TALLINNA TEHNIKAÜLIKOOL
TALLINN UNIVERSITY OF TECHNOLOGY

Industrial Engineering and Management

PROCESS DEVELOPMENT AND DIGITALIZATION AT STEELDOOR OÜ

PROTSESSIDE ARENDAMINE JA DIGITALISEERIMINE STEELDOOR OÜ NÄITEL

MASTER THESIS

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AUTHOR'S DECLARATION

Hereby I declare, that I have written this thesis independently.
No academic degree has been applied for based on this material. All works, major viewpoints and data of the other authors used in this thesis have been referenced.

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Industrial Engineering and Management

THESIS TASK

Student: Karl Kerdt 163415MARM

Study programme: MARM06/15, Industrial Engineering and Management

Supervisor(s): Tauno Otto, Professor

Thesis topic:

Process development and digitalization at Steeldoor OÜ

Protsesside arendamine ja digitaliseerimine Steeldoor OÜ näitel

Thesis main objectives:

1. Conduct an audit that gives an overview of the current situation of the company
2. Development of a customized information system for sales process
3. Improving and streamlining processes at the company via digitalization and automatization

Thesis tasks and time schedule:

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2.	Literature overview	18.04.19
3.	Company digitalization overview and processes mapping	30.04.19
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CONTENTS

PREFACE

This thesis is initiated by Karl Kerdt, who is working in Steeldoor OÜ as an manufacturing and development engineer. Most of the work was conducted at the company office and manufacturing plant. The supervision from the university was done by professor Tauno Otto.

I am thankful to everyone at Steeldoor OÜ, who helped to collect data and development processes. Furthermore, I would like to thank my supervisor Tauno Otto and other lecturers who have influenced the outcome of this thesis. I would like to specially thank my friends, members of the "Spordi- ja sõprusselts Marmeelads" and my partner for inspiring and pushing me towards the completion of this thesis.

List of abbreviations and symbols

API – Application programming interface

B2B – business to business

B2C – business to customer

CNC – computer numerical control

ETO – Engineered-to-order

IIoT – Industrial Internet of things

JIT – just in time

MTO – made to order

VBA – Visual Basic for Applications

INTRODUCTION

Manufacturing is driven by global competition and therefore continuously changing market requests fast adaptation to company processes is vital. Those requirements can be met via developments in manufacturing technology. Increasing efficiency in the value chain is the only way to survive in the tight competition, for example via deploying digital improvements.

Digitalizing manufacturing means utilizing new technologies and processes in a way, that the long-term overall costs will decrease, profits will rise, and value added by manufacturing processes will increase. [1]

The main objective of this thesis is to analyse, optimize and develop new ways to redirect and share the responsibilities and work load between the employees and create new ways for problem solutions by digitalizing processes. This way employees can focus on more important tasks and not waste time and money on processes that can be automated.

Steeldoor OÜ is a small project-based steel product manufacturing company located in Tallinn, Estonia. Company has a selection of standardized products but also manufactures engineered-to-order steel constructions. The general overview of the company is presented in chapter 1.

The chapter 2 is focused on the conducted literature review on the topic of digitalization of manufacturing company. In chapter two subjects like Industry 4.0, IIoT and how to perform a digitalization audit of a manufacturing company are discussed. Furthermore, the reasons of the need for digitalization are analysed and companies' attitude towards digitalization and automatization of their processes is examined.

The goal of the thesis is to analyse the company’s processes, formulate a development plan using digitalization and then implement the digitalization solutions in the company and as a result measure the impact. One of the most important decision is to select which processes should be combined, automated and streamlined. Chapter 3 outlines the audit process, proposed development plan and the outcomes of implemented solutions.

1. OVERVIEW OF STEELDOOR OÜ

Steeldoor OÜ is a small metal manufacturing company founded in May 2017 and it is a privately held company and based on Estonian equity. Company is specialized in manufacturing different steel products for construction, metal doors etc. Company has a selection of standard products and product lines such as different doors, roofing solutions and handrail solutions. Chapter 1.2 gives an overview of company's products. The manufacturing is project based and the company revenue comes mostly from Estonian market. In 2018 revenue was 448,000 euros. Figure 1.1 shows the ratio of the sales, where 96% were from business to business (B2B) and 4% was business to customer (B2C). Most of the B2B revenue comes from sub-contracting for construction and civil-engineering companies. [2]

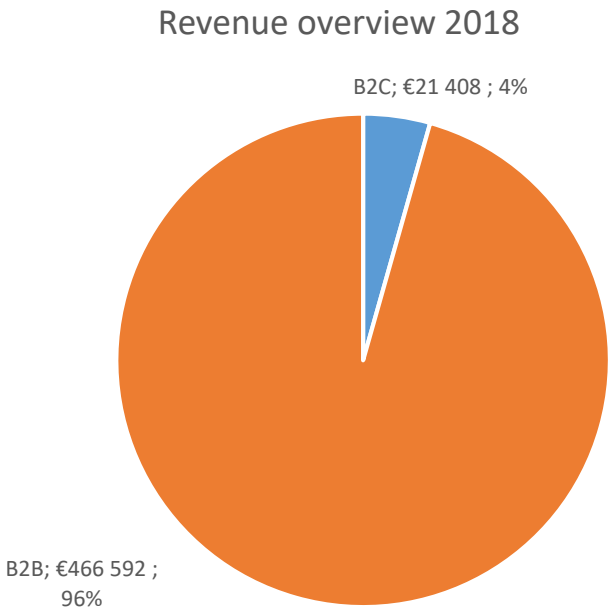

Figure 1.1 Steeldoor OÜ distribution of 2018 revenue [2]

The manufacturing facility is located near Tallinn in Laagri. This location grants great logistical solutions and is close to main suppliers. Steeldoor OÜ has been certified for EN 1090-2:2008 and EVS-EN ISO 3834-3 since June 2018.

In current situation the company faces difficulties in many vital processes that keep the company running. For example, order processing, order negotiating, production planning, production supervision, quality control, sales, marketing and etc. Tackling those problems is a great challenge. Only way to solve those issues is systematically categorize them and start from the most important

and crucial processes. The company does not have unique problems that require complex solutions, nevertheless, there are many issues that have to be looked as a whole, analysed and found universal and existing solutions.

Solving the problems require cooperation from the whole team that works in the company and outsourcing knowledge from consultants and the IT development or IT partner. This also means, that the owners of the company must be onboard with the developments and be ready to invest in this process. The thesis main focus is to analyse and map the problems, prioritize the problems then propose and find solutions for those problems. Ideally this thesis will provide a comprehensive framework to develop a customized IT system to provide control over the company processes or at least automate them. The minimum viable outcome is a project and execution plan for an automated purchase order system that is able to calculate prices for standardized products and services the company offers, like doors, roofing solutions, installation etc.

The biggest constraints will be human and financial resources. The company has only three employees who are able to contribute to the development process and there isn't much surplus financial resource for the fulfilment of the project. All costs related with the development have to be considered, reasoned and validated.

The company has 16 employees out of which 5 are office workers and 9 are manufacturing employees and 2 installers. Overview of the structure is shown in Figure 1.2. The board consists of two people out of which one is the owner and the other the CEO, in everyday tasks an assistant helps the CEO.

The CEO is responsible for most of the tasks in the company like sales, manufacturing, project management, short- and long-term planning. The accounting, sales department, engineering department and quality control and development department report directly to the CEO. The problem with this kind of organization structure is that one person, the CEO, is responsible for multiple different fields. In a bigger company these responsibilities would be divided to different subordinates.

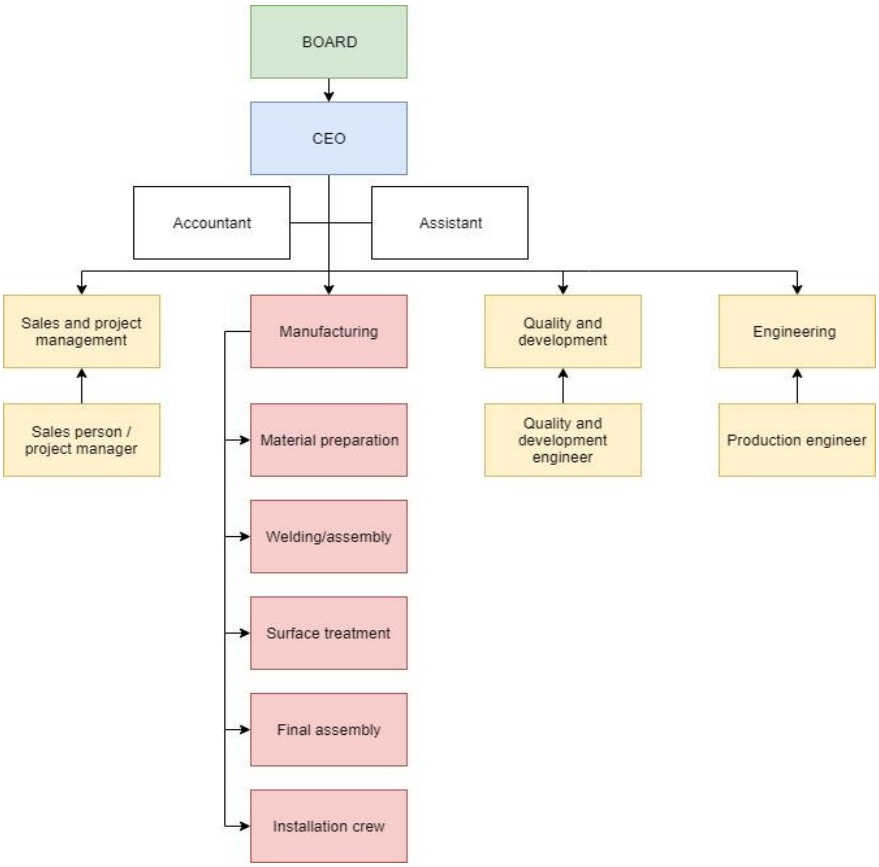

Figure 1.2 structure of the company [27]

To give a better overview of the current responsibilities and main processes in the organization a RACI matrix diagram is composed. A RACI chart is a matrix of all the activities or decision-making authorities undertaken in an organization set against all the people or roles. At each intersection of activity and role it is possible to assign somebody responsible, accountable, consulted or informed for that activity or decision. [3] See appendix 2 for the company RACI matrix.

The main reason of this thesis is to analyse, optimize and develop new ways to redirect and ease the responsibilities and work load between the people and create new ways to problem solutions by digitalizing processes. This way employees can focus on other more important tasks and not waste time and money on processes that can be automated.

1.1 Manufacturing capability overview

Manufacturing facility is located near Tallinn, in Laagri. It is 15 kilometers from the city center and next to Tallinn ring road. Thanks to highly developed highway system the Saue Logistics and Industrial park is 5 minutes away and Rae Logistics and Industrial park is 15 minutes away.

The company handles most of the processing in house and only a small portion is done via sub-contracting. The company has band saw and guillotine for cutting the material, two bending presses, five MIG/MAG welding stations. The company does its own powder coating and sometimes wet painting surface treatment. Also, the assembly for our products is done inhouse and the final installation is handled by the companies own team of installers. Processes like laser and plasma cutting, CNC machining and turning, zinc coating and profile bending are done by subcontractors. This way most of the value stream is controlled by the company. The company has a horizontal integration which means that the company do not take over different level operations of the value chain in the industry. [4]

Steeldoor OÜ does most of the sub-contracting for construction companies. The projects and products vary in size, complexity and quantity. For steel construction projects the production planning is based on the just in time (JIT) method and manufacturing type in mostly batch and job-shop type. This means projects will vary in volume and variety. There can be only one custom made staircase or a custom engineered advertisement billboard, 10 identical metal constructions or a batch of 60 identical balconies, in that case the manufacturing process is jobbing. The classification of different production systems is presented in Figure 1.3.

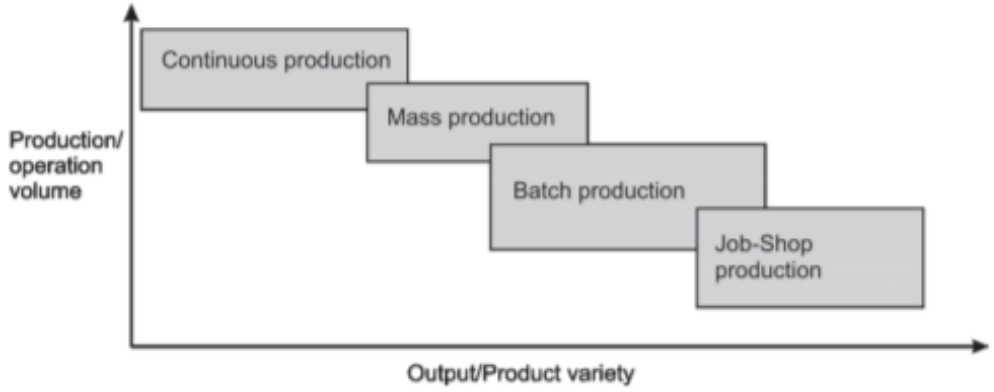

Figure 1.3 Classification of production systems [5]

For the company's standard products like doors and canopies the production planning is based on the made to order (MTO) method and manufacturing type in mostly job-shop. Because in a single project there can be 5 different doors but also 10 identical doors. When manufacturing canopies and roofing solutions the project will usually only involve one product.

1.2 Overview of products

The company has designated its production in to four different categories – doors, steel constructions, canopies and barriers. Those categories have many different sub-categories. The company has products engineered-to-stock in all main categories and is able to adapt existing engineering solutions to client needs.

Doors and partitions are one of the main products we produce in this company. Table 1.1 gives an overview of the subcategories of produced doors. For most categories the company has engineered-to-stock solutions which are adapted to client's needs. For exterior, interior, industrial and sliding door solutions the company has its own frame and door sheet designs that are then engineered to order. Figure 1.4 shows some examples of produced doors. Components like frame details are premade and ready to be processed when the order is given but the door sheets are specially made when the production order is given.

Table 1.1 List of door subcategories [6]

1.	Interior doors
2.	Exterior doors
3.	Fireproof doors
4.	Profile doors and partitions
5.	Sliding door
6.	Industrial doors
7.	Partitions
8.	Custom engineered-to-order doors

For profile system doors and partitions the company uses Forster products. With this system the planning and production is simpler than having own products, because all the production processes and steps have been dictated by Forster. They have also engineered all the needed templates and clamps needed for welding. Also, they offer free of charge engineering, drawing and documentation service for custom engineered-to-order (ETO) service and they will produce special details for it also, like bent profile etc.

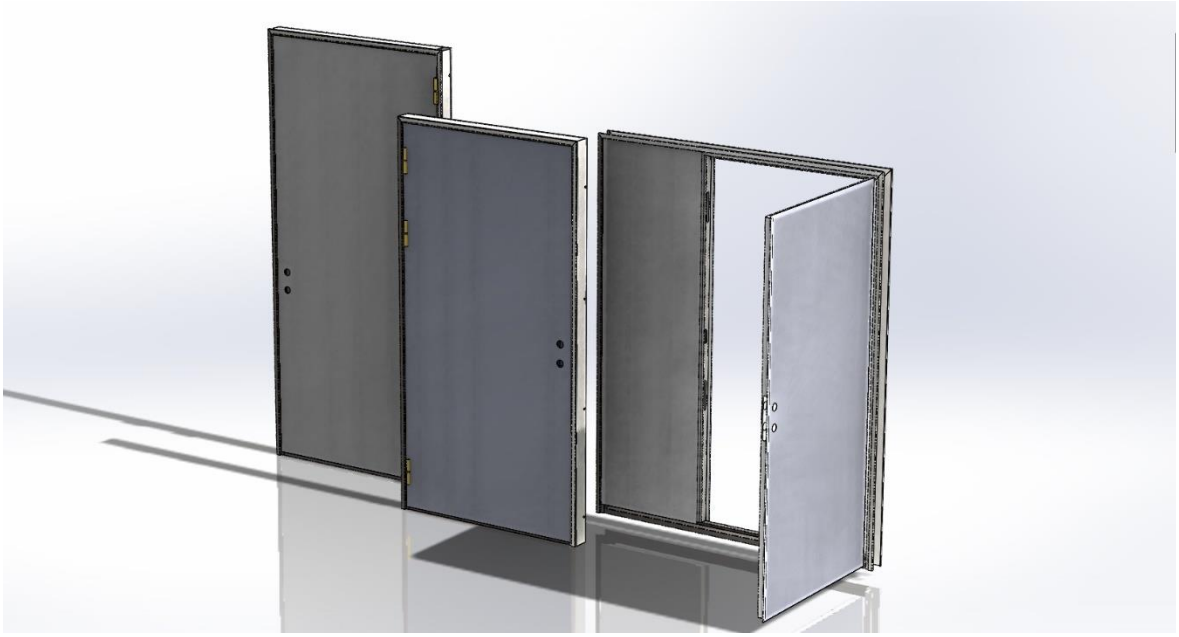

Figure 1.4 Example of produced metal doors [6]

Sliding, industrial and custom ETO doors could be taken as a one whole group of products, because usually there has been a previous project onto which the new products design can be based. Company has produced doors for industrial building varying in sizes from small hatches in 300x300 mm to massive four-part folding doors measuring 4990x5300 mm.

Steel constructions (civil engineering products) make up the second product category. Table 1.2 list the subcategories for this product group. This category consists mostly of subcontracting projects for construction companies in civil engineering sector. In this group the client will provide their own drawings made by architects and civil engineers and the company will generate the needed manufacturing drawings from those. Steeldoor OÜ is certified for EN 1090-2:2008 which means the company can issue CE- markings for steel structures.

Table 1.2 Metal construction subcategories [7]

1.	Staircases and handrails
2.	Billboards and advertisement banners
3.	Platforms
4.	Ramps

In this category the manufacturing process can vary between in length, complexity and quantity. For example, in this category products may vary from small stairs to 12-meter-high and 3-meter-wide advertisement banners with LED screens that weigh up to 10 tons. On the last example, Steeldoor OÜ manufactured and installed the whole product, offering the client full service from manufacturing, building the foundation and also did the landscaping afterwards. That kind of full service is highly appreciated by clients and a good way to ensure, that the client will return to the company for further projects in the future. On Figure 1.5 a range of different stair designs is presented that the company has manufactured.

In the case of retrofitting platforms, handrails, ramps etc. to existing buildings and constructions, the company offers the same full service from initial sketches, measurement, design, manufacturing and installing.

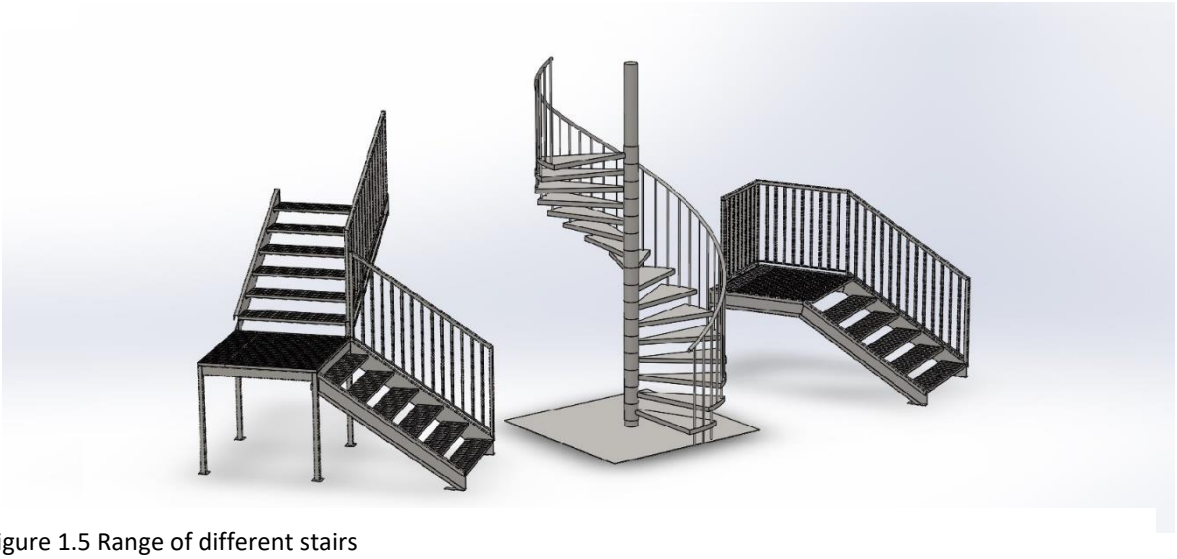

Figure 1.5 Range of different stairs

Canopies and roofing in this product category the company has its own developed standardized products and can provide a wide range of solutions but is also open to design and ready to create totally new products or manufacture a product that has been designed by architects. The Table 1.3

lists the subcategories in this product group. The need for those kind of roofing solutions comes from the requirement, that apartment building have to have their bins covered and contained in those buildings.

Table 1.3 Canopies and roofing subcategories [8]

1.	Standardized roofing for garbage bins storage
2.	Custom engineered-to-order roofing
3.	Canopies
4.	Bus stops

Standardized roofing for garbage bins the company has developed a module system that allows to manufacture many variants of the similar product quickly and efficiently. The client can choose the size, colour of the frame, facade materials and colours, roof colour, where the door is placed and how it opens. The modular design is derived from the components and raw material used to manufacture the product.

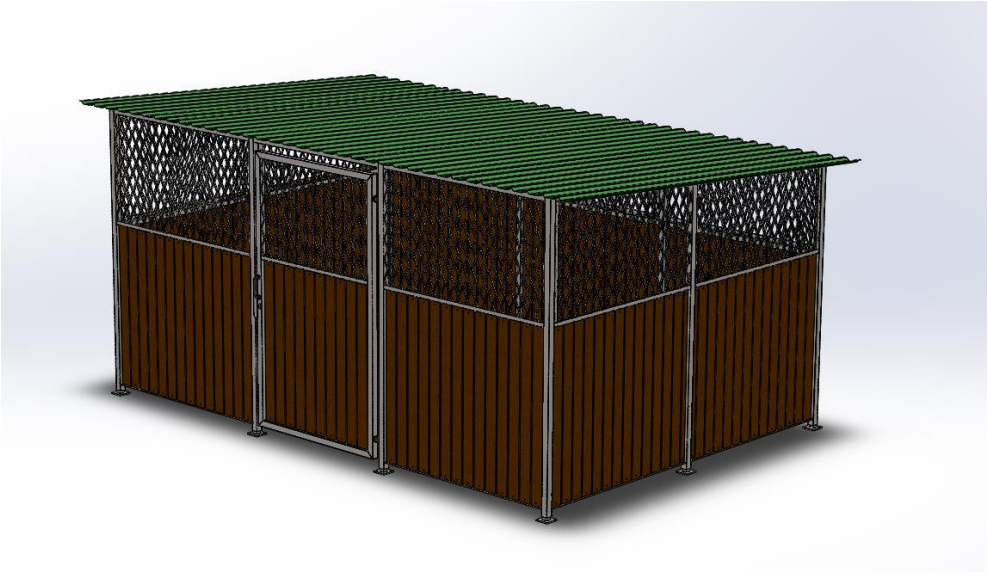

Figure 1.6 4400 x 3100mm standard sized roofing

Company manufactures two sizes of standardized roofing for garbage bins. Firstly, 4400 x 3100 mm that fit 6 bins and secondly, 2600 x 3100 mm that fits 4 bins. On Figure 1.6 solution is shown that features wooden façade. The frame is welded together from 50x50 square and 40x50 U-profile steel, the bottom part of the building can be covered in profiled sheet metal or wood. The upperpart

is usually welded mesh. The whole construction is zinc coated and powder coated to provide the best weather protection.

The company has also done one-of custom engineered-to-order roofing, for garbage bins storage, bike parking etc. Usually for those products the client will already have the architectural drawings and the company will just have to manufacture and install the products. The roofing for garbage bins shown in Figure 1.7 were manufactured for an apartment building located near Tallinn University of Technology and was fitted with LED lightning for design. That usually means creating the engineering solutions for manufacturing the product. Those kinds of projects are really welcomed by the company because they provide a challenge to the team and have a higher revenue and profit than standardized solutions. The problem with projects in this category might be the balance between manufacturing part and general construction part. When the design will utilize a somewhat conventional metal structure and only the facade is an unconventional design the project can be profitable and reasonable to execute. But some requests from clients have drifted too far away from metal fabrication plus manufacturing towards projects where metal structure and manufacturing part is minimal and most of the product consists of other building materials.

Figure 1.7 Custom made-to-order roofing for garbage bins [8]

Company also offers a selection of canopies and bus stops. For bus stops there are a few designs ETO-d and if needed those can be modified. The same goes for canopies, there are a few designs.

Some of those designs are modular so those will be easier to adapt to client's needs, like car parking canopies and bike parking canopies.

Barriers in this segment the products are usually designed by architects and civil engineers and most of the manufacturing is just sub-contracting. The Table 1.4 lists subcategories of products in the barrier type product group. The company also provides full service to clients from design, manufacturing, removal of the old fence to installation of the new one.

Table 1.4 Subcategories of barrier type products [9]

1.	Fences
2.	Balconies
3.	Barriers

In the case of balconies, the project almost is always sub-contracting for a civil construction company. In that case the engineering and drawings come from the client and only the manufacturing and installation is provided by the company. On Figure 1.8 a CAD model of a balcony is shown that was produces for a real estate development in Tallinn.

Figure 1.8 Balcony for an apartment development in Tallinn [9]

For barriers, the projects can vary from sub-contracting to new buildings, retrofitting existing ones and creating totally new solutions for clients. In those cases, most of the engineering part is dictated

by building norms and the company will only provide the manufacturing and installation. In the last year the company has produced many staircase barriers for newly developed apartment buildings in Tallinn.

Figure 1.9 Gate assembly for a fence [9]

To conclude the company's product portfolio is diverse and varied. For most projects the manufacturing type is make-to-order so the material and purchased products stock size is quite minimal as all the necessary materials and components are ordered in a just in time ethos. The company tries to only focus on projects that need more tailor-made and specialized solutions, because those with those projects the value-added component is greater than the material resale one as it might happen in many cases in the steel construction manufacturing sector.

1.3 Manufacturing facility overview

The factory buildings are over 30 years old and have been renovated and enlarged from time to time. The overall area of the factory is 1036 square meters also outside there is a raw material and storage area of 1000 square meters. This is also good area to store semi-finished products and product that must be transported somewhere.

The Figure 1.10 show the manufacturing plant floorplan. Currently the area marked in green is for general movement and makes up around 30% of the whole area. Material preparation areas take up 211 m² and consist of two bandsaws, 3000 mm guillotine, and two bending machines in width of 3000 mm. There are five dedicated welding tables and the area assigned for those is 110 m² but depending on a project those areas can usually move, and tables change locations. Designated inside storage area is around 145 m². This is the centre part of the building and this room is used to store raw material, sub-assemblies that will move forward to surface treatment also are ready to transport zincing. Next area from there is surface treatment and powder coating. It consists of preparation and cleaning station, powder coating station and the oven, also the room where the cured products are taken out of the oven and stored to be ready for assembly is counted under the surface treatment. The last part in the manufacturing process is assembly and packing, this area is 92 m². There is a 410 m² storage building located next the factory building that is used to store raw material and also finished products for a longer period of time, this room is also used for the production of very large assemblies like 12-meter-long construction beams.

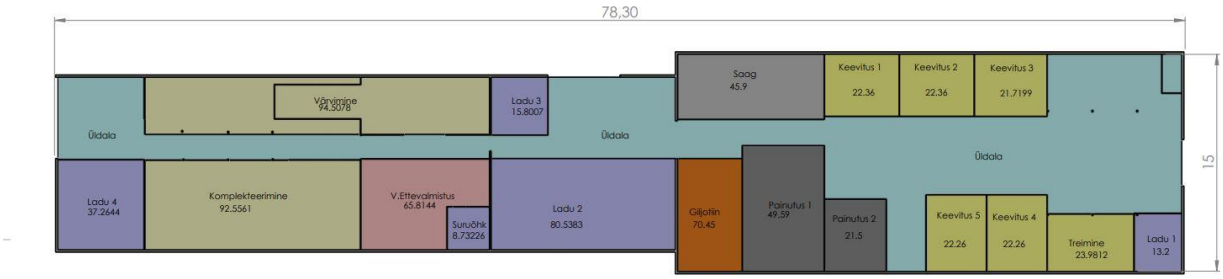

Figure 1.10 Manufacturing facility plan. The yellow areas are welding stations, purple areas are warehouse and buffer areas, light gray area is band saw station, dark grey areas are bending presses, orange are is guillotine, red area is surface preparation, light green areas are surface treatment and assembly areas, the green area is for general movement.

2. LITERATURE OVERVIEW ON DIGITLIZATION

Digitalization is the use of digital technologies to change a business model and provide new revenue and value-producing opportunities. [10] Companies leadership should work on growth and development on a daily basis but usually most of the effort goes on every day running tasks, which means that there usually is not much time left to deal with growth and development issues. Development must be tackled systematically and thus will reveal what steps and in which order are needed to achieve the goals.

The initiative for change must come from shareholders and leadership and has to be carried out by a competent team. The more work done before hand and a better base is constructed for the developments the bigger the potential that the goals will be met. The team should consist of people who can see the bigger picture, possess certain skills and also who are responsible for the growth. This means that the team will usually consist of many different employees from different departments and if needed outsourced consultants.

The first step in company's digitalization process should be a thorough audit that will map all the processes. The three main topics the audit should consist are following: collecting base data, analysing base data and generating a development plan. Basically, change will come from asking the right questions and finding answers to those questions. Through this mapping process most of the needs should be discovered and a clear picture of next steps and needed tools will develop. This process will be concluded by creating a comprehensive plan and a potential timetable for the digitalization process. It is important to first examine the existing situation. This will give the company a benchmark, against which it is possible to compare new results. Those metrics will give a clear overview of effect of the implemented developments and tools. [11]

When creating the development plan, it is important to categorize and prioritize the processes. This is very important because it will designate the sequence of the processes. Also, in this phase the developments can be categorized by capability of the company. Some ideas might be too big for the company and on the other hand some might not fit in other ways or the investment versus outcome will not be of value. The rule of thumb is to first implement developments that are the simplest to execute and have the most impact like implementing simple routines and habits.

Collecting the data is a really important part of the process. The data has to be valid and complete. Sometimes the data collected might not give a correct overview of the situation or give a distorted overview. This will cause problems down the line.

A survey conducted by the Ministry of economic affairs and communications gives an overview of the digitalization situation in Estonian manufacturing sector. Figure 2.1 shows how important manufacturing companies find using digital technologies currently.

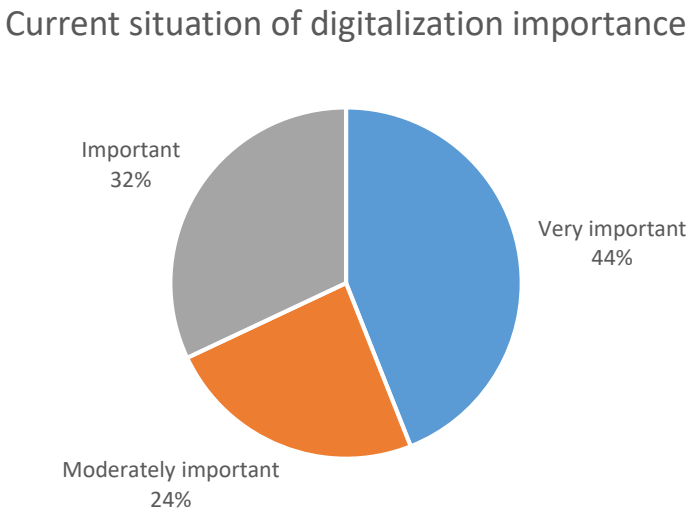

Figure 2.1 Current situation of manufacturing digitalization importance in Estonia according to Ministry of economic affairs and communications survey [9]

The Figure 2.2 shows how important it is in 5-year perspective. From this we can conclude that in long term perspective companies see, that using and implementing digital technologies is very important. Companies understand that digitalization gives them stronger competitive advantage and help to manage their resources better. Furthermore, in short-term view companies do not consider digitalization as very important, however understand that digitalization is important in the long-term perspective. [12]

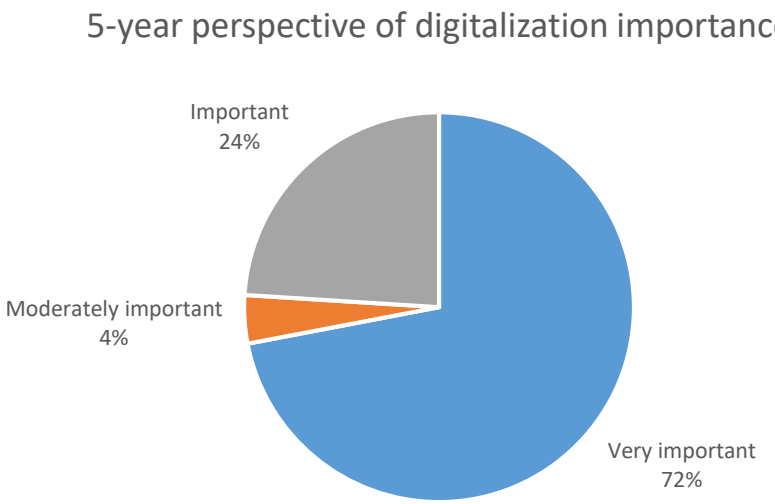

Figure 2.2 Five-year perspective of manufacturing digitalization importance in Estonia according to Ministry of economic affairs and communications survey [9]

In recent years the labour costs in Estonia have risen and make up a big part of the company's turnover. In 2018 the average salary in the manufacturing sector rose 6,5% to 1249 euros [13]. The average salary rose in manufacturing sector in 2018 presented on Figure 2.3. This in turn has reduced the profits and lowered the overall investments to the companies. It is crucial to stabilize and develop competitiveness through investing and implementing new technologies and develop companies' products, processes and employees.

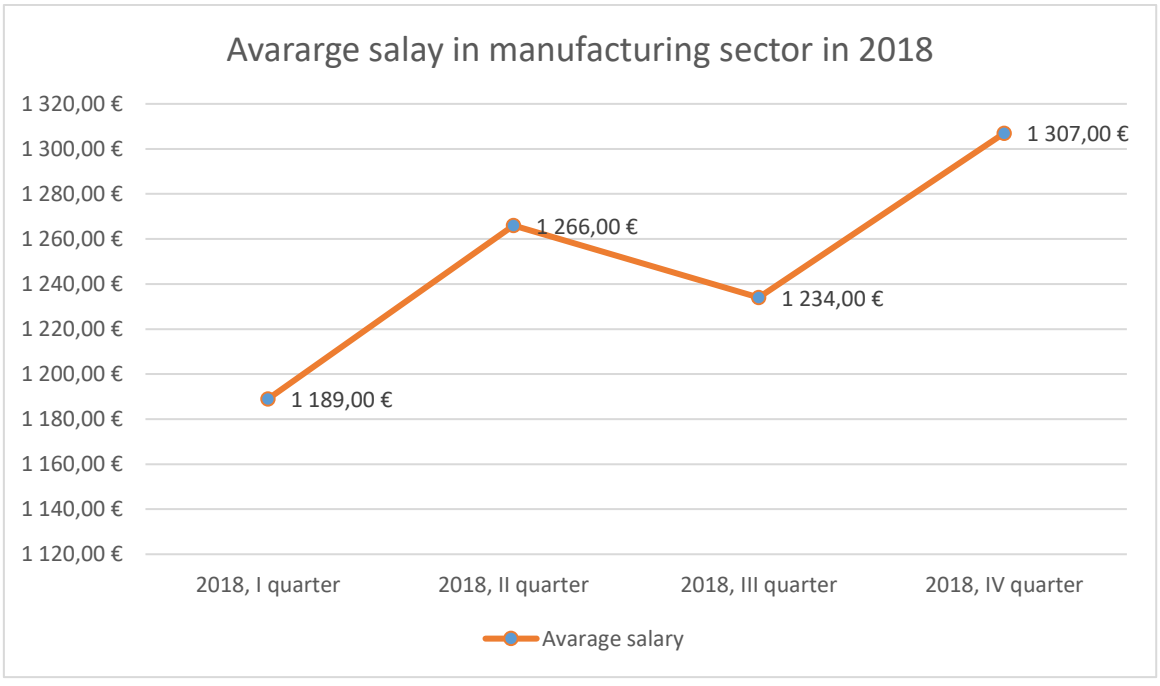

Figure 2.3 Average salary in manufacturing sector according to Estonian Statistics in 2018

Manufacturing sector companies' profits have decreased in the last few years due to many different circumstances, the investments in technologies, developments and new machinery also have declined. All investments are calculated thoroughly, and companies cannot allow themselves to make wrong decisions, because those mistakes might destroy the company financially.

The initiative to digitalize the company is caused by the lack of skilled workforce in most manufacturing sectors in Estonia. Also, to maximize the value added to the product, cut down operating costs, decrease waste in production and use new technologies to control and predict manufacturing.

In a recent survey conducted by EAS that included 300 manufacturing companies from Estonia revealed that only 23.9% of those companies have digitalized their processes. Most of those companies were medium and large sized companies. The leading sector in digitalization and automatization is food manufacturing, which is followed by wood, paper and furniture manufacturing companies where 1/3 of the interviewed companies have digitalized over 60% of their processes. [14]

Digitalizing manufacturing means utilizing technologies, implementing processes and integrating machinery into integrated systems in a way, that the long-term overall costs will decrease, profits will rise, and value added by manufacturing processes will increase. [1]

It was revealed that in metal and machinery manufacturing sector 25% of companies have digitalized around 40% of their processes. The lowest percent of digitalization is in clothing and textile manufacturing.

The survey also revealed that frequently the reason for low digitalization in companies is that, the leadership does not feel the reason for development or thinks that all the available developments have already been finalized and there is nothing more left to develop. But in reality, there is always processes to develop and streamline. On many occasions manufacturing companies only think about manufacturing processes but in industry 4.0 mindset there is no differentiation between manufacturing, sales, management, logistics processes all those areas are summarized as processes. The survey concludes that 52% of the companies examined declared that they will start or continue ongoing development in the next year. [14]

2.1 Industry 4.0

Industry 4.0 is an approach to achieve production results via development and advancements with new technologies. Industry 4.0 is regarded as the fourth industrial revolution that means the development is based on digitalization. [15]

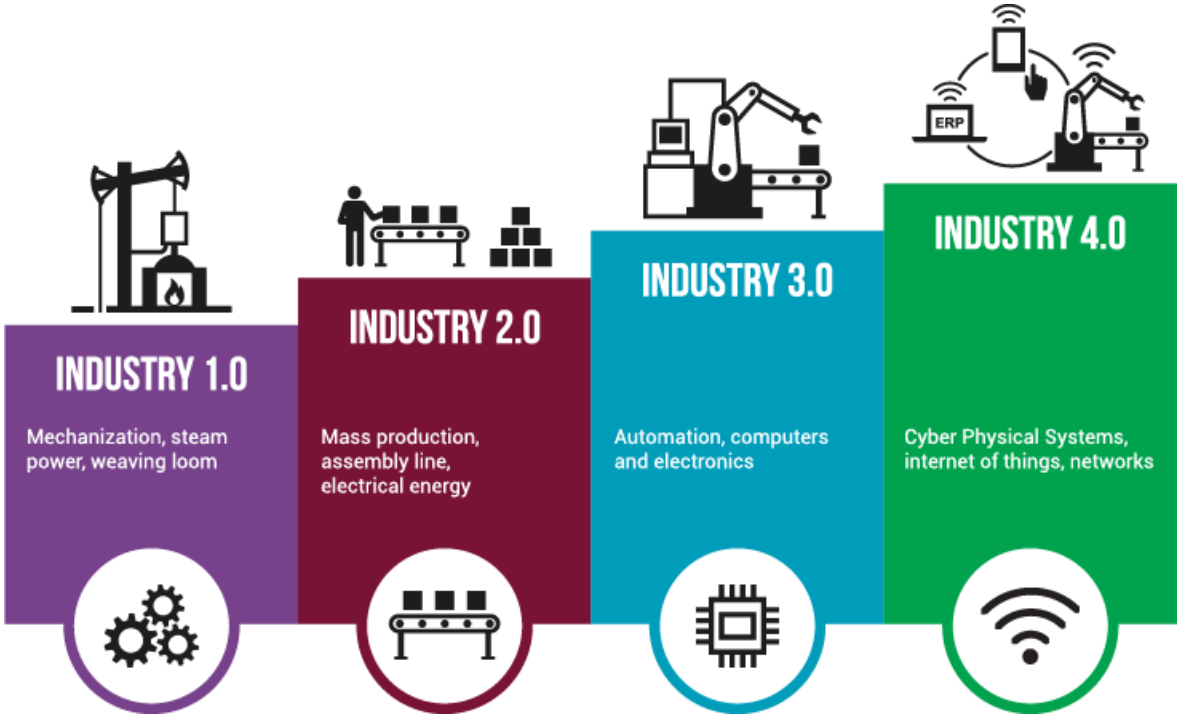

Figure 2.4 Development of industry [26]

The first industrial revolution started in Great Britain when the jobs moved from farming to factory production with the help on steam power. The second industrial revolution spanned from the 1850s to the 1910s and include early electrification of factories and first steps of mass production. The third industrial revolution is considered too took place on the beginning of 1960s when factories started change from analog technology to digitally controlled technologies. [15] The fourth industrial revolution combines cyber-physical systems, internet of things, artificial intelligence to create smart production.

Since 2011 industry 4.0 has become top priority for industrial development. However, a major shortcoming is that thought the subject is widely researched the results are still way to general to put in practice, or to detail and focused on special industry processes and cannot be implemented in others. This means there is still a big gap between academy and real-world practice. [16]

Industry 4.0 describes organization of production processes based on technology and devices communicating autonomously with each other along the value chain. As a result, manufacturing

systems will be seamlessly integrated with business processes and connected to value networks that can be managed in real time. [15]

The main concept of Industry 4.0 is a series of disruptive innovations in production resulting in a significantly higher productivity. This means intelligent factories where every part of the production and value chain has been developed and automated.

The rapid development also creates obstacles for companies, specially SME sized manufacturing companies. Large manufacturing enterprises account for more 50% of total value added in the European union and this is because workers in large enterprises were 86% more productive than workers in SMEs. The difficulties are lack of awareness about new and advanced technologies and the benefits of implementing those in production processes. Financial and human resources capacity problems like the ability to invest in new technologies or the availability of highly skilled staff who are capable of integrating advanced production processes and machinery into manufacturing processes. [15]

2.2 Industrial internet of things

The Industrial Internet of Things (IIoT) – as a subset of the larger Internet of Things - focuses on the specialized requirements of industrial applications in various industry segments such as manufacturing, oil and gas, and utilities. Hence, IIoT refers to the usage of IoT in industrial settings. IIoT systems are mainly set up to harvest, store and structure data in a way that they can be managed and analysed. [17] The Figure 2.5 shows the value chain of IIoT and the technologies involved.

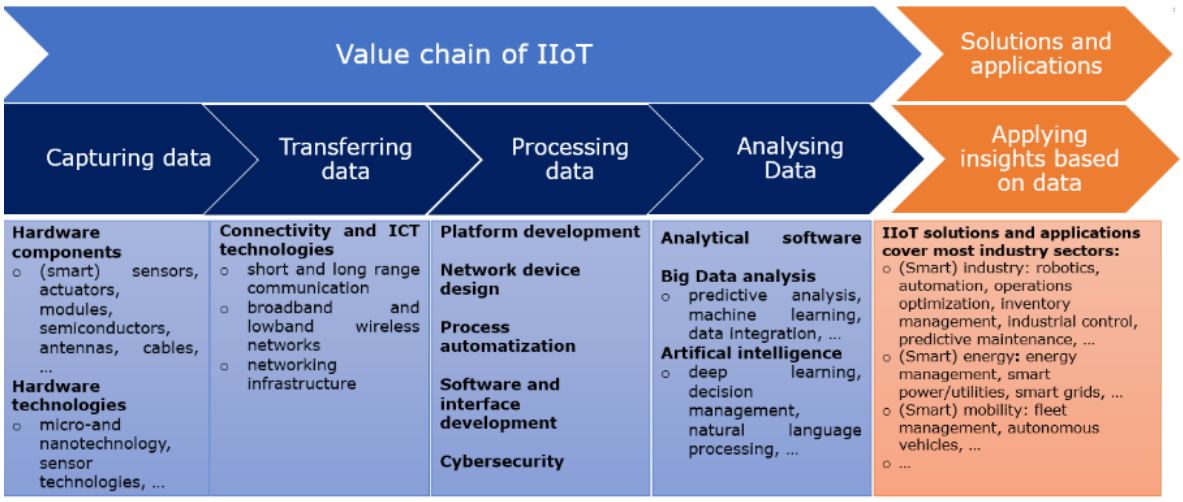

Figure 2.5 Value chain of IIoT [15]

First step combines the tools and technologies to capture data. The hardware typically consists of sensors, modules, cables etc. that capture data. Sensors are devices that detect and measure relevant info. The second step consist of technologies that transfer the data between objects. Usually a network, it can be wired or wireless. There are many ways to transfer data like 4G, RFID, NFC, Bluetooth etc. In this block security is very important. The third part consists on processing the data collected by the sensors and transforming it into formats that can be analysed. The fourth step of the value chain of IIoT is the part where most of the value is created. How the data is analysed and what decisions can be based on that data. This step is also where artificial intelligence is used to analyse vast amounts of data. [17]

2.3 Approach to creating the digitalization concept

Creating the digitalization concept or project plan is a five-step process. This procedure is illustrated in Figure 2.6 and starts with preparation. In this stage, information is gathered to start the ideas of digitalization. [11]

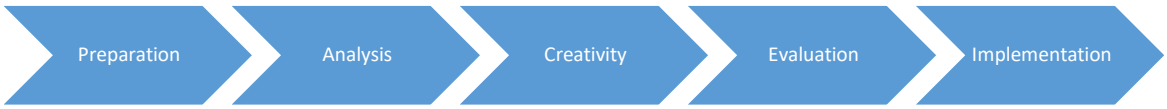

Figure 2.6 Structure of the process

- Preparation phase will give an in-depth overview of the company processes in business and production. It is important to create common understanding of the subject of digitalization within the company;
- Analysis phase aims to identify the problems and current situation. In this step a starting basis for later idea generation is made;
- Creativity phase aim is the generation of new ideas and concepts of new business models. The implementation will be based on the fundamentals created in the analysis phase. This part consists of two steps. The first part is to identify and collect initial ideas. Then those ideas must be discussed and further developed in the second part. In the end of this phase ideas should be developed into concepts;
- Evaluation phase objective is to classify the concepts potential in the companies plan to digitalization. The aim is to identify high potential ideas that will gain a competitive edge;
- Implementation phase draws up the generated proposals and presents the ideas to the management. This way the results can be transferred into practical implementation; [11]

3. IMPLEMENTATION OF DIGITALIZATION

The development towards digitalization starts with assembling a team who will be responsible for the preliminary audit of the company. The next step is to generate ideas and plan how to digitalize and streamline processes that will make the company more profitable and gain a competitive edge against competition.

3.1 Project plan to digitalize and develop the company

The company set out to find new solutions to problems that are crippling the company and further develop processes that were already in use. The first step in digitalization and development process for the company was to compose a comprehensive overview of the situation, that will conclude all the processes, machinery, human resources, financial resources etc. This comprehensive prospect will give a detailed understanding and will help to categorize and direct the next steps in the process.

The chapter gives and overview of the main processes and corresponding software usage in the company. From this we can conclude that digitalization was very low. Some processes were done using computer programs but those were only vital things that cannot be done without a computer.

It was crucial to then select what processes out of those can be combined, automated and streamlined. And find out what were value adding processes, not-value adding but necessary processes and which were non-value adding or waste.

The first group of processes looked at was sales. The results are presented in the Table 3.1, from this it was concluded that no centralized system was used and there was no real-time overview of the progress of sales.

Table 3.1 Company sales processes overview

Process	Sub-process	Software	Comment	Problems
Sales	Communications with the client	Zoho Freeware email application	Company used a free email service host.	Regular server down time and mail box size was limited to only 500mb per user. No way to save and host project materials and files.
	Order evaluation	Word, excel	Employees that were related to the sales process all dealt with their processes separately and no cooperation was done.	There was now unified process how the incoming orders were handled or who was responsible for it.
	Creating the tender	Word, excel	Some employees used old excel worksheets that had year old material prices and there was no unified tender template and pricing system	No centrally developed and updated pricing system and formal ways to send out up to date tenders.
	Management of the sales processes	Word, excel	No system was used to give an overview of ongoing sales.	Management had no overview of what sales were pending and in what state various projects were.

As there was no project management solution it meant the planning phase was also in chaos. There was no overview of the material warehouse, material resources planning was usually done on paper or sometimes in excel, which depended on who was the responsible sales representative or project manager. The Table 3.2 presents the processes audited.

Table 3.2 Planning process overview

Process	Sub-process	Software	Comment	Problems
Planning	Manufacturing recourses planning	None	Planning was done on paper and was organized on a daily basis. Order documents were placed in different folders to give an overview	There was no overview of manufacturing processes and how far the products were in manufacturing flow
	Material resources planning	Excel	An excel worksheet was used to calculate the material needs for projects.	No overview of stock size and content.
	Sub-contracting quotations	Freeware email application	Information was gathered via email or by calls.	No system to collect and compare competing offers

The drawings and manufacturing processes are combined into one group. This is because those are closely related and intervened in the real-world application. The processes are described in Table 3.3. In some cases, the product drawings have to be made for the price tender. It was clear that drawing process had to be updated. The drawing used for door manufacturing is shown in appendix 1, this caused a lot of problems and because it combined all the information on one single paper.

Table 3.3 Drawing and manufacturing process overview

Process	**Sub-process**	**Software**	**Comment**	**Problems**
Design and drawings	Creating drawings	Solid works, specialized 2D drawing software for doors	Two not cooperating software's were in use.	Some products were drawn and designed in SolidWorks 2015 but all door related drawings were created in a software developed in the beginning of year 2000 had close to none functionality. This created many problems in manufacturing.
	Creating Bill of materials (BOM)	Solid works + excel, by hand		Products that were designed in SW15 had BOMs automatically created and if needed modified in excel. But the BOMs for doors were created by hand on a piece of paper.
Manufacturing		None	There was no software in use. Manufacturing drawings were printed out and handed to the employees.	Total chaos in production control.

All the supporting processes are presented in the Table 3.4. While there were not used any digital solutions and therefore there were no data creation or collection, there was only manual work-time reporting without equipment maintenance overview.

Table 3.4 Support processes overview

Process	**Sub-process**	**Software**	**Comment**	**Problems**
Quality control		Word, excel	All reporting was done my hand and on paper	In reality there was no quality control
Finance		Smartbooks finance software		No centralized system
Equipment maintenance		None	No actions were done for any equipment maintenance	No overview of owned machines, no records of maintenance and repair work.
Human resources		none	All reporting was done my hand and on paper	Employees were reporting their workhours by hand written paper. This caused a lot of problems in information inaccuracy.
Installation		None	All reporting was done my hand and on paper	No planning of work ahead and no batching objects in similar areas

After mapping the company processes the info was visualized into a model. The Figure 3.1 describes the whole overall process flow of the company. The processes are divided into three major groups. Product and client include the processes of communications with the client and defining the product. Company main processes like marketing, sales, manufacturing and overall project management are defined in the company everyday process group. The third processes are different support processes that are crucial to the everyday operations of the company but have a supportive role.

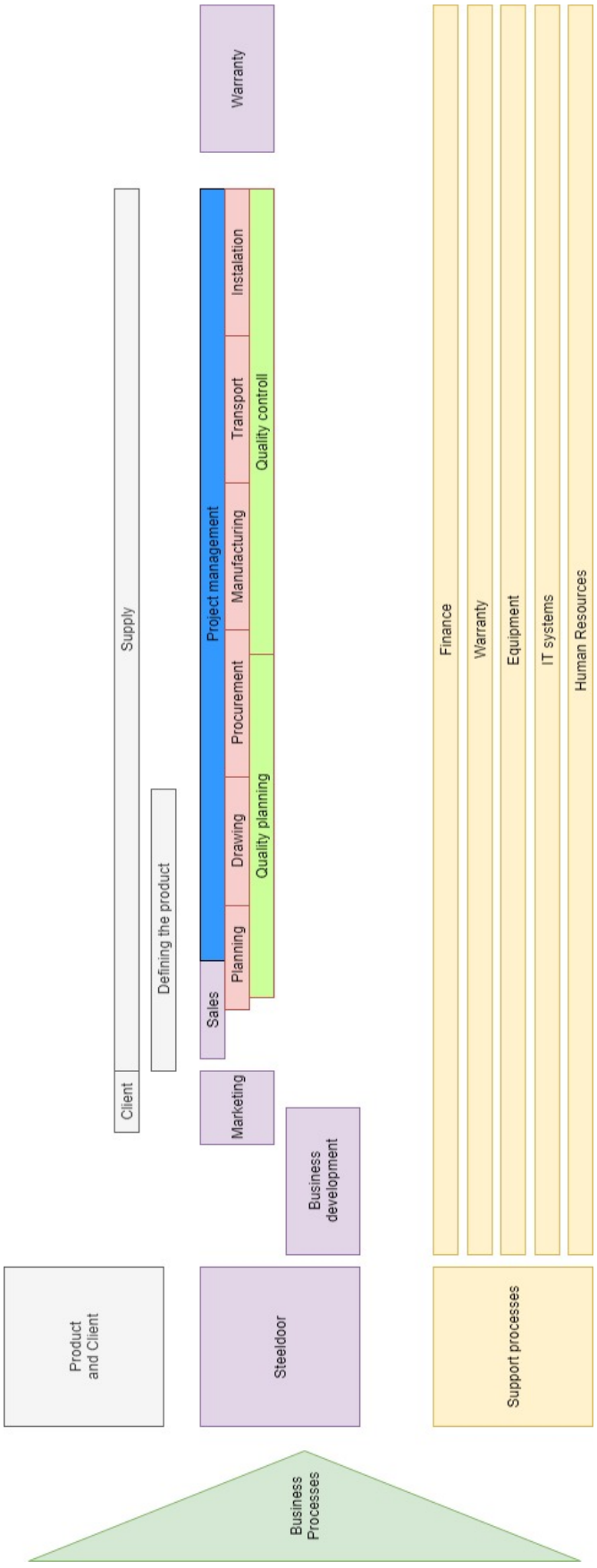

Figure 3.1 Company processes overview

It was crucial then to analyse what processes can be combined, automated and streamlined and find out what were value adding processes, not-value adding but necessary processes and which were non-value adding or waste. From that a digitalization and development project can be formed. With this procedure there is also a chance that some processes can be combined and rearranged so that the value will rise. In Table 3.5 the digitalization and development of the processes are categorized on a 5-point scale where 0 was not important at all and 5 was most important.

Table 3.5 Process evaluation table

Process	**Importance**	**Problems**	**Possible software solutions**
Sales	5	No overview of the sales process. No singular pricing system. No cooperation between employees.	Erply, Pipedrive, Zoho, Scoro, Dynamics CRM
Project management	4	No overview of ongoing projects. No communications between staff and departments.	Pipedrive, Erply, Outlook, Dropbox, Scoro,
Drawing/design	5	Slow drawing process, inaccurate drawings, incomplete BOM, invalid drawings	SolidWorks, DriveWorks Solo
Manufacturing	2	No overview of manufacturing, no way to give out work orders and collect feedback and have a manufacturing reporting system	Prodmaster, Eziil, Katana MRP, Microsoft NAV, Oracle, Scoro
Quality control	2	No quality control system	Own inhouse developed solution
Human resources	3	No workers management, no timesheet and payroll management	Begin, Clockify, Toggl, TimeTac
Finance	2	No central system for creating and managing sales, inventory, purchase, invoices, quotes, etc.	Pipedrive, Erply, Outlook, Dropbox, Scoro,
Equipment maintenance	1	Incomplete overview of the machinery and equipment that is in use.	Taskilo, Calemeam, CommaCMMS, Fiix, On Upkeep,
Installation	4	No overview of workorders and work process.	Own inhouse developed solution

It was clear from the audit what had to be done, but lack of financial and human resources also put big limitations for further steps. One big bottleneck which stood out was design, because the company used an outdated software to create manufacturing drawings. For simpler designs the processes took from 2 up to 3 hours and with complex doors the designer took a minimum of one

day and sometimes up to 5 working days just to create drawing and a hand written BOM. Long waiting time, errors in drawings and unreadable drawings caused a massive problem. This in turn caused many financial problems by reworking and sometimes totally scrapping finished products, also many manufacturing stops. It was clear that this was one of the processes that had to be redesigned and hopefully automated. The solution how drawing generating problem was solved and what benefits were achieved are described in paragraph 3.4.1.

3.2 Digitalization SWOT analyse

This chapter provides a SWOT analysis of the digitalization of the company. The Table 3.6. below will give an overview of the topics discussed and bring out the strengths, weaknesses, opportunities and threats.

Table 3.6 SWOT analyze topics

Strengths • What can the company do better than its competitors? • What unique resources does the company have? • What factors make the company successful?	Weaknesses • What disadvantages does the company have? • What the company does worse than its competitors
Opportunities • Of which opportunities could the company take advantage? • What market trends might favour the company	Threats • What trends could hurt the company • What obstacles the company has • What are the competitors doing better

Strengths of the company are following:

- Steeldoor is a small sized company and can be flexible and rapidly deal with changes in the market;
- As the company is small so implementing digital solutions and automating processes will take much less effort than in bigger companies;
- Company has a good team that works well together and is success oriented;

Weaknesses of the company are following:

- The company does not have enough financial and human resources to follow through on all its plans;
- The infrastructure is old and in need of renovation;
- The digitalization implementation process will slow down and create problems in everyday running of the company;
- Some ideas might not work in real life;

Opportunities of the company are following:

- Creating an e-shop for its standard products like doors;
- Creating an online configurator for doors so that a client will receive an automatic price; tender online and can turn it into a purchase order;

Threats of the company are following:

- If there is an economic crisis the first thing to get hit is the real estate market and if the company does not have any other products in its catalogue, there is a big chance of going bankrupt;
- The company runs out of free money before the digital developments are in place;
- Other similar manufacturers already have implemented similar solutions and bigger competitors are developing their own;

3.3 Summary of the development plan

To digitalize company processes, it is important to answer three following questions: what needs to be digitalized, why to digitalize and how the digitalized process adds value to the company. It was clear that for order to revamp the company big steps towards automation and digitalization had to be made. So, a comprehensive plan was composed of what was needed, what was realistic and in what time period the company could realize it. The plan how to digitalize main processes is described in Table 3.7.

Table 3.7 Digitalization plan for company main processes

What	Why	How
Sales process	To create a centralized pricing system, have a standardized tender generating process, have real time overview of sales processes in the company	First step is to create a unified product pricing system. The second step is to develop an automated sales tool. An all-encompassing IT system that is described in chapter 3.6
Project management	Have a standardized project management procedure that gives real time overview of the project process	First to standardize project management process with Dropbox and unified project folder structure also unique project number creation.
Drawing and design	Creating correct and error free drawings is crucial for manufacturing company	Develop and implement an automated solution for creating standardized product drawing and manufacturing drawings.
Manufacturing	Have real time control and overview of manufacturing and warehouse	Implement an ERP.

The plan for development of supporting processes is presented in Table 3.8.

Table 3.8 Digitalization plan for company support processes

What	Why	How
Quality control	Manufacturing quality products is crucial for the company.	First crate an EN 1090 applicable quality system.
Human resources	To have overview of the work force and get reliable data	Implement and solution for work-time registration and handling all the process related to human-resources
Equipment maintenance	Collecting and managing equipment data can save money in the long-run	Create a system to collect and manage all the data related to manufacturing equipment.
Installation	Manage the installation team and streamlining their processes will save money for the company	Create standardized processes and a solution how to manage the installation processes
Finance	Have a single and clear overview of the financial status of the company	Consolidate all the financial processes onto one single platform.
Marketing	Without marketing the company might not survive. Relying only on returning customers can backfire catastrophically company has to find new customers.	Crate a web page, find marketing partner to market the company.

Some of the solutions would be resolved by simple solutions but the most critical problem is to find an IT solution that will combine sales, automated drawing, procurement, quality control documentation etc has be developed. This system will conclude all the information for the product. Overview of this is presented in the chapter 3.3 future developments.

3.4 Implemented solutions and impact on the company

From the audit we reached to conclusion that in order to revitalize the company and gain a new competitive edge extensive changes must be made. First four topics to tackle were sales, project management, drawings and human resources. In this paragraph the author explains what actions were taken, what solutions were found and how the implemented processes helped to gain profit. As the author cited in the previous chapter, it is important to deal with easy problems first or so-called low hanging fruits. Those will give positive feedback and have an encouraging effect for the team responsible for developments in the company. It also will give the management of the

company a positive note that development is good and implementing new technologies and solutions will help the company be successful in long run.

3.4.1 Development of automated product configurator based on parametric modelling

During the first half of 2018, 60% of all production were doors, 20% roofing solutions and other 20% other steel products. That meant a lot of ETO projects where all had small variations and no project was identical. Generating drawings and design for manufacturing is crucial for the company. If there are no drawings, there is no production. If the drawings have errors in them or are hard to understand this also causes problems down the path. Which leads to rework and scrap, those were also big problems in the company at the time. There are many ways to automate 3d modelling process but as our products were ETO and had usually really small differences and only variations are type, colour, size, locking system. For this application parametrical modelling suited the best and then it was important to select the software that suited our needs.

Parametric modelling is used to define a dimension's ability to change the shape of model's geometry immediately when the dimension value is modified. This modelling process is great for projects with a lot of manufacturing requirement and that need a high accuracy such as mechanical projects. This modelling process is built from mathematical equations. It is a practical process if you need to produce products with little variations. Indeed, it is good to create designs that need to be modified on a regular basis. It will totally be adapted to your design intent. All the models created with this process have what we call features. These are attributes that include length, width, depth, orientation, geometry, material, density functions, etc. Parametric modelling is actually focusing on relationships between features, and between parts, assemblies and drawings. [18]

The company used Solidworks 2015 at the time and we did not want to change the 3D modelling software, so we had to look at solutions that will cooperate with SW15. First thing that was offered to us was Solidworks own solution DriveWorks Xpress which license comes with every SW standard product, but its only capable of modelling single part at a time. Our models were assemblies consisting minimum of 40 parts and more. The next solution was DriveWorks Solo that had most of the features we needed, but still lacked some crucial parts. Also the Estonian reseller demanded that we have to update our base software to the newest edition and that they will not sell us the older version of the software. For comparison the Driveworks Pro was also looked at but this

solution was far too complicated, expensive and had to many useless features for us. In Table 3.9 a comparison between different versions of the DriweWorks software is shown.

Table 3.9 Cross reference of DriveWorks software [19]

Feature	**DW xpress**	**DW solo**	**DW Pro**
Drive Dimensions, Features and Custom Properties	Yes	Yes	Yes
Drive Advanced Feature Properties (Hole Wizards, Sheet Metal, Weldments)		Yes	Yes
Replace Components (with existing files or dynamically driven files)		Yes	Yes
Create additional model file formats (drive3D, STEP, STL, PDF, DXF, JPEG, etc.)		Yes	Yes
Full control over new model file names and location		Yes	Yes
Create multiple drawings for each part and assembly		Yes	Yes
Form generator	Yes		Yes
Full control over new drawing file names and locations		Yes	Yes
Integration with 3rd party solutions			Yes
Fully customizable document creation (from Word, Excel, XML, etc.)			Yes
PRICE	Free	3750 euros + VAT	25000-30000 euros + VAT

While it was possible to solve most of the problems with DriveWorks Solo software, it did not solve all the problems and the PRO license software was clearly too expensive and too sophisticated for this company. So, it was evident that other options had to be pursued.

It is possible to create parametric modelling API with Microsoft excel to control dimensions, configurations and models but this is a very unstable and difficult way to do it. Also, all the development must be done by the company itself and as we had no spare resources we had to find another and quicker and easier way.

While looking around for options a solution popped up. A US company with an open-sourced tool called GoAutomate. It used Microsoft Excel VBA to create a parametrical modelling automation API interface for Solidworks. [20] This tool suited our need best, because it was free, easy to modify and adapt and complied with our version of the Solidworks 2015 software.

First a proof of concept an alpha version of the software that was able to automate one specific door was created. This took two weeks and some help from the GoAutomate developers. This version had a lot of bugs and only features that were automated were the dimensions of the doorframe, door skin and the model mates. After it was defined, that this solution will work in our case further development was done. A second version was created, version that was able to automate four different models. Two types of frame and door hand meaning which way the door opens. Second version also featured all the parts that were missing from the first model, like structural ribs inside the door, isolation material inside the door and inside the doorframe and hinges. This covered all components were produced in-house and were parts of the manufacturing processes.

Also, it was able to create automated coordination drawings for the sales team and more importantly manufacturing drawings for manufacturing. This version lacked the opportunity to add purchasing products like locks, windows etc. to the model but it was a final proof of concept, that this solution will work. The user interface of the software is presented in Figure 3.2, on the upper left side area, the data is inserted via dropdown menus. The solution can automatically generate the product code from the unique project folder where the generated files will be saved.

Depending on the degree of complexity and number of parts the automated process takes from 10 to 25 seconds. And the whole process of inserting the base data and afterwards controlling the drawings will take around 15 to 30 minutes depending on the number of drawings created and individual parts in the BOM.

Every version of the software has more features and the development will culminate with a software that is able to generate all the necessary drawings and files for the product automatically.

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-00	Custom property	Klient	0108010019-00	
-00-01	Dimension	D1@Extrude-Thin1	0108010019-00-01	629
-00-02	Dimension	D1@Extrude-Thin1	0108010019-00-02	1959
-00-03	Dimension	D1@Sketch1	0108010019-00-03	614
-00-03	Dimension	D2@Sketch1	0108010019-00-03	1984
-01	Comment			
-01-01	Comment			
-01-01	Dimension	D1@Boss-Extrude1	0108010019-01-01	2200
-01-01	Dimension	D3@LPattern1	0108010019-01-01	600
-01-01	Dimension	D1@LPattern1	0108010019-01-01	4
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Figure 3.2 User interface of software

Currently, the development has reached a point where the solution can automatically generate all of the necessary drawings and manufacturing document needed to manufacture the door, also the coordination drawings, shown on Figure 3.3, required by the sales team and also the BOM for material resources planning. The application uses a measurement form or worksheet where all the required information is written about the door, extra components and the surrounding wall.

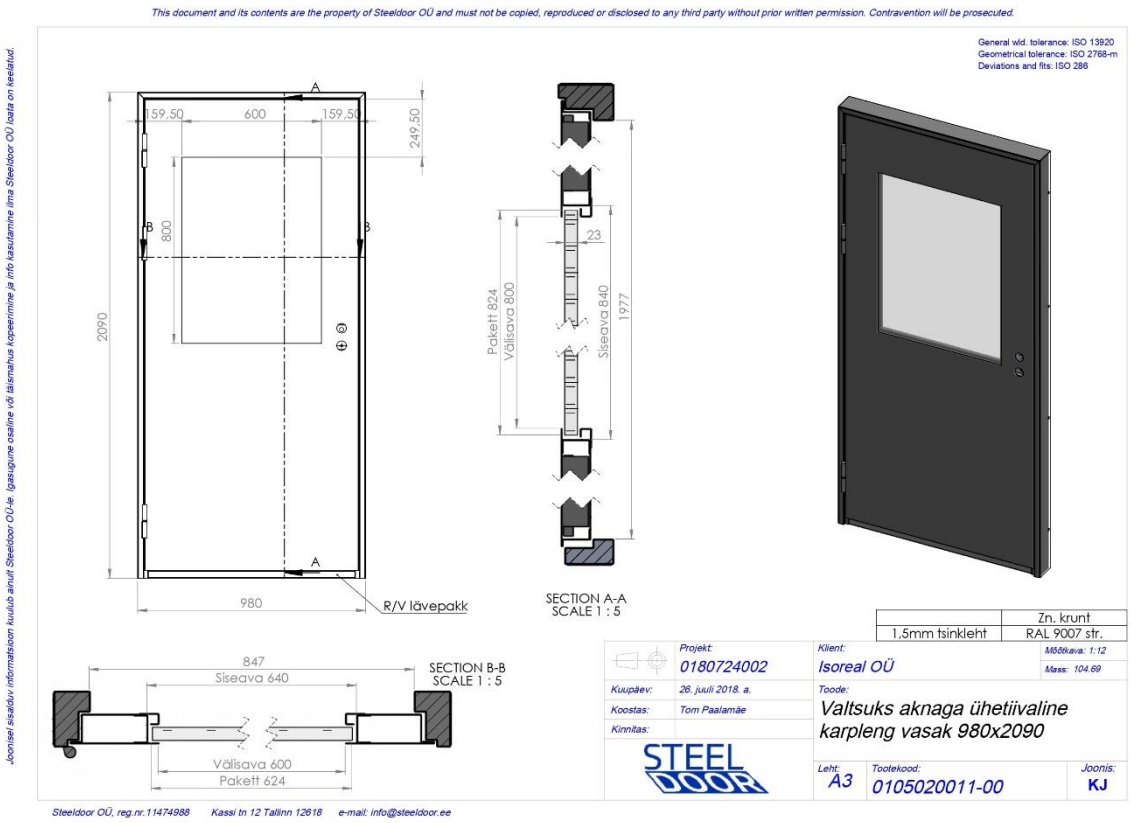

Figure 3.3 Automatically generated drawing of a 3d model of a door

Further description how the automated product configurator development was evolved into automated sales tool and what are the future plans for this application is covered in paragraph 3.3.

3.4.2 Customer relationship management software - Pipedrive

When the company scanned the market for customer relationship management (CRM) software we did not look any further than Estonian own Pipedrive. Pipedrive is a sales management tool designed to help small sales teams manage intricate or lengthy sales processes. [21] Pipedrive gives the employee a comprehensive overview of the sales process and helps them in every step of the process. It also gives overview of the sales processes to the management.

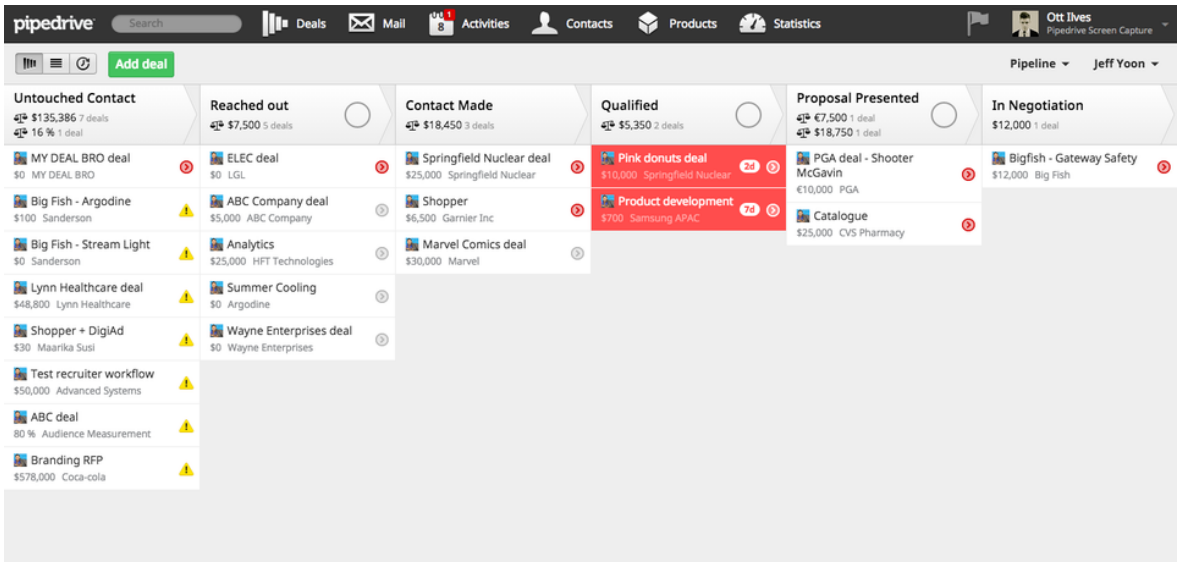

Figure 3.4 Pipedrive user interface

Pipedrive develops a web-based sales management tool to help small sales teams manage sales processes. This tool is used for pipeline management; email integration; activity remainder emails, mobile notifications, and alerts; sales reporting; sales forecasting; Google apps integration; product catalogue creation; and API, integrations, customization, web forms, and reliability and safety. [22]

3.4.3 Work time-tracking solution - Begin

Begin is a web-based solution, which helps you schedule work, manage timesheets and expedite payroll. Depending on the need, Begin offers many ways to register and track the worktime. For stationary workers there is a device that uses fingerprint registration, for mobile workers there is a phone application. The Table 3.10 gives a good overview of the benefits of using digitalized work-time tracking solution.

Table 3.10 Benefits of digitalized work-time tracking

1..	Financial savings with accurate time recording
2.	Real time information on employee arrivals and departures
3.	The time-consuming paperwork associated with hourly papers disappears
4.	The calculation of working hours, or the total number of hours, becomes automatic
5.	When using the mobile APP management has the overview of the movements of the worker
6.	All the information dealing with human resources is centralized in one software

Implementing the automatic work-time registration was not welcomed by the workers, who were used to report their timesheets on paper. This meant that the management had no real overview of value adding work being done and just sitting around. During the first four months the reporting met great resistance, but the workers got used to it. The reported work hours decreased compared to the previous paper reporting method and also the calculation of working hours and wages became automatic that saved a lot of time for the management. The Figure 3.5 show what the everyday interface for an administrator. It shows what time the worker started, when he took pauses and the end-time. Also, it is specified how the employee registered his time-stamp.

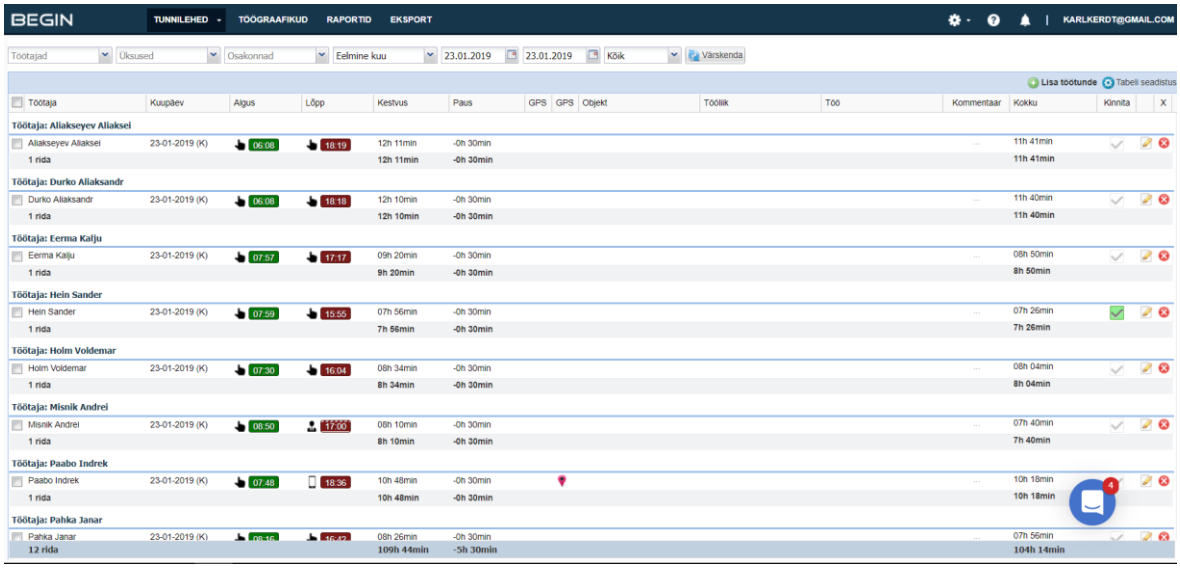

Figure 3.5 Begin user interface

Return of investment (ROI) is a traditional way to measure the value of an investment. The costs are the sum of all direct and indirect cost such as; training, consulting, implementation, material costs. The benefits are the sum of all direct and indirect benefits like, better quality, employee motivation, productivity etc. ROI is a calculation where financial benefits are divided by the financial costs. [23]

ROI is a metric that can be used before to evaluate investment opportunities and after investment to evaluate to which extent the investment paid off. ROI is a good way to convince management that the investment will pay off and has benefits for the company in the long-run. Also, in this case to prioritize software implementation and process development plan. ROI gives a simple understanding if the investment is worth it or the money will be wasted. In most cases it is enough

to calculate if the ROI is positive, break-even or negative. The purpose of ROI calculations is to decide if the investment is worth its money. [23]

The metrics of ROI are meant to measure economic value of the implemented software. Three basic ROI metrics are recommended. Those are costs, benefits and return of investment. Each metric uses the previous one and refines its accuracy of the final economic value. [24]

The first thing to be calculated is overall cost of the investment or total amount of money spent This calculation is presented in Table 3.11. This takes into account all the implementation costs related to the process like hardware installation and training of management and employees.

$$\sum_{i=cost}^{n} a_i = a_{cost1} + a_{cost2} + \ \dots + a_{cost\ n} \tag{3.1}$$

Where $a_i - overall\ cost$

$a_{cost} - single\ item\ cost$

Table 3.11 Initial investment calculation

Article	**Cost in €**	**Quantity**	**Total cost in €**
Time registration hardware	20 per month	1	20
Smartphone app	12 per user	2	24
Hardware install	38	1	38
Training management	38	2	76
Training employees	15	4	60
Installing WIFI network hardware and routers	1840	1	1840
Creating employee's database	15	4	60

$$\sum_{i=cost}^{n} a_i = 20 + 24 + 38 + 76 + 60 + 1840 + 60 = 2118\ €$$

From the calculation we can conclude that total cost of first system implementation was 2118 euros. This price was achieved by a minimum of one-year contract. This means there are further costs to add as there are monthly user licenses and hardware rent. This took the first-year cost to 3306 euros. Monthly and yearly charge for the service are presented in Table 3.12. One year of service will cost 1188 euros, but this can change on the number of employees. [24]

Table 3.12 Monthly and yearly cost calculation

Article	Cost in €	Quantity	Total cost in €
Time registration hardware	20 per month	1	20
User license	5 per user	11	55
Smartphone app	12 per user	2	24
Total per month		1	99
Total per first year	2118*1 + 99*12	12	3306
Total per year		12	1188

The second step is to calculate benefits or total amount of money gained from the implementation. When calculating benefits all the accompanying benefits have to be taken into account. This includes direct benefits like time saved by automating the data inserting processes for the management and calculating the salaries and indirect benefits like better overview of real time work-time registration. Also, more precise time stamping. First thing that occurred after implementing digital work time-tracking software was that previously workers registered about 8% more work hours than were performed. Most of this was caused because workers rounded-up their working time. The calculations for benefits are presented in Table 3.13.

$$\sum_{i=Benefits}^{n} a_i = a_{Benefits} + a_n \tag{3.2}$$

Where $a_i - overall\ finacial\ befefits\ gained$

$a_{benefits} - single\ benefit$

Table 3.13 Benefits calculation

Article	Cost in €	Quantity	Total cost in €
Time saved by automating the time-sheet inserting process to management	25	2	50
Time saved of workers not filling paper time-sheets	12	11	132
Time saved by automating the salary calculation process	25	2	50
Previously over registered work-hours	153,60	11	1689,60

From this the monthly and yearly benefit can be calculated. Those results are presented in the Table 3.14. The monthly benefit is calculated as 1921,60 euros from which 1689,60 euros comes from previously over-marked work hours. A distinct differentiation can be made that direct benefits were 232 euros and the saved salary costs are indirect. From that a yearly financial benefit was calculated that summed up to 23059,20 euros. That meant an 8% decrease in salary costs.

Table 3.14 Monthly and yearly benefit calculations

Article	Quantity	Sum €	Total €
Monthly financial benefits	1	1921,60	1921,60
Yearly financial benefits	12	1921,60	23059,20

The third metric to be calculated is the return of investment. This is a financial metric to measure return from investment. In this case a percentage method was used. ROI is a very easy to understand and standardized metric and is perfect to evaluate the efficiency of the investment [25]. On Table 3.15 the ROI results are presented.

$$\frac{Benefits - Costs}{Costs}\ x\ 100\% \tag{3.3}$$

$$\frac{23059{,}20 - 3306}{3306} x\ 100\% = 597\%$$

Table 3.15 ROI calculations

ROI with all benefits	597%
First year with only direct benefits	-15%
Second year with only direct benefits	134%

There is an obvious financial gain from the implementation of this solution. Furthermore, now all the information concerned with human resources is centralized in one software. After the first annoyance from the employees against the automated solution was over, workers got used to, understood the reason for it and most importantly company saves money in the long-term.

3.5 Streamlining the sales process

The second relevant problem was processing sales orders. It was important to find a way to have an accurate overview of the sales process. For this we visualized the sales processes as-is shown in Figure 3.6. It was concluded that the reason of low sales success was caused by no control and overview of the sales process, no singular pricing system and no cooperation between sales employees.

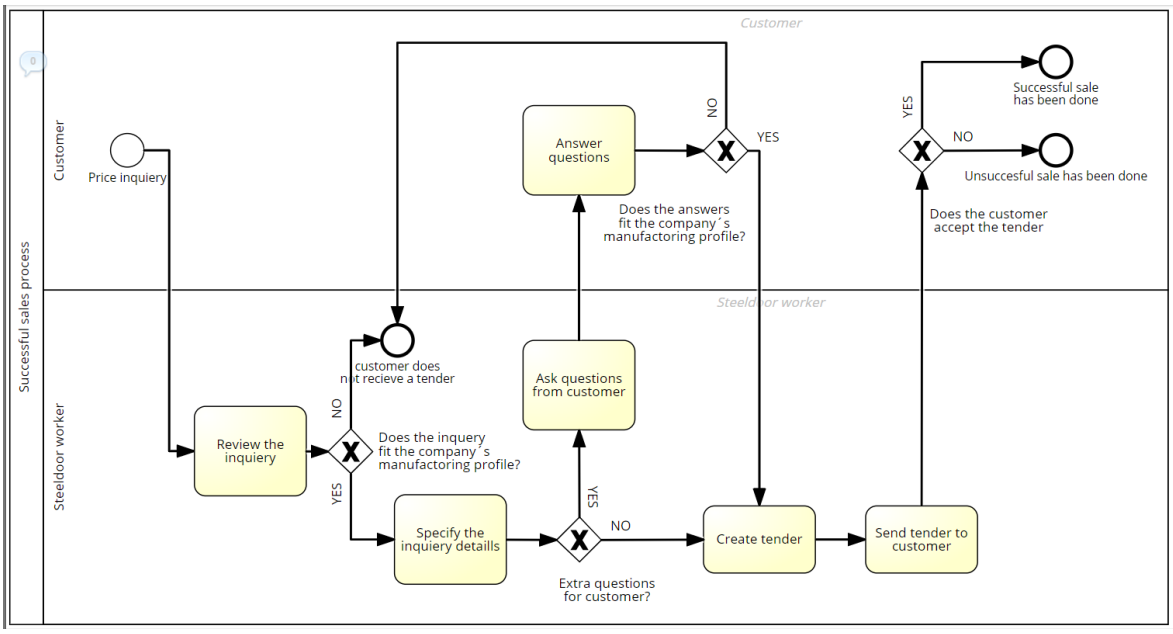

Figure 3.6 AS-IS process flow of sales process at the company

Improved sales processes and methods are visualized in Figure 3.7 and methods how to handle the sales process were developed. An assistant started to categorize incoming price inquiries and answering with standardized answers, depending on the company and inquiry, that we have received their inquiry and we will answer it in a week. Also, the assistant selected and categorized the price inquires and only picked out the ones that were suitable for the company's profile, if it did not fit the company's manufacturing capabilities the inquiry was ignored. Then the inquiry was registered in Pipedrive and a dedicated folder with a unique project code was given to it. Then it was assigned to an employee responsible for the generation of the inquiry. Also, it became mandatory to ask feedback from the clients about the reasons when our offer was not accepted. This data was the collected and analysed in weekly meetings.

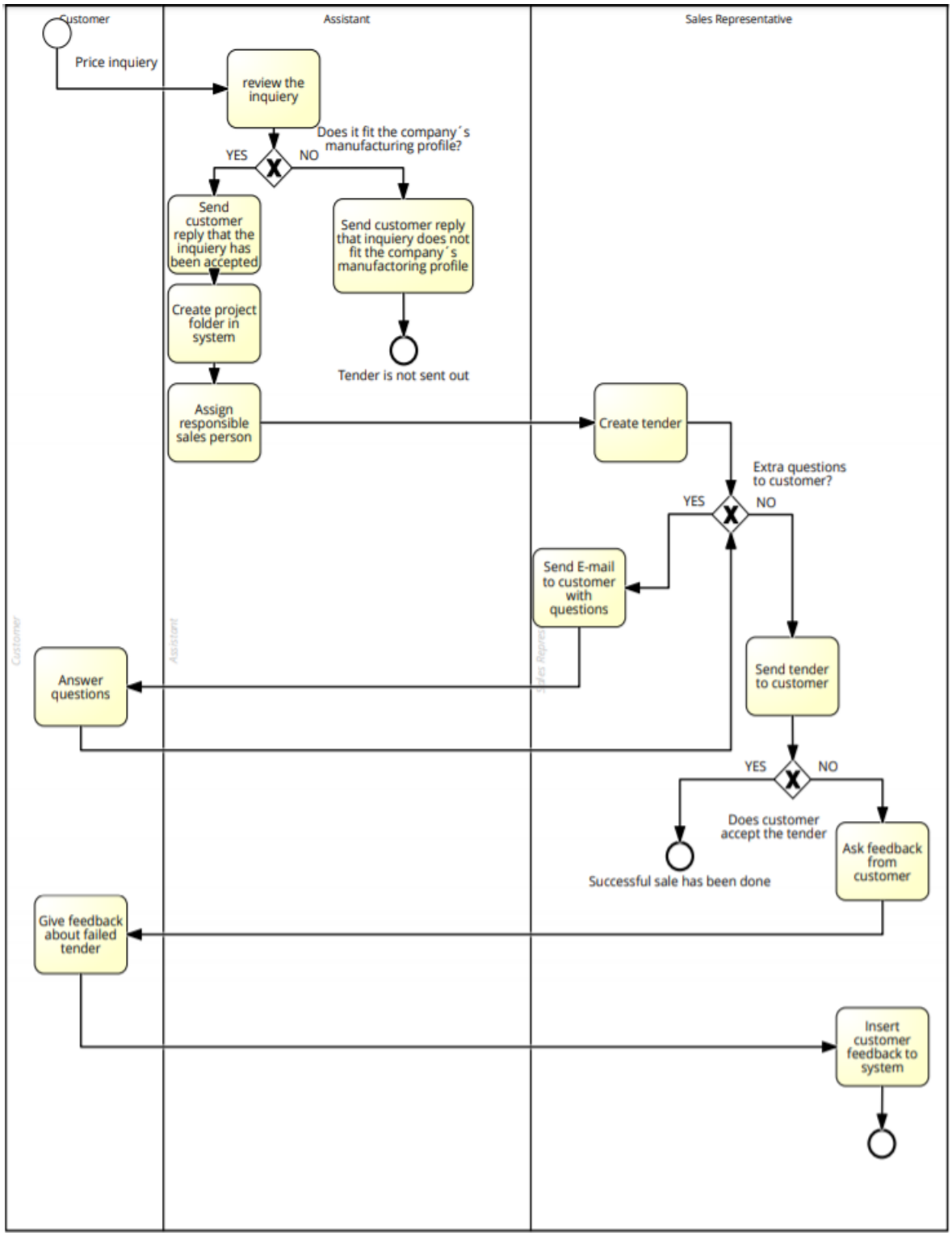

Figure 3.7 TO-BE process flow of sales process at the company

Redesigning the sales processes has met resistance from the sales employees but from further acknowledgment of the improvements the employees understood the benefits of this system. The

differences of old and new sales processes are presented in Table 3.16. It is clear, that there is a lot more to improve the average answer time. The data for the old sales process was collected in a time period where a lot of construction companies submitted price inquires for upcoming spring and summer period. Many of those inquiries are sent to tens of similar companies and that is why the number of inquiries that went into the negotiation phase is so low. Also, the percentage of successful sales differs because a number of registered inquiries were ignored because those did not fit the company's manufacturing capabilities.

Table 3.16 Sales process comparison

	Number of incoming inquires	Number of answered inquires	Percentage of answered inquires	Average answer time	Number of price negotiations	Successful sales	Percentage of successful sales
Old sales process	187	48	25,6%	18 days	32	18	9,6%
New sales process	124	68	54,8%	6 days	45	27	21,7%

3.6 Development of automated sales application

The objective is to develop an IT system for the company that automates sales processes. The application has to be able to generate tenders for standardized products so that the user does not need to have any knowledge of the product. The system will be based on the parametrical 3D modelling application that was covered in paragraph 3.4.1. The system architecture is shown on Figure 3.8.

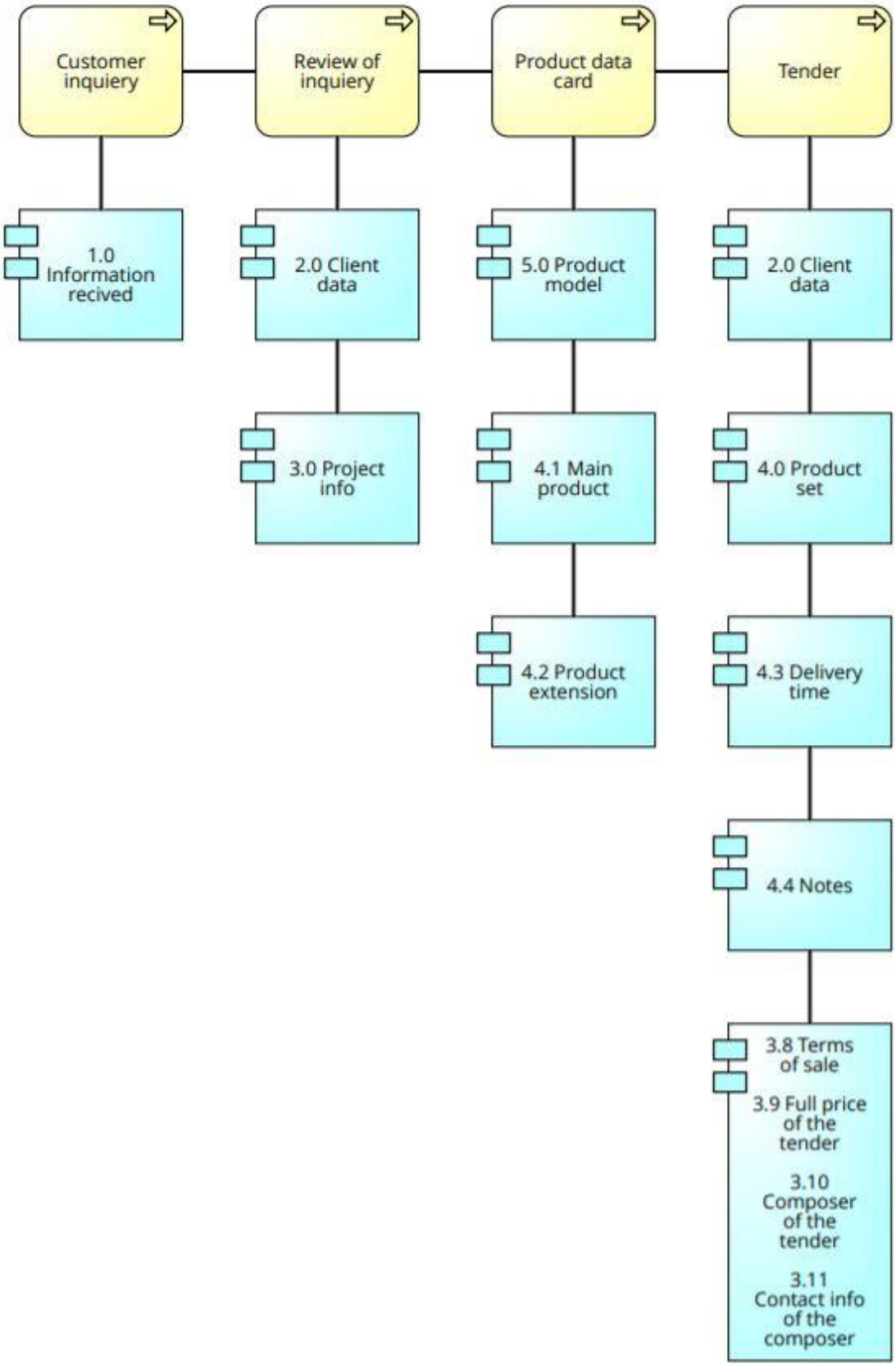

Figure 3.8 Automated sales application IT system architecture

The first part of a sales process is the incoming client's inquiry. From this most of the information required to start the tender generation process. The required information is covered in Table 3.17. If the client has any previous history in the system this will speed up the data inserting process also if the conditions do not fit the company manufacturing profile, an answer will be sent to the client informing them about it.

Table 3.17 Clients inquiry

Incoming price inquiry
1.0 Info received
Client – who?
Product or service – What?
Deadline – When?
Conditions - Specifications

After the inquiry has been received the next processes is review and of the inquiry. All the data is imported, a unique project code is generated, and all the necessary documents are created automatically by the software. The list of components that make up the review is presented in the Table 3.18.

Table 3.18 Project data overview

Review of the inquiry	
2.0 Client information	
2.1	Client name
2.2	Client address
2.3	Name of the representative
2.4	Phone number of the representative
2.5	Contact e-mail address of the representative
2.6	Object location
3.0 Project info	
3.1	Project number
3.2	Tender number
3.3	Project net-cost
3.4	Project revenue
3.5	Project revenue distribution
3.6	Project profit forecast
3.7	Project deadline
3.8	Terms of sale
3.9	Full price of the tender
3.10	Composer of the tender
3.11	Contact info of the composer

The tender creation process consists of two parts. First gives the user an overview of the to-be created offer in detail where product net-price and mark-up are presented, also all other fundamental info will be presented in this process. Second part will be the tender that will be sent out, this will consist of all the necessary components to also make it a binding sales-contract. It will contain the buyer's info, seller's info, info about the products and all the extra services offered, also the coordination drawings and terms of the sale like delivery date and etc. The information covered in tender architecture is presented in Table 3.19.

Table 3.19 Tender architecture

Tender	
3.1	Project number
3.2	Tender number
2.0 Client information	
2.1	Client name
2.2	Client address
2.3	Name of the representative
2.4	Phone number of the representative
2.5	Contact e-mail address of the representative
2.6	Object location
4.0 Product set	
4.1 Main product	
4.1.1	Product designation
4.1.2	Product quantity
4.1.3	Unit
4.1.4	Product net-cost
4.1.5	Product mark up
4.1.6	Product sale price
4.1.7	Notes
4.2 Product extensions	
4.2.1	Product designation
4.2.2	Product quantity
4.2.3	Unit
4.2.4	Product net-cost
4.2.5	Product mark up
4.2.6	Product sale price
4.2.7	Notes
4.3	Delivery time
4.4	Notes
3.8	Terms of sale
3.9	Full price of the tender
3.10	Composer of the tender
3.11	Contact info of the composer

Product data card will conclude all the information about the product. The overview of information conclude into a product card is presented in Table 3.20. In this step the parametrical modelling application is used that creates the BOM, drawings and everything else needed. From this the net-cost, material requirements, manufacturing requirements, purchasable products and the final product price will be generated.

Table 3.20 Product data card

Product data card	
5.0 Product CAD model	
4.1 Main product	
Purchased products	
Standard services	
4.1.1	Product designation
4.1.2	Product quantity
4.1.3	Unit
4.1.4	Product net-cost
5.1	Product Bill of materials
5.2	Component quantity
5.3	Component unit
5.4	Component price
4.2	Product extension
4.2.1	Product designation
4.2.2	Product quantity
4.2.3	Unit
4.2.4	Product net-cost
4.2.5	Product mark up
4.2.6	Product sale price
4.2.7	Notes

Most standard products manufactured by the company have some procured products in the BOM, this info must be up to date and available when generating tenders. All this information will be concluded in a database and managed as required. An overview of product types is listed in the Table 3.21.

Table 3.21 Purchased goods

Purchased products	
	Glass and other partitions
	Locks
	Seals
	Fasteners
	Etc.

Standard services will contain the pricing of the necessary processes need to manufacture, assemble and install the final product. This module will also generate needed quality documents for the project and the measurement form for the ales department. The list of standard services is presented in Table 3.22.

Table 3.22 Standard services

Standard services	
	Welding/assembly
	Surface treatment
	Final assembly
	Packing
	Transport
	Installation
	Designing
	Quality control documentation
	Measurement form for sales department

The CAD will be composed form the database of standard parts, mathematical formulas, purchased products and other needed CAD assembly files. The Table 3.23 gives an overview of the components of the CAD model.

Table 3.23 CAD model components

5.0 Product CAD model	
	Standard component CAD files
	CAD assembly files
	Mathematical formulas

Using this information an offer was asked from three IT development firms. All allowed to publish their price estimates but not their company names. Those calculations are presented in the Table 3.24. Two of the lowest estimates differed in 10 750 euros, but their estimates development time differed by 550 hours and the third offer was too expensive and also their estimated time of development was the longest.

Table 3.24 IT system development price estimates

	Estimated development time	Price per hour	Total
Company 1	850 hours	45 eur	38 250 eur
Company 2	1800 hours	75 eur	135 000 eur
Company 3	1400 hours	35 eur	49 000 eur

Those estimates were done on the knowing that the parametrical modelling application, all the product info and manufacturing info databases are going to be developed by ourselves in the company. The outsourced development would be all the user interfaces, back-end and etc.

Part of the development should also be an online product configurator, where the client is able to define the product and receive an instant price offer. If they accept it, this can be directly transformed into a purchase order form the web page.

First interface will be specialised for the inquiry and generation of the tender should consist of:

- Clients inquiry
- Review of the inquiry
- Generating the tender

The second module will focus on the product data card includes the information.

- Product data
- Product 3d model
- Procurement products
- Standardized services
- Quality control documents
- Measurement blanket for the sales department
- Etc. documents

The development is still mostly in its planning stages with the exception of most of the product databases completed and the automated parametrical model application developed and in use.

SUMMARY

The main objective of this thesis was to analyse the company processes, propose a digitalization plan that will help to streamline and automate processes and then to implement those solutions and measure the impact.

The first chapter gives an overview of the company management and an introduction to the company`s processes is presented. Also, in the first chapter the manufacturing capabilities are assessed and a through insight of the product portfolio is given. This chapter helps to reader to understand the company's everyday operations and presents the problems that this is thesis is set out to solve.

The following chapter is focused on the conducted literature review on the topic of digitalization of manufacturing company. The literature review revealed the recent years the average salaries have grown, and this has caused the companies' profits to decline. Companies understand that digitalizing their processes will have a positive long-term effect by decreasing overall costs, raising profits, and the value added by manufacturing processes will increase. However, in the short-term the companies do not want to invest into digitalization or do not have the resources to digitalize. It is concluded that increasing efficiency in the value chain by digitalization is the only way to survive in the tight competition.

Third chapter focuses on the audit of the company and a comprehensive plan how to digitalize and automate processes like: sales, generating manufacturing drawings, handling human-resources. A SWOT analyse of the digitalization is conducted. Finally, the development and implementation of automated parametrical 3D modelling CAD software is explained. This solution can generate manufacturing drawings and automated bill-of-materials for standardized doors that are in the company portfolio. The process time was decreased form 2 - 3 hours to 15 – 30 minutes, depending on the complexity of the project.

The next development was the implementation of a work time-tracking solution. This centralized the processes related with human-resources like: work-time sheets, salary calculations and work schedule planning. The initial investment to implement this solution cost the company 3306 euros and the ROI calculations show that the first year ROI with all direct and indirect benefits included was 23059 euros, most of that sum came from the previous over registration of work- time by the

employees. The running benefits also outweigh the running cost, so this solution has a positive effect on the company as the efficiency is raised by automating the processes.

After that the sales process was optimized, reworked and implemented. A new system how the price inquiries were processed, and tenders created was designed. This had a positive effect to the capability to answer to client inquiry's and also to the final number of successful sales. As a part of the redesign of the sales processes a new project management system was also implemented and the costumer relationship manager was implemented.

Lastly the development of automated sales application is covered. In the end this should be a sales tool for automatically creating tenders by an employee who does not have to have a technical education or any sales skills. The software will be responsible for most of the project management processes and generate all the necessary documents like terms of sale, tenders and quality documentation. Furthermore, part of the development will be an online product generator that is able to instantly generate all the necessary documents needed for sale and offer the client quick and easy information about the product. This development is still mostly in planning stages. Some parts of the development are already done, and the overall architecture is fixed like it is shown in the last chapter.

In conclusion, the thesis had a very positive effect on the company and the objectives set out were met. Additionally, during writing of the master's thesis the company gained a lot of valuable knowledge about digitalization.

KOKKUVÕTE

Magistritöö põhieesmärk oli analüüsida ettevõtte protsesse ja töötada välja digitaliseerimiskava, mis aitab protsesse arendada ja automatiseerida. Samuti oli eesmärk ka neid lahendus rakendada ning nende mõju hinnata.

Esimeses peatükis antakse ülevaade ettevõtte juhtimisest ning tutvustatakse ettevõtte protsesse. Samuti hinnatakse ettevõtte tootmisvõimekust ja antakse ülevaade tooteportfellist. See peatükk aitab lugejal mõista ettevõtte igapäevast tegevust ja esitab põhiprobleemid, millele magistritöös püütakse lahendus leida.

Teises peatükis keskendutakse erialase kirjanduse ülevaatele tootmisettevõtte digitaliseerimise teemal. Kirjanduse ülevaates selgus, et viimastel aastatel on keskmised palgad kasvanud ning see on põhjustanud ettevõtete kasumi vähenemise. Ettevõtted mõistavad, et protsesside digitaliseerimisel on positiivne pikaajaline mõju, vähendades üldkulusid, suurendades kasumit ja seeläbi tootmisprotsesside lisandväärtus suureneb. Lühiajalises perspektiivis ei soovi ettevõtted digitaliseerimisse investeerida või neil ei ole selleks vahendeid. Samas on jõutud järeldusele, et efektiivsuse suurendamine väärtusahelas digitaliseerimise kaudu on ainus viis pingelises konkurentsis ellu jääda.

Kolmandas peatükis keskendutakse ettevõtte digiauditile ja arenduskava loomisele. Vaadeldakse kuidas digitaliseerida ja automatiseerida protsesse nagu: müük, tootmisjooniste loomine ja inimressurssidega seotud protsesside haldus. Selles peatükis esitletakse ka digitaliseerimise SWOT-analüüs. Samuti selgitatakse automatiseeritud parameetrilise 3D modelleerimise CAD tarkvara väljatöötamist ja rakendamist ettevõttes. Esitatud lahendus suudab luua automaatselt tootmisjoonised ja materjali vajaduste nimekirja standardiseeritud ettevõtte tootmis portfellis olevate uste jaoks. Protsessi aeg vähenes, sõltuvalt projekti keerukusest, 2 - 3 tunnilt 15-30 minutile.

Järgmise alampeatüki sisuks on tööaja jälgimise lahenduse rakendamine. See tsentraliseeris inimressurssidega seotud protsessid, nagu näiteks tööaja lehtede haldus, palgaarvutused ja töögraafiku planeerimine. Esialgne investeering lahenduse rakendamiseks maksis ettevõttele 3306 eurot ja investeeringu tasuvusarvutused arvutused näitavad, et esimese aasta investeeringu tasuvus, koos kõigi otseste ja kaudsete hüvedega oli 23059 eurot, enamik sellest tasuvusest tuleneb

faktist, et eelnevalt märkisid töötajad oma tegelikku tööaega üle. Jooksvad tulud katavad väga hästi jooksvad kulud, seega on sellel lahendusel positiivne mõju ettevõttele, sest efektiivsust on tõstetud protsesside automatiseerimisega.

Müügiprotsess analüüsi ja uuendamist kajastab alampeatükk 3.5. Esialgse protsessi analüüsi järel loodi uus hinnapäringute käitlemise ja pakkumiste loomise süsteem. See avaldas positiivset mõju kliendi päringutele vastamise võimekusele ja kui ka eduka müügini jõudnud tehingute lõplikule koguarvule. Müügiprotsesside ümberkujundamise osana rakendati ka uus projektijuhtimissüsteem ja klindisuhete haldamise tarkvara Pipedrive.

Viimaseks on kajastatud automatiseeritud müügi lahenduse arendust. Lõppkokkuvõttes peaks see kujunema müügivahendiks pakkumise automaatseks loomiseks töötaja poolt, kellel puudub tehniline haridus ja müügioskust. Tarkvara vastutab enamiku projektijuhtimise protsesside eest ja genereerib kõik vajalikud dokumendid, nagu müügitingimused, pakkumised ja kvaliteedidokumentatsioon. Lisaks on osa arendusest veebirakendus tootekonfiguraator, mis suudavad koheselt luua kõik vajalikud müügiks vajalikud dokumendid ning pakkuda kliendile kiiret ja lihtsat teavet toote kohta. See arendus on veel suuresti planeerimisetapis. Mõned arenduse osad (üldine arhitektuur jm.) on valmis see on kajastatud viimases peatükis.

Kokkuvõttes oli magistritööl väga positiivne mõju ettevõttele ja seatud eesmärgid said täidetud. Lisaks on omandas, ettevõte tervikuna uurimuse kaudu palju uusi teadmisi digitaliseerimisest.

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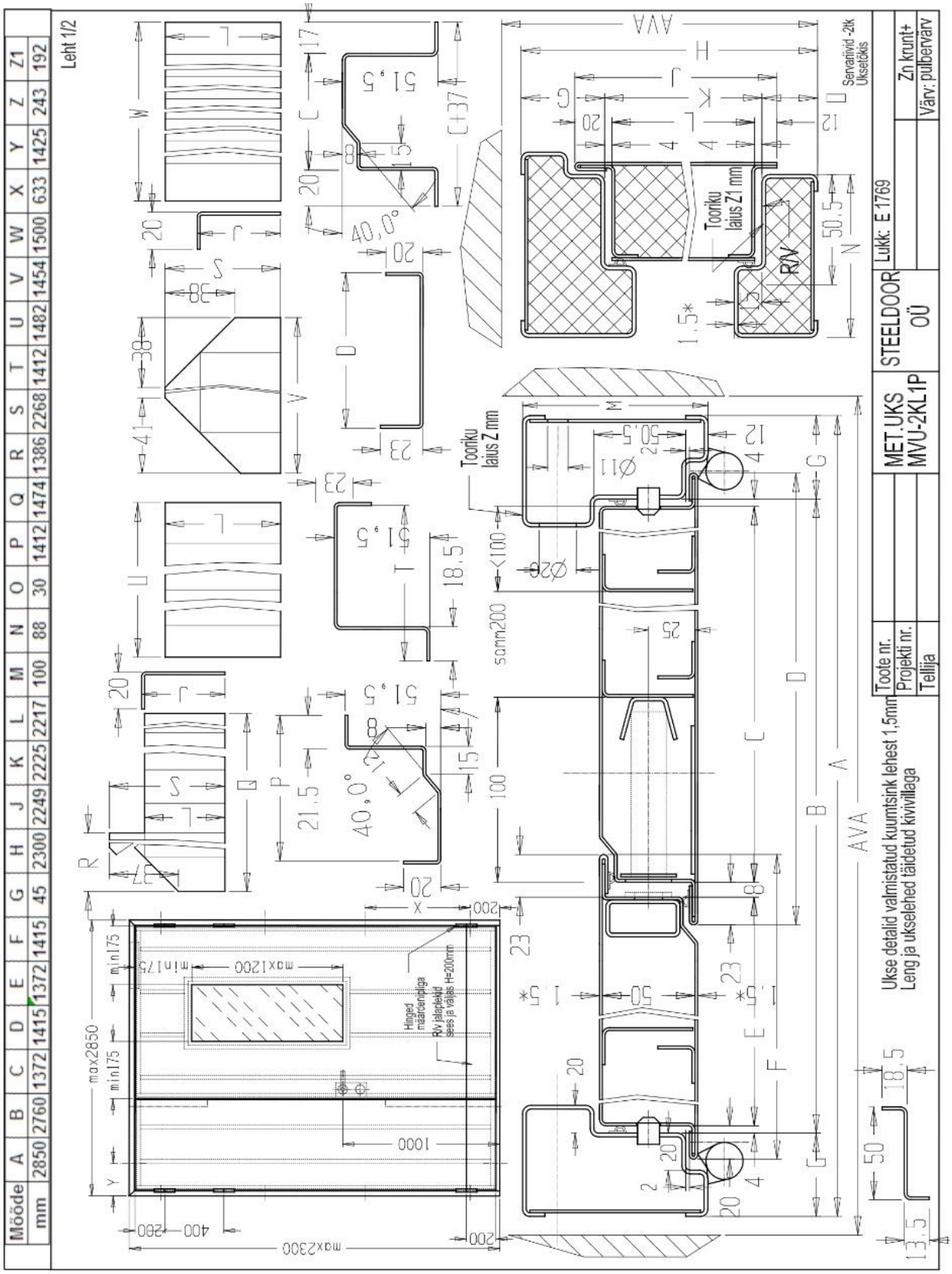
APPENDIX 1 As was type door manufacturing drawing



APPENDIX 2 Steeldoor OÜ RACI matrix

Process - role	CEO	Production engineer	Quality engineer	Sales	Assistant	Accountant	Prepartion	Welding	Surface treatment	Final assembly	Installers	Logistics
Order inquery evaluation	R			R	R							
Tender compilation	I/R			I/R	I							
Negotiations and Accepting offer	I/R			I/R								
Creating coordination drawings	I/R	R										
Creating manufacturing drawings	I/R	R	I									
Creating BOM	I/R	R										
Raw material price quotations	I/R			I/R	A/R							
Sub-assemblies quotation	I/R			I/R	A/R							
Sub-contracting quotations	I/R			I/R	A/R							
Order documentation	I/R		C	I	A/R							
Production planning	R	C										
Profile material cutting	I						R					
Sheet metal processing	I						R					
Welding	I							R				
Quality control	I	C	A	I			R	R	R	R	R	
Transport to zinc-coating	I/R						I	I	I			R
Preparation for surface treatment	I	C	A						A/R			
Powdercoating	I		A						A/R			
Final assembly	I		A							A/R		
Packing	I		A	I						R		A
Transport	I			I						R		A
Installation	I			I							A/R/C	
Quality documentation	I	C	R	I								
Sending invoices	A					R						
Payments for material	A					R						
Overview of accounts	A					R						
	R - Responsible A - Accountable C - Consulted I - Informed											