FRD Automatic door
Travelling cable, LOC E with card reader		
Travelling cable, Optional intercom		
Travelling cable, DOM/SSA**		
If MAP will be moved to TOP-1		
If Cabinet will be moved to TOP-1		
SHL		
FOB		
RBO		
Layout update		
Other costs:		
Engineering		
Order handling fee		
TOTAL: [€]		SSE Transfer price FCA distribution center
Related tenders for this upgrade:		

Figure 5. Price calculator.

5.2.3 MonoSpace, MonoSpace 500, MonoSpace 700, TranSys

In MonoSpace, MonoSpace 500, MonoSpace 700 and TranSys sheets specific information for the elevator types can be found. Each elevator type has different materials and prices. In these sheets those can be compared. More specific information about A-process elevator can be found in these sheets and thus choosing the right elevator type is easier.

5.2.4 Hidden and Locked Sheets

Hidden sheets in the pricelist contains mechanical material and electrification material prices. Also rules and calculations are stored in these hidden sheets. Hidden sheets are password protected so that only the pricelist administrator can change prices and add elevator types or new material.

5.3 Process Guideline Documentation

SSE Work instructions for floor extension process are targeted only for the SSE Modernization personnel. Because the work instruction contains information on how to modify and add the prices to the pricelist, it is confidential document and cannot be shown to other organizations. The main content of the instructions are: explanation of the floor extension, clarification of the floor extension a-process and instructions on how to use and alter the pricelist.

SSE Work instructions for order check are used by the customer service. These instructions are updated with notes gathered from customer service personnel. The main content of these instructions are: performing an order check, filling the variable configuration in SAP, informing the order for other teams and performing the pricing.

Pricelist instructions for the frontline are attached to the pricelist. The purpose of the instructions is to help frontline personnel to fill the pricelist correctly. The instructions contain more information about materials and available options. Reason why the instructions are attached to pricelist, is to keep the documentation at minimum and easily available for frontline personnel.

5.3.1 SSE Work Instructions: Floor Extension Process and Pricelist

SSE Work instructions first describes the purpose of documentation which is a description of one of the SSE Modernization processes. Also target group, scope and responsibilities are defined in order to let personnel know if they are allowed to work with this process and know who is responsible for the application of this work instruction.

After purpose and scope of the documentation is described, meaning of floor extension is explained. It is easier for new personnel to understand process flow and different phases if they already have orientated to product. After introduction of product whole floor extension, A-process flow is clarified phase by phase. Floor extension A-process flow consists of twelve different phases, which are divided between frontline, customer service and etc. Floor extension A-process flow can be found in chapter 4.1.

Detailed instructions how to use pricelist contains clarification of every sheet contained in the pricelist as explained in chapter 5.2. Also, instructions on how to change and add rules and prices or add more elevator types are displayed in documentation.

In the end of the documentation approvals and version history is shown. SSE Work instructions contains confidential information and so it is meant to be used only by SSE Modernization personnel. Sending it to any other personnel or party is prohibited.

5.3.2 SSE Work Instructions: Order Check for Floor Extension

As described in chapter 5.3.1, SSE Work instructions first described purpose, target group, scope and responsibilities of the documentation. This documentation is meant to be a guide for SSE Customer service on how to make an order check for floor extension. The documentation for order check did already exist, but customer service personnel had made many notes to their printed versions of the work instructions. The new documentation contains notes and changes gathered from the printed version.

Work instructions starts with description on how to perform an order check for floor extension order. Order form filled by frontline, must be checked and verified that everything needed is mentioned and conflicts does not occur. In order check phase, also SAP order is filled and listing, layout engineering and engineering is informed about order. SAP

order must contain specific information about elevator under update, because this information is used when engineering makes calculations about new needed material.

Filling VC contains instruction on how to fill is needed for elevator update to SAP order. Customer service fills in information about elevator and order. VC contains: elevator and order reference numbers, update type, dates when update is handed over to customer and information about update and about needed material.

Customer service must provide specific information engineering, layout engineering and listing. Also, layout diagrams must be available in PDM for engineering and layout engineering to use. Work instructions contains information on how to contact different teams and what information they need to proceed with floor extension.

In final phase the pricing is instructed. Work instructions describes how to add the prices and freight cost to SAP order. With A-process floor extension, the pricelist is used for pricing. Frontline will calculate price while ordering and send it to customer service, where price is checked. In some cases, floor extension may have been tendered to customer, then customer service will use that price. As in floor extension work instructions, approvals and version history is displayed in the end of documentation.

6 Evaluation of the Results

The first defined goal was to study the floor extension process and make guideline documentation and working instructions about it. The process flow of A-process was clarified and described thoroughly with the help of SSE Modernization personnel and engineers from other departments. The work instructions were made simple enough, so that even new personnel can understand the meaning of floor extension and can use the pricelist to calculate the price for floor extension. Lastly the work instructions were audited by technical team with accepted conclusion.

The second main goal was to find a way to improve the floor extension A-process. The improvement of process was started with a theory level study. The most useful process development method was delimited from various different process development methods, from which DMAIC was selected. With the basic idea of DMAIC, floor extension process was examined. A conclusion was made to expand the scope of A-process pricelist to cover more elevator types and multiple floor extensions. As the prices are calculated by material and added options, customer receives more accurate tenders and has to only pay for the needed materials and options. Feedback from the technical team and pricing team is that the new pricelist itself was successful. With the help of work instructions, it is easy to update and even adding new materials and options can be done easily.

The constrains of the study were ambiguous borderline between A-process and C-process. Many elevator types have both A- and C-process elevators. Some C-process features can be priced with the basic price but they may need some other material, which demands more engineering. In that case pricelist is no longer valid.

Recommendation on future development could be adding even more elevator types and options to the pricelist. In addition, the pricelist could contain floor extension order form as one of the pricelist sheets, this way frontline personnel would only need to send only one file to SSE Modernization team.

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