Revenue and material cost forecasting model for heavy engineering industry

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Abstract

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Forecasting the revenue and costs is an important aspect of the financial management of a company and thus the process should be as accurate as possible. The forecasts, such as budgets, are used in the decision-making of the management and as such must be informative as well as reliable.

To fulfil this need, this project-based thesis aims to create an automatic forecasting model for the commissioning organisation to be used in the company's monthly net sales as well as profit and loss forecasting process. The commissioning organisation operates in a heavy engineering industry with variable customer base and thus variable production level as well as revenue and cost level.

The objectives of this thesis are divided into one main objective and four sub objectives. The main objective of the thesis is to create the forecasting model for the commissioning organisation utilising the Excel VBA language to automate the process. The sub objectives were divided into four individual aspects: to create a more accurate forecast to allow the management to make informed decisions, reducing the manual work associated to the forecasting process, eliminating errors and creating an easy interface for the users.

All of the objectives were achieved during the project. The model is in regular use in the commissioning organisation in the forecasting process. The accuracy increase was achieved by linking the customer's forecasts with the company's own internal data to make an up-to-date accurate forecast that could still be modified according to the user view on the matter. The automation reduced the manual work as well as the time spent on the forecasting process, although as the forecasting tool was developed further some of this gain was lost because the accuracy of the forecast was deemed more important. The automation also reduced the possibility of errors in the transference of the data as this was done by the program created. The model has been used on multiple forecasting rounds in the company, and the usage of the final model has been easy enough to manage and extract the data needed.

The accuracy of the forecasts produced by the model were evaluated during the model's use in the spring of 2018. Although small deviations were experienced in the comparisons between the forecasted and actual revenue and costs incurred from the operations, no significant issues were found in the forecasts. The model will be developed further in the future as new information is needed and wanted by the management regarding the financial operations of the company. For example, capacity data regarding the production is one of the main development topics for the future for the model. The overall process was successful both for the achievement of the thesis' objectives as well as company's management's opinion of the final result.

Keywords
Financial modeling, VBA, cost accounting, profit analysis, cost, revenue, engineering industry

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1 Introduction

Accurately predicting the revenue and costs of a company is an important part of the business operations. They provide strategic and operative information about the company's future and this knowledge could be used, for example, in investment decisions. Making these decisions require as accurate as possible financial data on future cash flows. In order to make accurate decisions, companies need an understanding of the evolution of their economic situation and of their current market. Often, however, forecasts are made based on historical developments or decision-makers' own professional skills.

This project-based thesis is a commission from Group X. The purpose of this thesis is to create a model for one of the commissioning Group's units to forecast sales and sales related costs. The model utilizes Excel VBA programming, and this aims to automate the process as far as possible. The thesis consists of presenting the model itself and its operating principles, as well as a user manual for the program, which makes it easier for the model’s users to make use of the created program and to correct any potential problems. The program was chosen as the subject for this thesis since the subject is a current and important topic in the commissioning organisations continuing improvement strategy in all of its operations through its processes. The basis for model was started in the summer of 2017 and finalised in December 2017. Into full use the model was taken in January 2018 to be used monthly in the forecasting process.

1.1 Research question and delimitation

The main objective of this thesis is to create revenue and direct material costs forecasting tool for the commissioning organisation, which can be then used monthly as part of the profit and loss forecasting process. The tool will be created using the Excel and its VBA programming language. Although more costs in addition to the direct material costs are most likely included to the model in the future, at this point the main focus is on the direct material costs. The main objective can be divided into following sub objectives:

1. Create more accurate forecast
2. Reduce the manual work associated with the forecasting process
3. To prevent errors in the process
4. Create easy-to-use user interface

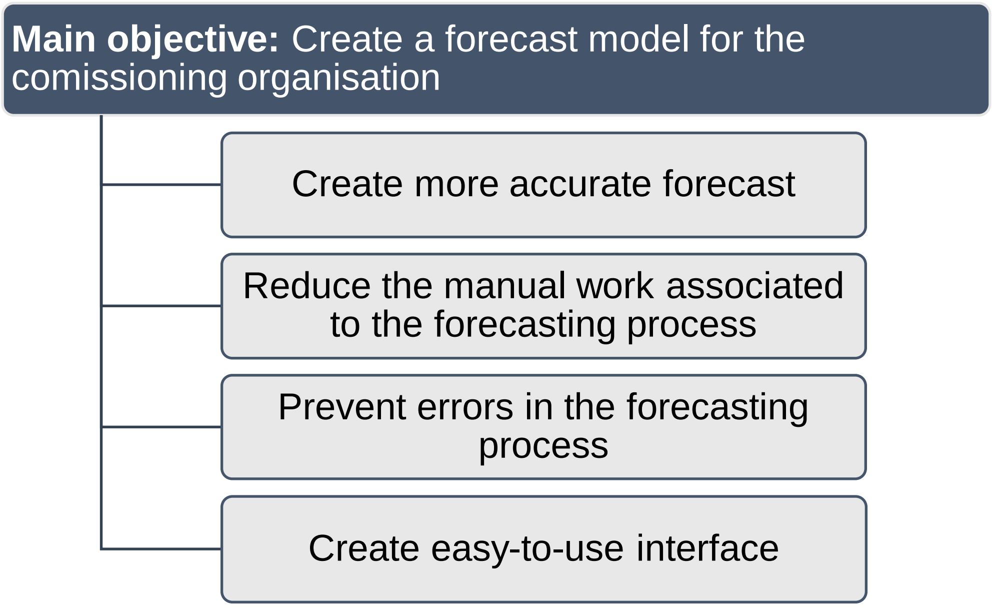


Chart 1. Thesis objectives

Achievement of the goals is measured by the model's capabilities to accurately create probable forecasts relevant to decision-making. Since certainty of this cannot be necessarily gained directly after the creation of the model, it is important to see the accuracy of the model in terms of actual sales and costs. This can then be compared with the generated forecast and the model's operation will be refined. Thus, the accuracy of the model cannot be fully assured at first, but its operation can be tested by making experimental projections based on historical data. During these experiment runs, the issues in the code that may affect the behaviour of the template, can be found. Although it is not possible to get a definite picture of the model's accuracy as soon as it's created, it can be quite accurate to determine the achievement of the work objectives before long-term use of the product.

In addition to making the forecasting process more accurate, one of the objectives is to reduce the manual time associated with the forecasting process and eliminate human errors in the transferring and copying of data. In the present situation, these are done manually, and the risk of errors is relatively high. The errors may have a significant impact on management's decision-making. With the help of the model, these can be eradicated, and the forecasting will be sharpened.

1.2 The commissioning organisation

The commissioning Group and the unit which will use the model itself have not been published because of the sensitive and confidential information contained in the thesis topic.

When referring to the commissioning organisation, the term "Group", "target company", "commissioning organisation" or similar term is used.

The Group operates in the heavy engineering industry and it serves its customers in wide range of industries. The Group's is producing various components and other services according to its customer's needs. The company's operations are focused on multiple business sites in Europe concentrating on Eastern Europe. The Group's target market and its customers are widely operating in material handling, mining, construction, agriculture and forestry as well as in energy production industries with the focus being on the material handling industry. The company's customers are located all over the world but the main customer base is located on the European market, although Asian and North American customers are also served. (Company X 2018.)

The company aims to continuously improve its own business processes while at the same time having its own competitive edge on the market. It believes in seeking the best solution for the customer through strong leadership and high performing, motivated and healthy employees. The Group invests considerable time and effort in training of individuals as well as teams to ensure quality and performance demanded by the customer. The Group continuously monitors and follows the current state of the processes and moves in co-operation with its suppliers, employees and customers to address issues that might arise from the daily operations. (Company X 2018.)

Commissioning organisation's interest in the thesis topic sparked in summer 2017. The subject for the project was strongly influenced by the author's knowledge of the Excel VBA programming language and combining this knowledge to the group's profit and cost analysis. The model will be used monthly in the financial forecasting for the chosen business site. The main users will be the company's business controller and the unit's general manager. As stated earlier, the accuracy of the model is a key objective because the group operates in very cyclical market where accurate forecasting of the revenue and costs is important for well-placed decisions.

1.3 Structure of the thesis

Structurally, this work consists of a theoretical part that addresses the principles of performance and cost accounting as well as the structures of the Excel VBA programming language, the empirical part and conclusions. The sources used are literary and network sources. As the model's functions are based on the business operations of a company and sales and direct costs related to production of the commodities, the theoretical part focuses firstly on the business operations of a company and the aspects of the different production, material and cash flows generated in the operations. Later the focus of the business operations chapter moves to the cost accounting side of the model to give the reader a view of how the costs are differentiated and divided in accounting according to their nature and how these affect the total profit of the items as well as the company itself.

As the model was aimed to be as automated as possible, the theoretical part of the thesis also provides the basics of the VBA programming language structures used in the program. The VBA chapter gives a concise view of the Excel VBA language: its key terms and structures as well as how and what the user can manipulate with the language. One key aspect of any automated program is constructing a looping structure that goes through the desired actions. The VBA chapter gives an example of a looping program to visualize this important aspect.

The empirical part focuses on the design of the program itself, the process of creation, the quantification of the operations and the objectivity of the model’s results. The aim is to describe the model as accurately as possible to allow the reader of the thesis to get a complete picture of the program's operating principles and the structure of the model, without compromising the confidentiality of the program and the information in it.

1.4 Key terminology

Income and revenue: Companies receive their income from the sale of products and services according to their operations or from other sources, such as financial income from rented premises. The income of a product or a service is its sales volume multiplied by the price the company has set for it. Revenue is defined as the income from sales less the adjustments, such as cash discounts. (Eklund & Kekkonen 2014, 28-30.)

Cost accounting: An accounting method that aims to collect all costs incurred by the production processes during a set time-frame and to classify the cost according to their nature as well as to analyse the results. (Investopedia 2018; Ikäheimo 2016, 122.)

Variable cost: Costs that change in relation with volume of the production. These include typically costs directly linked to the production, such as material and energy costs. Some variable costs could be classified as semi-variable. These are fixed when the volume is zero but increase with the volume when it increases. (Ikäheimo 2016, 123; Ikäheimo, Laitinen, Laitinen & Puttonen 2014, 138.)

Fixed costs: Fixed costs are constant and aren't affected by the volume. These include for example rents and machinery costs. Fixed costs can be classified as semi-fixed. These costs don't move in a linear fashion with the volume but increase in steps. (Ikäheimo 2016, 123-124.)

Contribution margin: The main key figure in break-even analysis is contribution margin or gross margin. This is defined as the result of income from sales less the variable costs from the production. (Ikäheimo etc. 2014, 144-145.)

Break-even point: The level of volume after which the product or service sold is profitable. When the volume is under the break-even point, the product makes losses for the company. If the volume is higher than the break-even point, the product is profitable. (Eklund & Kekkonen 2014, 77; Ikäheimo etc. 2014, 144-147.)

Visual Basic for Applications: Visual Basic for Applications, VBA, is a programming language developed by Microsoft and is included in all Microsoft Office packages without extra costs. It allows Office users to develop their own solutions and programs to use in their Excel calculations and also control the Excel software itself. (Walkenbach 2013b, 11-14.)

Macro: A macro is a sequence of instructions that automate a process to be executable repetitively and performs time-consuming tasks. Macros can be created using two ways, by recording a task with the recording tool in Excel or by writing the code manually to the VBA module. (Walkenbach 2013b, 844.)

Module: The user performs actions in VBA by writing and executing commands of code which are stored in a module as procedures. The modules themselves are accessed and edited in a Visual Basic Editor. The modules work like text editors and are stored in the Excel workbook. (Walkenbach 2013c, 121; Walkenbach 2013a, 844-845.)

Procedure: The procedures in a module are units of computer code that execute actions. The VBA language uses two kinds of procedures: Subs and Functions. A Sub procedure is a series of statements that are executed. Functions are procedures that can be accessed by other VBA procedures. (Walkenbach 2013c, 121.)

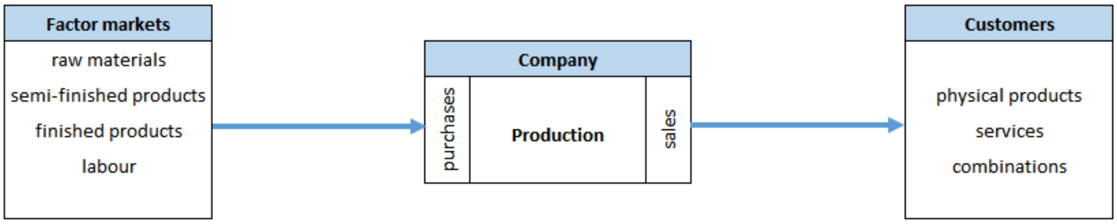
2 Processes, costs and profitability

This chapter will focus on the different business processes of a company as well as how revenues and costs are calculated. At first the focus is on the differentiation between the operational and cash flow processes within a company. After this, the incurrence of income and costs is viewed in more detail.

The purpose of companies is to produce and sell commodities to customers according to their needs. These commodities could be physical products, such as clothes, services or combinations of physical products and services. The production requires materials, services and labour which the company must acquire from the markets. This creates costs to the company which in turn decrease the revenues from the sales. For the company to stay profitable and alive, the revenues from sales must be larger than the costs from the production. (Eklund & Kekkonen 2014, 12.)

2.1 Operational process

The operational process of a company shows how the company interacts with the factor market as well as the customers. The operational process includes all processes that the company has in all of its production steps. These include purchases, logistics, production, sales and marketing as well as management. The Picture 1 shows the processes of a company in relation with the suppliers and customers. (Eklund & Kekkonen 2014, 12-14.)



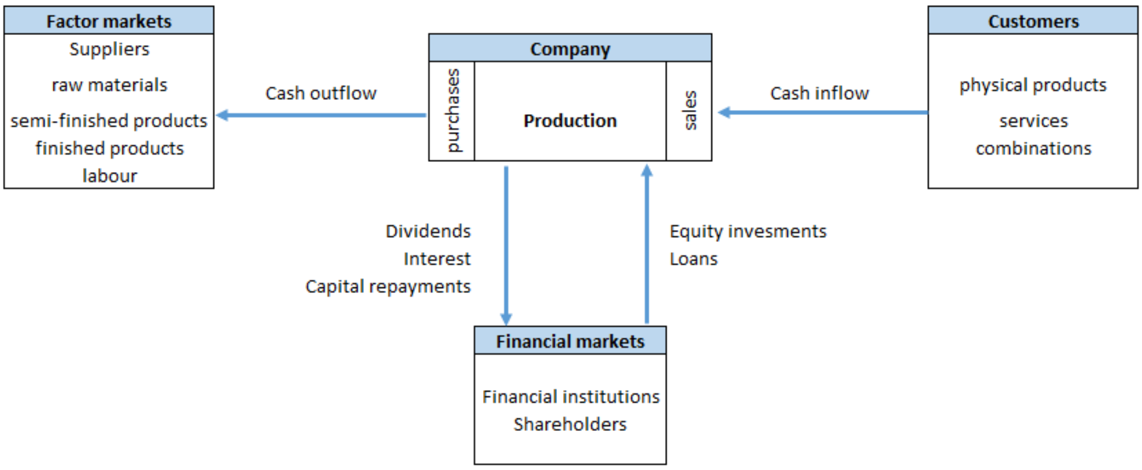
Picture 1. Operational process of a company (Eklund & Kekkonen 2014, 12.)

Companies have different operations, all which have distinct duties in the overall process. For the company to be able to sell its products or services to the customer, these processes must be operational. The first step to production is functional purchasing department. The company's purchasing department acquires the raw materials, semi-finished products and finished production needed for its own production from the factor markets. In addition to the materials needed, labour is also acquired from the factor markets in form of employees. After these materials and labour force is bought or hired, the production department changes the materials to final products or services to be sold to the customer by the sales department. (Eklund & Kekkonen 2014, 12-13.)

As the production should be continuous, the company must invest in different assets even before starting the actual production. These include business premises, warehousing, machinery and spare parts to keep the machinery functional. Each of the aforementioned items create expenses for the company; the price for the materials, the wages and salaries paid to the employees, rents and maintenance costs for the premises and other assets. The costs are offset by the revenues from the sales of the products and services. The income and costs are shown in the cash flow process of a company. (Eklund & Kekkonen 2014, 13-14.)

2.2 Cash flow process

The operational process is supplemented with the cash flows related to the operational functions of the company. As shown in the Picture 2 below, the cash flows related to purchasing and sales are mirror images of the operational flows. The company has cash inflows from the sales as payments from the customers according to the prices and cash outflows related to the purchases to the suppliers of material as well as the employees as wages and salaries. (Eklund & Kekkonen 2014, 14.)



Picture 2. Cash flow process (Eklund & Kekkonen 2014, 14.)

The financial markets are introduced to the processes as the companies need additional capital in addition to the cash flows received from sales. This need arises often from the fact that the cash outflows are due before the cash inflows are received. The capital invested to the business at the start of the operations is not sufficient to finance the everyday operations, as these are needed to the investments to the machinery and other assets. This means that the companies need extra capital to keep the operations running. (Eklund & Kekkonen 2014, 14-15.)

The financial cash flows could be in the form of equity or loans. Equity is acquired from investors that could be the current or new shareholders of the company who invest into the company. Loans are received from different financial institutions, such as banks, as well as from individual investors. Both of these capital investments, equity and loans, require payments to the investors. The shareholders expect the company to make profit and pay some of the profits back to them as dividends. Loans are capital which needs to be paid back at the agreed date or in instalments, and as such create costs for the company. With loans, the company has to pay interest according to the contact with the creditors as well as loan repayments. (Eklund & Kekkonen 2014, 15.)

2.3 Revenues in business processes

Companies receive their income from the sale of products and services according to their operations. The income of a product or a service is its sales volume multiplied by the price the company has set for it. The income is therefore comprised of two variables, the volume of the product or service and the price for which it is sold. In accounting, revenue is defined as the income from sales less the adjustments, such as cash discounts. (Eklund & Kekkonen 2014, 28.)

In addition to the income from the operational business, companies can receive income from other sources. These include income from sold assets, such as machinery and buildings, rents from rented premises or some government subsidies. In addition to these, the companies can receive financial income from its investments. It may have loans outstanding with other businesses from which the company receives interest income or it may be a shareholder in some company and as such, receives dividends. Finally, companies could have nonrecurring one-off sales from asset deals related to part of its business operations. (Eklund & Kekkonen 2014, 30.)

2.4 Cost accounting

Cost accounting has three main roles and duties in a company. The first to define and control how inventories are valued in a company. The valuation is important part of accounting and legislation has exact regulations for what costs could be included in the valuation of different inventory items. The second main responsibility of cost accounting is responsibility accounting, or cost centre accounting. As companies have multiple processes, the costs are booked to different cost centres according their incurrence. For example, marketing related costs are booked to its cost centre. Cost centres can be divided as precisely as needed and the marketing cost centre could be divided into different costs centres for digital marketing and traditional marketing. The third and final role of cost accounting is to define the costs of individual products, services and customers. (Ikäheimo 2016, 122.)

The cash outflows are divided into two groups in accounting. Expense is defined as the acquisition price of a commodity or service. Cost is the portion of the expense that is allocated to the fiscal year. (Ikäheimo 2016, 123.)

2.5 Variable and fixed costs

Costs are also differentiated according to their behaviour related to the volume of the operations. Variable costs, as their name suggests, change with the volume. As the volume decreases, the costs related also fall and when the volume rises the costs increase. Variable costs are typically costs related directly to the production, such as material costs and energy costs. Semi-variable costs are defined as fixed when the volume is zero but increase with the volume when it starts to increase. For example, some salaries have variable part that changes with the working hours and a fixed part that stays constant whether or not actual work done. (Ikäheimo 2016, 123; Ikäheimo, Laitinen, Laitinen & Puttonen 2014, 138.)

Fixed costs are stable regardless of the level of the current volume in the production. These costs aren’t affected by the increases or decreases in the volume. Costs related to business premises, information systems, machinery and management are usually classified as fixed costs. Some costs can be classified as semi-fixed or alternatively as step-costs. This means that they change with the volume but the changes happen in steps and not in a linear or exponential fashion. (Ikäheimo 2016, 123-124.)

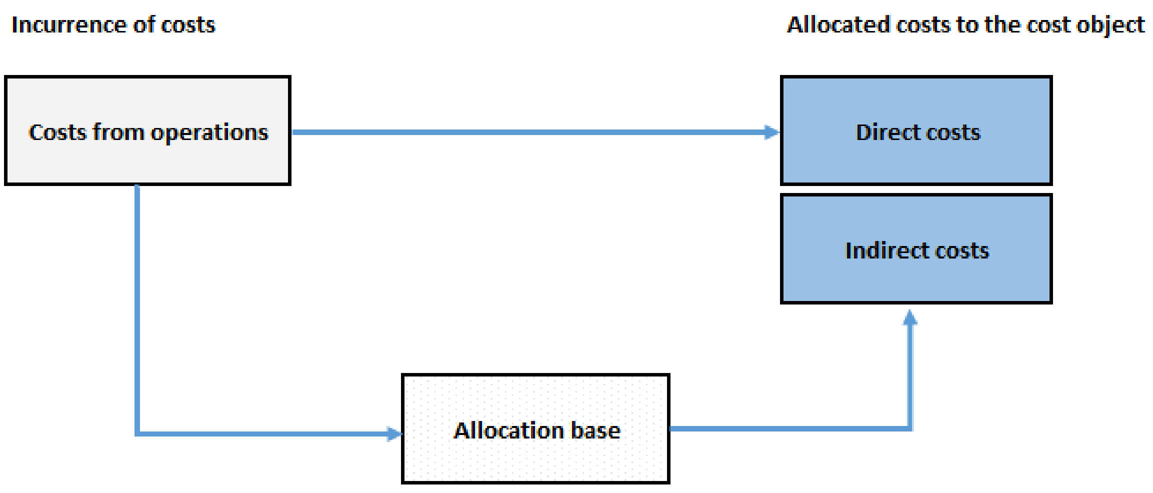
The differentiation of the costs to variable and fixed also depends on the timeframe in which the costs are viewed. If the timeframe is long enough, for example multiple years, each cost could be defined as variable. Within a month it is difficult to affect the costs but in the very long-term each cost is open for changes. For example, in a time-frame of 10 years the company could affect its costs base significantly. (Ikäheimo etc. 2014, 138.)

2.6 Cost allocation with direct and indirect costs

The costs from the processes have to be targeted to the different production steps to allow precise reviewing and reporting of the costs for each cost centre. Usually, the costs are allocated to the product or customer that has incurred them. This process is called cost allocation. Cost allocation is needed by the management for planning calculations as well as in post calculations. (Ikäheimo etc. 2014, 135.)

Typically, the allocation is done in two steps. First, the costs that could be allocated to the cost object without further investigation are allocated. These costs are called direct cost as they could be directly allocated to a certain process or step. This is done with simply observing the process or by registering the costs to the process with the systems used. In the second step, the costs that could not be allocated directly to the process, or the allocation directly with enough precision isn't feasible, are examined. These costs are called indirect costs. These include, for example, different management or marketing costs that usually could not be allocated directly to a certain product. (Ikäheimo etc. 2014, 135.)

The indirect costs are allocated using an allocation base which purpose is to describe the connection between the cost and the cost object. The basic principle is that the costs are assumed to increase directly in relation with the allocation base. This means that the allocation base is usually based on the nature of the cost object. The Picture 3 shows the basic principle of the cost allocation process. (Ikäheimo etc. 2014, 135-136.)



Picture 3. Cost allocation process for direct and indirect costs (Ikäheimo etc. 2014, 136.)

The proportion between direct and indirect costs is typically in the hands of the management, at least partially. If the processes in company are designed to be exact and most costs are considered direct, the cost allocation and monitoring of the costs of different cost objects could be accurate but usually these kind of processes are heavy to maintain and use resources that could be used elsewhere. If the company decides to keep most of the costs as indirect, the processes would be lighter to maintain but then the company must settle for more inaccurate cost allocation. The decision on the differentiation of direct and indirect costs depends on the management's view between the effort and the more precise information. (Ikäheimo etc. 2014, 136.)

2.7 Scope of cost accounting and valuation of costs

The allocation of costs and the scope of what costs are taken into account in the allocation process, is for the management to decide. Some costs that are deemed as non-recurring or small in impact, could be left out of the allocation as these costs don't have continuous impact on the processes of the company and the effort to allocate these costs is not worth the more precise result. The scope of cost accounting is defined as the decisions which costs are to be taken into the allocation process and which are to be left out. (Ikäheimo etc. 2014, 136-137.)

The correct valuation of the costs is important to allow continuous and precise monitoring as well as to enable correct and fact-based decision making in the company. The costs could be valuated with multiple different means. The simplest way is to use the current unit price for the item. However, as the prices for materials and services change over time, this isn't the most efficient way of valuing the costs. To alleviate this, the use of the materials could be valued in the order in which they have been bought and consumed or alternatively weighted average of the costs could be used. (Ikäheimo etc. 2014, 137.)

2.8 Break-even analysis

Break-even analysis, or contribution margin analysis, is a basic calculation of the profitability of a certain product or even a whole company. It enables the examination of the income, costs and profit of the production when the variables behind the production, such as volume, prices and costs, change. The analysis gives an answer to the question how much of the product or service has to be sold to reach profitable level, a break-even point. The break-even analysis is used especially in short-term reviewing of the production. (Eklund & Kekkonen 2014, 77; Ikäheimo etc. 2014, 144; Jormakka, Koivusalo, Lappalainen & Niskanen 2016, 151.)

	Income from sales
-	Variable costs
=	Contribution margin/gross margin
-	Fixed costs
=	**Result**

Picture 4. Contribution margin calculation (Ikäheimo etc. 2014, 145.)

The main key figure in break-even analysis is contribution margin or gross margin. This is defined as the result of income from sales less the variable costs for the production. This is shown in the Picture 4 above. (Ikäheimo etc. 2014, 144-145.)

For the sake of simplicity, volume is considered as the main driver for both variable costs and income in the calculation. The income and cost are assumed to be directly proportional to the change in the volume and move to the same direction as the volume. Other principle of the calculation are as follows:

1. total income and costs are linear in the time period viewed,
2. unit price, variable unit cost and fixed costs are known and assumed to be constant,
3. the analysis is done one item at a time,
4. all costs and income is incurred in the same time period and
5. volume is the only variable that affects the income and costs (Ikäheimo etc. 2014, 145.)

The break-even point for the item can be calculated with a simple function shown below where “p” is the unit sales price for the item, “v” is the variable unit cost, “q” is the volume for the item and “F” is the total fixed costs. When the result is set to 0 and the volume “q” is solved from equation, this is the break-even volume at which the result for the company or product is zero. If the volume is under the break-even point, the product makes losses for the company. If the volume is higher than the break-even point, the product is profitable. The difference between the current volume at which the product is profitable, and the break-even point is called margin of safety. (Ikäheimo etc. 2014, 146.)

$$(p * q) - (v * q) - F = Result$$

Equation 1. Break-even point (Ikäheimo etc. 2014, 146.)

The equation above shows the calculation of the result. In the equation “p” is defined as the price for the product or service, “q” is the current volume, “v” is the variable cost related to the product and “F” is the company’s total fixed costs. (Ikäheimo etc. 2014, 146.)

The break-even point and the relation between the income, costs and the result is visualised in the Chart 2 below. In this calculation the unit sales price is set to 150.00 EUR, the variable unit costs to 100.00 EUR and total fixed costs to 20,000.00 EUR. The volume starts from 0 and is increased in increments of 50 units. With the equation above, break-even point is at volume of 400 units, when the total income is 60,000.00 EUR, total variable costs are 40,000.00 EUR and total fixed costs are 20,000.00 EUR. The red line in the chart shows the break-even point for the product.

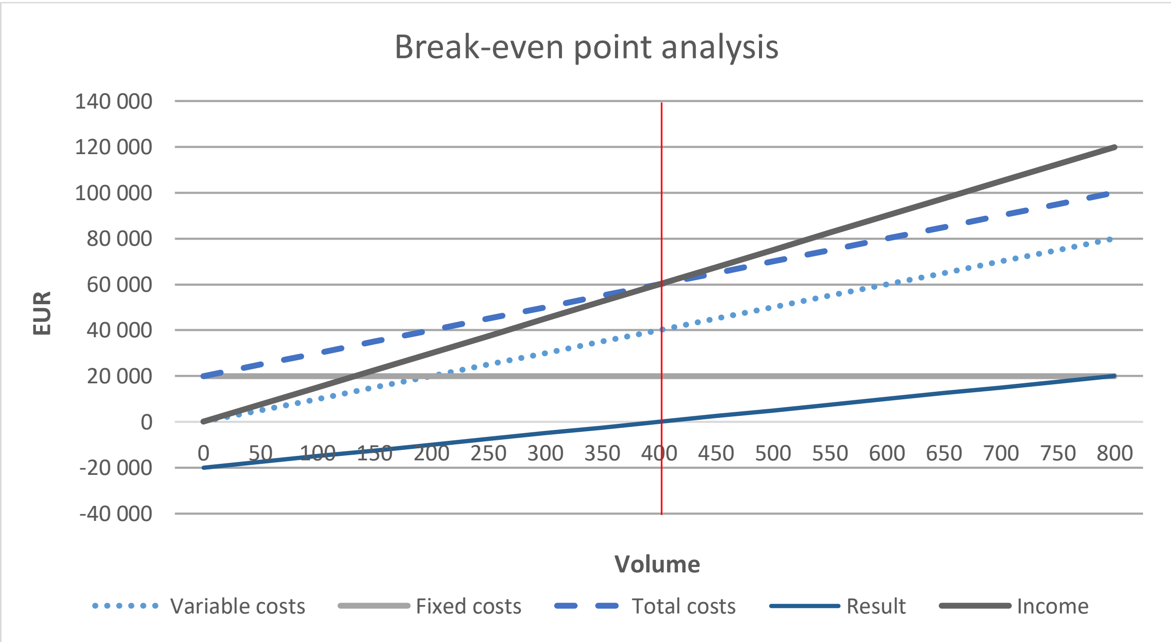


Chart 2. Break-even point analysis

2.9 Budgeting

The company's strategic planning and forecasting of the future cash in and outflows are often made for a very long time period. This timeline could extend upwards of over five years into the future. Budgeting on the other hand is planning for the imminent future, often for the next fiscal year. A budget is a plan for a set time period shown in number format. The budget is created based on the company's strategy and long-time goals. The company's resources as well as operations are taken into account in the planning process. (Jormakka etc. 2016, 172.)

The budgeting process itself consists of creation of the budgets, the controlled use of the set budgets and monitoring as well as analysing the operations to ensure that the set limits are used. The aim for budgeting is to produce goal-based operations and coordinate the processes of various aspects or sections of the company. The monitoring of the budgets is one the most important aspects of budgeting. As the budget is the aimed goal for the revenues and costs for the fiscal year, the analysis of these goals is important to enable the management to do comparisons of the processes and operations in relation to the set limits as well as make corrective actions based on the possible deviations. (Jormakka etc. 2016, 172-173.)

The budgets are divided into two distinct groups: master budgets and individual budgets. The master budget is the collection of the company's financial data. It includes the operating budget, financial budget and cash flow budget. Operational budgets cover the revenues and expenses incurred from the main operations of the company. Operating budgets are usually divided into weekly or monthly sections to allow the management to compare the actual income and expenses to the budgeted goals. The financial budget shows the assets, liabilities and capital expenditures as well as gains for the company. Finally, the cash flow budget shows the cash in and outflows of the company for the set period. The master budget's goal is to present the whole situation of the company's current state and it combines sales, expenses, assets and liabilities into one budget. The number of individual budgets varies depending on the structure of the company's operations. The individual budgets can be created for each of the company's processes for example a production company may have a budget for purchasing and production. (Jormakka etc. 2016, 173-174; Smallbusiness 2018.)

3 Microsoft Excel and VBA programming language

This chapter focuses on the structures and basics of the Microsoft Visual Basic for Applications programming language. The chapter will look into the background of the language and its uses today. The main part of the chapter will focus on the principles of program creation with the language and the language's different main parts. Because the created model is the main substance of this thesis, the range of covered subject in this chapter will be delimited to the used structures without going into extreme detail about VBA.

Microsoft Excel is the most used software for spreadsheet calculations in the world most likely due to its inclusion to the Microsoft Office software package. Although other spreadsheet software exist, Excel has kept its popularity through time. One of the benefits of Excel is its versatility and Excel's strength with numerical calculations. With Excel, the user is able to create budgets, analyse survey results, create charts or manipulate data. (Microsoft 2018; Walkenbach 2013a, 3-4.)

3.1 Introduction to Visual Basic for Applications

Visual Basic for Applications, VBA, is a programming language developed by Microsoft and it is included in all Microsoft Office packages without extra costs. VBA allows Office users to develop their own solutions and programs to use in their Excel calculations and also control the Excel software itself. For example, VBA language allows the Excel user to minimize repetitive manual labour, create customs commands to run, develop custom worksheet functions or create complete applications such as games. (Microsoft 2018; Walkenbach 2013b, 11-14.)

One of the main advantages of using Excel VBA to automate your processes relates to the accuracy and consistency as well as the speed of the process. By automating the processes with executable programs, the user can eliminate errors and shorten the time needed. As Excel executes the commands the same way with all runs, potential errors are minimised. This automation in VBA also allows the user to make complicated task doable for those who may not have the complete knowledge of the task by automating the process. Time-consuming tasks can be run in the background as the user continues his/her other duties. (Walkenbach 2013b, 14-16.)

However as with all programs, VBA is not without its potential disadvantages. One apparent disadvantage of VBA is that the programmer must have some knowledge of the VBA language as debugging is possibility when running programs with all programming languages. The other disadvantage relates to the fact that VBA is part of the Microsoft Office ecosystem. Although the written programs are exportable, the language is developed to be used with the Office software. All users that would want to use the created program must have Microsoft Excel installed on their computers. Also, Microsoft is constantly developing new versions of their Office products and as a result compatibility between versions is not guaranteed. (Walkenbach 2013b, 15.)

3.2 Macros and VBA language

The basic structure of the VBA language is based on *macros*. A macro is a sequence of instructions that automate a process to be executable repetitively and perform time-consuming tasks. In Excel, macros can be created using two distinctive ways, by recording a task with the recording tool in Excel or by writing the code manually to the VBA module. Recording allows the user to create automated tasks without knowledge of the programming language. If the user wants to create more intricate and complex programs, the manual programming is the better solution. To be able to write the code, the user must have good understanding of the VBA language and its different aspects such as objects, properties and methods. (Jelen & Syrstad 2013, 14; Walkenbach 2013b, 844.)

In short VBA language can be eight different aspects:

- code
- module
- procedures
- objects
- collections
- object hierarchy
- active objects
- objects properties
  (Walkenbach 2013b, 844.)

The user performs actions with VBA by writing and executing commands of *code* which are stored in a *module* as *procedures*. The modules themselves are accessed and edited in a Visual Basic Editor. The procedures in a module are units of computer code that execute actions. The VBA language uses two kinds of procedures: *Subs* and *Functions*. A Sub procedure is a series of statements that are executed. Functions on the other hand are procedures that can be accessed by other VBA procedures. (Walkenbach 2013c, 121.)

The VBA language is based on the notion of manipulating *objects*, either via macro or manually. Excel has over 100 classes of objects which the application can manipulate.

Few examples of these Excel objects are:

1. The Excel application
2. A workbook
3. A worksheet
4. A range or table
5. A data point or cell
   (Walkenbach 2013c, 11)

The objects follow a certain hierarchy. The Excel application contains workbooks, which then include different worksheets. The worksheets in turn can have ranges of data and the ranges have multiple different data points. When the user refers to an object in the code, the objects position in the hierarchy must be specified. The example in Picture 5 shows a line of code that refers to a cell "A1" in "Sheet 1" in a workbook "Book 1". (Microsoft 2018; Walkenbach 2013c, 11, 122.)

```
Application.Workbooks("Book1.xlsx").Worksheets("Sheet1").Range("A1")
```

Picture 5. Referring to an object (Walkenbach 2013c, 122).

The objects in the Excel workbook have their own *properties*. These can be thought as attributes that refer to the object. As an example, a RANGE object has Column, Row, Width and Value properties depending of the size and the data in the range. VBA language can be written to take two actions based on the properties. The first is to examine the current property, such as the Value, and make actions based on that Value. The other is to change the property's settings as commanded in the code. Referring to a property is done with placing a period after the object's name in the code. Below is an example of VBA code referring to a cell's property and setting a Value for it and taking an action based on the value. (Walkenbach 2013a, 847-848.)

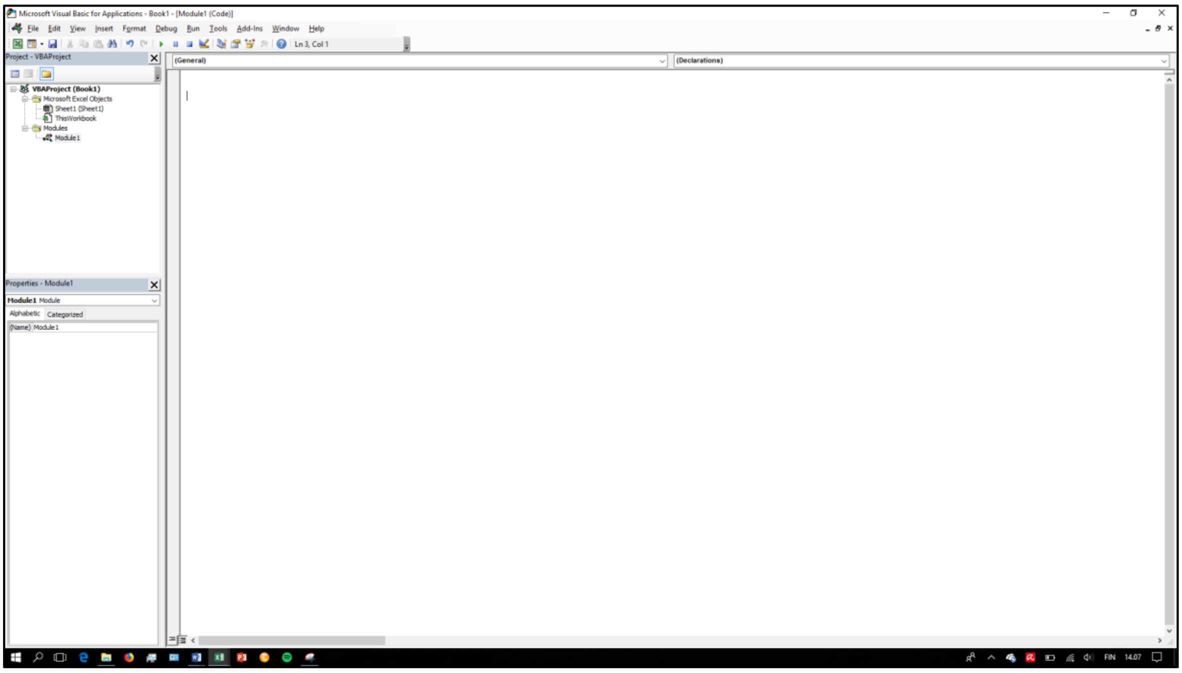
```
Range("A1").Value = 15

If Range("A1").Value < 20 Then
    Range("B1").Value = "Under 20"
```

The code above refers to a cell "A1" and its Value property, which is set to be 15. Then the second line of code looks at the Value in cell "A1" and takes actions based on the Value. If the Value in cell "A1" is less than 20, the Value in cell "B1" is text "Under 20". This is a basic example of changing the property's settings and taking and actions based on the property.

Writing of the code is done to a VBA *module* from a Visual Basic Editor window in Excel. The editor and new modules can be accessed by:

1. Pressing Alt + F11 to activate the Editor window
2. Locating the workbook that you are using
3. Choosing Insert and Module
   (Walkenbach 2013a, 844.)

The modules, shown in Picture 6, work like text editors, like Microsoft Word, and the user can use the same techniques such as copy, cut and paste through the module. The modules are stored in the Excel file and a single workbook can include as many modules as the user needs to have. (Walkenbach 2013a, 844-845.)



Picture 6. VBA Module

3.3 Sub procedures

As discussed earlier, a procedure is a series of code that executes actions and there are two kinds of procedures *Subs* and *Functions*. Sub procedures are declared with a “Sub” statement with the following syntax:

```
[Private | Public][Static] Sub name ([arglist])
    [instructions]
    [Exit Sub]
    [instructions]
End Sub
```

Picture 7. Sub procedure syntax (Walkenbach 2013c, 228.)

The Sub procedure is constructed of the following elements:

1. **Private/Public/Static**: These are optional indicators that determine that is the procedure accessible by other procedures in the module.
2. **Sub:** Required element that determinates the beginning of the procedure.
3. **name**: Required element that determinates the name of the procedure.
4. **arglist**: Optional elements in parentheses that influence the procedures actions.
5. **instructions**: Optional element that includes the VBA instructions for the procedure.
6. **Exit sub**: Optional element that forces the ending of the procedure.
7. **End Sub**: Required element that indicates the ending of the procedure.

(Walkenbach 2013c, 228.)

Picture 8 shows an example of a simple Sub procedure with most of the elements above. The example Sub has a Public state, the name of "Example" and instructions to set the value of cell "A1" to the value of cell "B1". Then if the value of the cell "A1" is 10, the Sub procedure is ended with a "Exit Sub" statement.

```
Public Sub Example()

Range("A1").Value = Range("B1").Value

If Range("A1").Value = 10 Then
    Exit Sub

End Sub
```

Picture 8. Basic Sub procedure

3.4 Variables in VBA

VBA, as all programming languages, allows the user to work with *variables*. Variables can be thought as names for different values that can be stored in the workbook (Walkenbach, J. 2013c, 124). When naming the variables, it is recommended to use as descriptive names as possible. Although this has no effect for the processing, it makes the code more understandable. In addition, VBA has three rules regarding the naming. Firstly, alphabetic characters, numbers and some punctuation characters can be used as long as the first character is alphabetic. Secondly, spaces and periods can't be used in the variable names. Thirdly, special character types, such as exclamation marks, can't be used. In addition, VBA doesn't differentiate between upper and lower cases, so it is useful to use both in the names when possible, for example "InterestRate", to make the code more readable. (ExcelFunctions 2018; Walkenbach 2013c, 181.)

Below is an example of a variable, where a variable “Interest” is set to be the Value in the cell “A1” in the first worksheet:

```
Interest = Worksheets("Sheet1").Range("A1").Value
```

Picture 9. Setting a variable in VBA (Walkenbach 2013c, 124.)

The difference between VBA and other programming languages is that in VBA the user doesn’t have to explicitly declare the variables before using them. Excel can take the actions without the declarations. However, when using variables, it is recommended for the user to specify the *type* of the data stored in the variable for Excel as this speeds up the processes. The data type determinates how the data in the variable is stored in the memory. Few often used types are integer and string or text. The Table 1 below shows the different data types that are used and supported by the VBA language. (Walkenbach 2013a, 850, 929; Walkenbach 2013c, 185.)

Data type	Bytes used	Approximate range of Values
Byte	1	0 to 255
Boolean	2	True or False
Integer	2	-32 768 to 32 767
Long (long integer)	4	2 147 483 648 to 2 147 483 647
Single	4	na
Double	8	na
Currency	8	na
Decimal	14	na
Date	8	1.1.1900 to 31.12.9999
Object	4	Any object reference
String (varible lenght)	10 + string length	0 to 2 billion
String (fixed lenght)	Lengt of the string	1 to 65 400
Variant (numbers)	16	Any numeric value up to the range of Double
Variant (characters)	22 + string length	Any value up to the range of String
User-defined	Any number	Any number

Table 1. Variable data types in VBA (ExcelFunctions 2018.)

If the user doesn’t declare the variable type, Excel uses Variant as the default type. Normally it is recommended to use the type that has the smallest number of required bytes but can handle the data needed. The speed of the processes in VBA is determined by the number of bytes needed for the calculations and used by the variables. In other words, fewer bytes used for the variables, faster the processes are. (Walkenbach 2013c, 185-186.)

Declaring a variable is done with a *Dim* statement first time the variable is used. The picture 10 below shows variables “i”, “j” and “k” declared as integers:

```
Dim i, j, k As Integer
```

Picture 10. Declaring a variable type (Walkenbach 2013c, 188.)

Variables can be declared as local variables, module wide variables or public variables. Local variables are declared to be used in a certain procedure, a sub or a function. This means that these variables are usable only inside the procedure and when the procedure ends, the variable stops existing and the memory that was used to store it frees. Module wide variables are declared in the beginning of the module before any procedures are written. Module wide variables keep their values through all the procedures and thus occupy the memory as well. The variable only stops existing when the VBA process comes to an End statement within the code and normal procedure endings don’t affect the variables existence. Public variables can be used by all the procedures through all the modules in the project. Differing from the local and module wide variables which are declared with the “Dim” statement, public variables are declared with “Public” statement before the first procedure. (Walkenbach 2013c, 188-190.)

3.5 Looping structures

In VBA looping is a procedure that repeats certain chunks of instructions or commands in a limited range of values. The most used looping structures are the following loops.

1. For…Next
2. Do…While
3. Do…Until
   (Jelen & Syrstad 2013, 79.)

“For…Next” loop is the most commonly used and the simplest looping structure. It goes through the actions between the set boundaries in the syntax between “For” and “Next”. The loop includes a variable which value is increased each time the loop is completed. The syntax for the “For…Next” loop is shown in the Picture 11 below. (Jelen & Syrstad 2013, 79; Walkenbach 2013c, 218-219.)

```
For counter = start To end [Step stepval]
    [instructions]
    [Exit For]
    [instructions]
Next [counter]
```

Picture 11. For-Next loop syntax (Walkenbach 2013c, 219.)

The loop is constructed of the looping limits (“start To end”), instructions, “exit” statements and “next” statements. The loop executes the procedure until the ending limit is reached. Picture 12 shows an example of a simple looping structure.

The procedure “Looping” in the example first declares the variables “i” and “sum” as integers. The loop itself consists of the counter “i” and limits of 1 to 10, instructions what to do during the loop and the Next statement declaring the move to the next counter. The variable “i” is set to a value of 0 in the beginning. The variable “sum” is a sum of the counters. During the loop, the procedure adds-up the current counter to the current value of the sum and then moves to the next counter until the value of “i” reaches the limit of 10.

```
Sub Looping()

Dim i As Integer
Dim sum As Integer

i = 0


For i = 1 To 10
    sum = sum + i
    Next

End Sub
```

Picture 12. Simple looping example

So, in the beginning of the first loop the value of “i” is 1 and the value of “sum” is 0. At the end of the first loop the value of the sum is 1 (0 + 1 = 1). In the second loop the value of “i” is moved to the next counter, which is 2, and it is then added to the previous value of the “sum” variable 1. This means that at the end of the second loop, the value of “sum” is 3. This process then repeats until the value of “i” is 10. The final value of “sum” is then 55.

4 The forecasting model

The basic principle behind the project was that the revenue and cost forecasting process could be improved by making the updating process more accurate by forecasting the sales on item by item basis and also by making the process more efficient and removing possibilities for human errors. To achieve this, a forecasting model was decided to be created by the author. The objective of this chapter is to describe the background behind the created model and the creation process itself. To give the reader a sufficient view of the model, the focus for this chapter is on the creation process as well as the operating steps of the model.

As with all projects, the exact functionality of the final model was not known at the start of the project. The model went through couple of versions with variable size of modifications to the fundamental functions. This chapter goes through the creation process and highlights the issues faced in the process and how these issues were corrected.

4.1 Description and desired end result

The commissioning organisation's desire was to have an automated model with accessibility for multiple users. Thus, it was decided that the model would be a macro-enabled Excel worksheet that could be accessed from the commissioned organisation's network drive. This file is then updated on monthly basis when the revenue forecasting on the Group level is changed. Currently the forecasting method for the commissioned organisation is manual and based on couple of customer forecast in Excel form or from verbal communication. The process isn't the most accurate one as the data item and material data is not updated on a regular basis and the forecast isn't done on an item by item basis. This means also that the comparison of the actual and forecasted sales is difficult and the reasons behind possible deviations from last forecast are not easily found. The current forecasting process is divided into six steps and the process is the following:

1. Couple of customers send their order forecast to the organisation. For the other customers these are received from verbal discussions with the sales representatives
2. Based on the information received, a sales pipeline report is updated with the previous actual sales data and the estimated forecast. This gives the total sales forecast for the period

Based on this sales pipeline report, a separate profit & loss calculation model is updated to match the sales forecast. This model is formed around the basic income statement structure and it gives the full forecast for the company.

3. The sales are updated to the P&L model
4. When the sales are updated, the material costs that correspond these sales are updated automatically by the P&L model
5. When all of the required data is updated, the P&L model calculates the forecasted profit for the period
6. The data is inputted to the external reporting database for collection

The purpose for the product of this thesis is to give better understanding for the steps 1-4. The effects of the model are also visualised in the Chart 3 below. These steps include a lot of manual processes and the sales estimations are not based on the current prices on an item per item level, but rather on the average price or discussions or intuition of the management. Furthermore, the other vital step is the fourth phase. Currently the material costs are not based on the actual costs per item but on an estimated percentage of sales on customer level. The aim of the product is to change the material cost estimation to view the costs on the item level. This will give more focused view of the material costs and give the management of the commissioned organisation a better look at the forecasted total material cost and changes in between the actual and forecasted sales. The subsequent steps are not included in product at this stage.

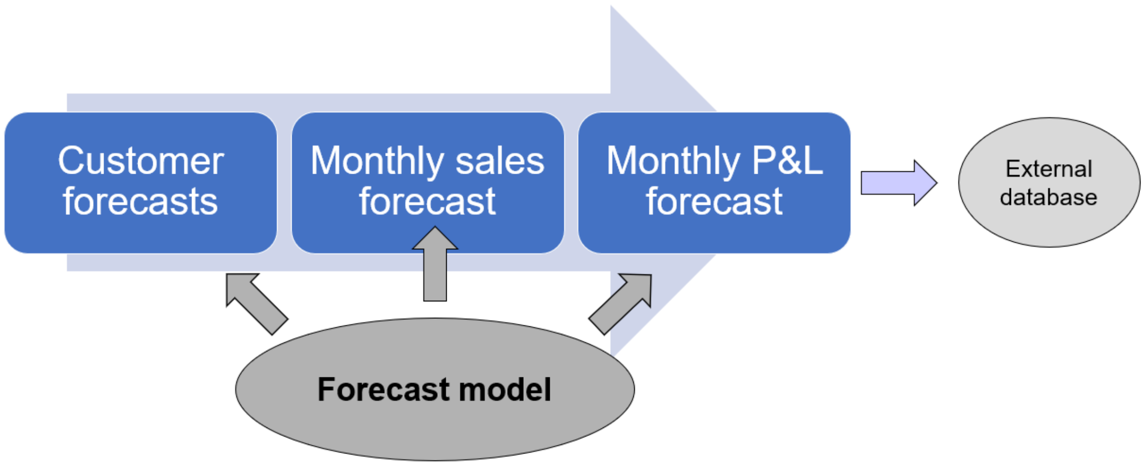


Chart 3. The model's desired effects on the forecasting process

4.2 Designing and schedule

The designing phase was started in June of 2017 after a preliminary discussion with the commissioned organisation’s management. The management staff presented their view of the final model and the desired inclusions. Additionally, the latest order forecast from a major customer was handed over to give the author a base onto which to create the automated processes. Furthermore, couple of ideas for the structure was brainstormed. The timetable for the whole project was agreed in the discussion, shown below in Table 2:

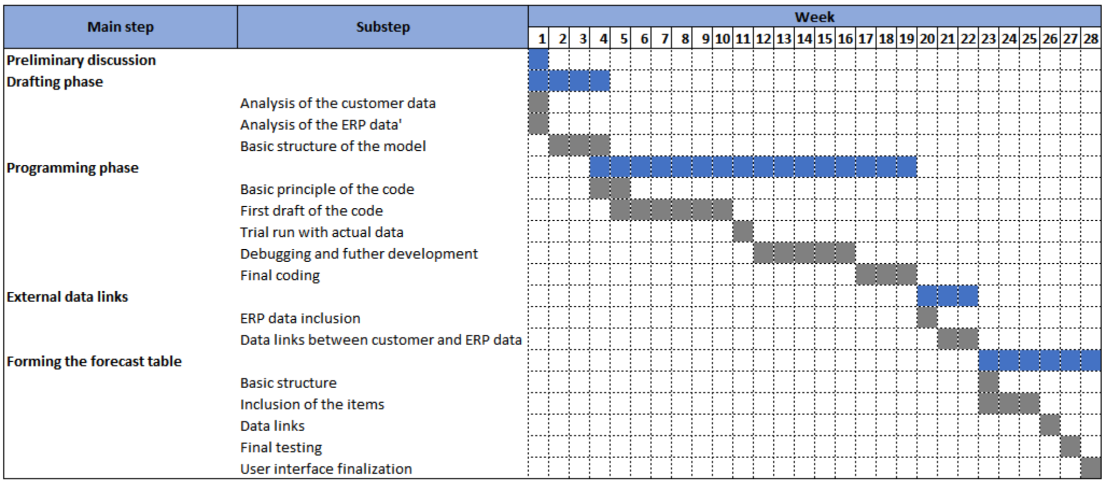


Table 2. Project timetable

The project was agreed to be completed in 7 months or 28 weeks at the latest. This allowed enough time to test and develop the model to the desired accuracy but also keep the deadline tight enough to prevent the progress from stalling. As shown in the timetable, the six main steps in the creation process are drafting and programming phases, external data linkage and forecast table creation. These steps are then divided into sub phases.

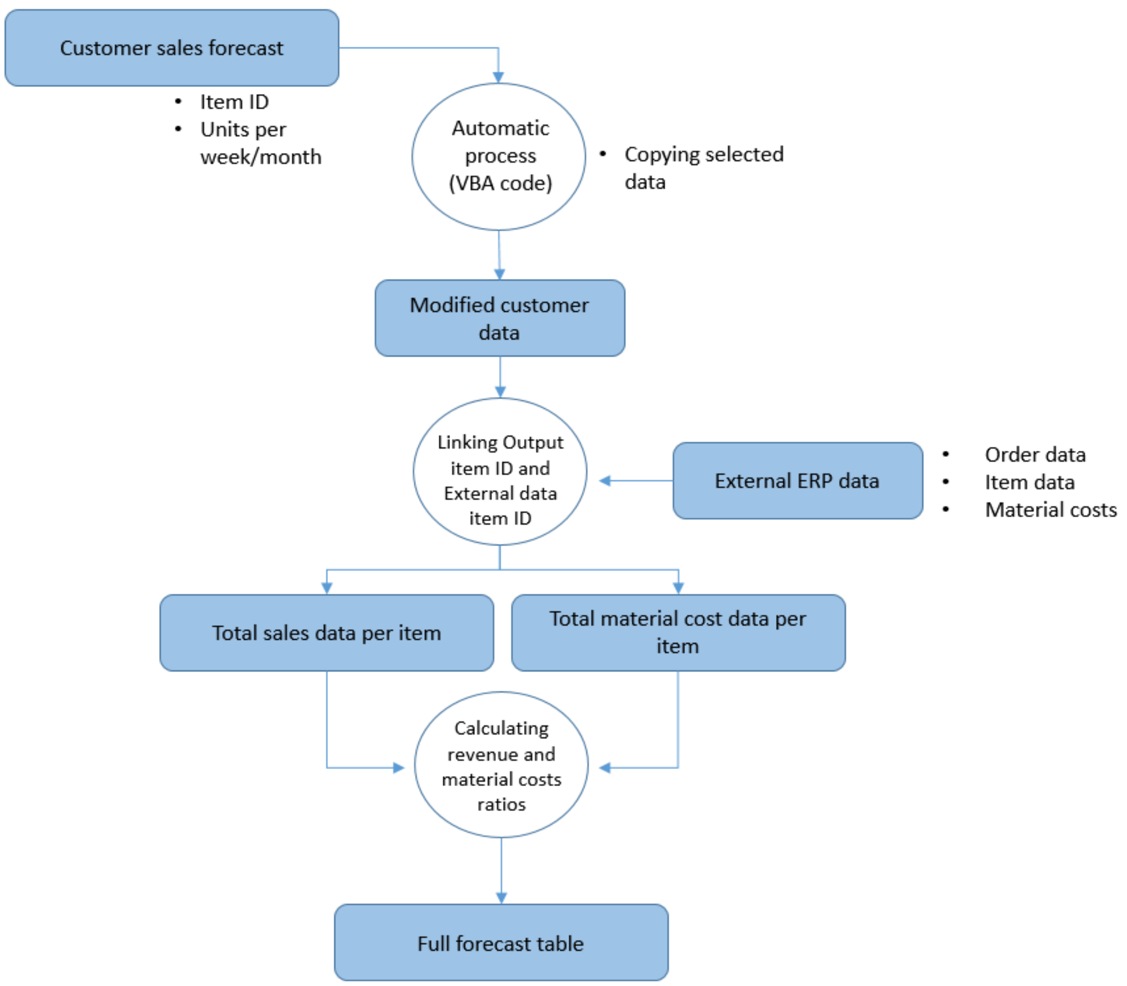
After the timetable was agreed, the project moved to the drafting phase. The main focus was on the basic principles of the model and how the master data could be processed to allow the model to include it to the analysis. The master file includes the ordered and forecasted units per item first in weekly basis and later in monthly basis in the more abstract forecast. The problem with the master data was that at its basic state the inclusion was not possible without manual modifications. The master file was formed in such format that some of the needed data was in every other row with the rest on each row. Furthermore, the ordered and forecasted units were shown in subsequent rows per item. These had to be separated.

These modifications were taken into account in the designing of the automatic process which would then separate the needed data from the master data and change the format to more usable form into a separate worksheet. The coding process will be shown in more detail in the next subchapter. Additionally, the longevity of the model could not be ensured without the modifications, as the form in which the order data from the customer was, could change. After these issues were identified, the crude draft of the Excel file was formed with the required sheets for different steps or data to give a framework for the programming step.

The sheets included in this phase were the following:

1. Forecast
2. Orders and corresponding sales per item
3. Forecasted orders and corresponding sales per item
4. Material costs for the ordered items
5. Material costs for the forecasted items
6. Order master data from the ERP system
7. Production order master data from the ERP system
8. Item master data from the ERP system

Basic principle of the model is to link the customer's forecasted items and the units in the forecast to the commissioning organisation's item data from their ERP system. These included: order data (order number, item identity code, item price) and item information (identity code, name and material cost). These would be then linked to the customer's forecast to provide total sales and material costs for the forecasting periods. The functionality is shown in the Picture 13 below.



Picture 13. Basic principle of the model

After the crude basis for the model was formed, the attention changed to the coding of the automatic update process that would then extract the needed data. This order was chosen because the later links between different data points and cells in the file would be based on the result of the process and its form in the file.

4.3 Coding of the automatic program

The coding process by nature is more-or-less a trial-and-error process where few lines of code are written, tested by running the code and then fixing the risen issues, which are almost unavoidable. Earlier experience from smaller projects helped in this process as the issues are mostly the same with the coding structure chosen. The first draft of the basis for the code structure was a simple copy and paste solution which copied the selected cells of data from the master data and pasted these to the output sheets in the file. The copying was formed into two parts:

1. the item information in every other row
2. unit information (ordered and forecasted)

The copying was structured to first check the last row in the master data sheet and saving this number as the last point of the copy range. After the borders were found, the code then copied the values in the master file to the respective sheet. For the item information this was a simple task that required only a few lines of code. The copy was kept in the same format as in this point as the every-other-row format couldn't be taken into account in the code. The range variable in the looping structure couldn't handle the changing references to the master data and as a result data was copied to the same cells.

However, for the unit information the copying wasn't as simple because the needed data was in every other row. This was solved by skipping every other row for the ordered units. For the forecasted units a loop was created to check a certain cell in the data table and if it was empty, to copy the data. This was done with cell-by-cell basis first by rows in the columns and then by the columns themselves. The drawback of this solution was that, as discussed earlier, the data in the master data was formed into every other row for the ordered and forecasted units in relation to the item information and as this same format was kept, the data in the output sheet was also in every other row. These empty rows had to be removed from the output sheet to keep the size of the sheet in check and also to keep the data in readable form. This issue was solved in this draft by creating a looping structure that would delete the empty rows in the sheet. The code checked if the first cell on the row was empty, and if this was true, deleted the row by selecting the entire row and then deleting it.

The major issue with this first draft of the code was that the executing process of the code took a long time as the code went through the deleting process. As there were over hundred rows to check and delete, the running time for the program was over 30 minutes. Also, the program strained the computer's processor heavily and prevented the use of other programs while the code was running. Other issue with this structure was that as the file was to be kept as backup after each update and when the forecast was to be updated a new copy of the file would be created. Because of the code structure was long, the size of the model exceeded 50 MB of storage space. This was unacceptable because the model would be kept in the network drive and with the current size the copying of the file took a while. Because of these weaknesses in the model, this version was scrapped to be replaced with more streamlined version.

The second version was changed to be lighter to minimize the strain on the processor and shorten the running time as well as the backup process. The main weakness of the first draft was that the data was copied to every other row straight from the master data because of the limitations of the Loop If and Range -statements of the VBA language. To alleviate these issues the loop was changed to copy the cells based on a mathematical model rather than cell references. The strength of this way is that the loop could be written to include one variable to reference both the master data and output data. The code of this loop is shown in full detail in Appendix 1 and 2. An extract is shown below in the Picture 14.

```
'Material desc'

    x = 5

    For i = 8 To LR
        If Worksheets("Customer 1 data").Cells(i, 1).Value <> "" Then
            Worksheets("Orders").Cells(i - x, 1).Value = Worksheets("Customer 1 data").Cells(i, 1)
            Worksheets("Orders").Cells(i - x, 2).Value = Worksheets("Customer 1 data").Cells(i, 2)

        Else
            x = x + 1
        End If
    Next
```

Picture 14. Looping process for material description data

This version of the code is based on the variable “i” which is an integer and is updated in each of the loops which the program goes through. With this way of structuring the process, the deleting of rows process could be removed from the code. The basic principle of the code is the same as in the first draft: to copy the item information as well as the unit information to the respective sheets. The loop above goes through the values of “i” from 8 to “LR” which is the last row in the data. The code then checks if the value of the cell (i, 1), which if “i” is 8 corresponds to a cell (8, 1) or “W1”, on “Customer 1 data” worksheet isn’t empty. If this is true, the value of the cell (i – x, 1), or (7, 1) on the first run, in the “Orders” sheet is changed to the value of cell (i, 1) or (8, 1) in the “Customer 1” sheet. After this the same is repeated to cells (i – x, 2). If the “If” statement is false, or the cell (i, 1) in sheet “Customer 1” is empty, the value of x is upped by one. After both of the actions are completed or the value of x is updated, the loop moves to the next value of “i”.

To provide the user a visual indicator of the program’s completion a simple message box code was written to the program. This message box tells the user that the program has finished, and the user can continue his/her work.

Comparing this version of the program to the first version, the benefits are easily seen. When the first version went through the code in about 30 minutes, the updated code finishes the updating process in under 30 seconds. This has been verified with multiple trial runs as well as multiple actual forecast updates in the fall of 2017. The second issue which was discussed earlier was the excessive strain to the computer’s processor. This issue was also alleviated with the updated version of the code. As the deleting of rows part was removed, the time to completion and the massive strain to the processor was removed as the basic copying process is light to use. The third issue was the large size of the file. After the modifications to the code the size decreased from 50 MB to the range of 13 MB which is much more manageable level to store as well as manage in the commissioning organisation’s network drive.

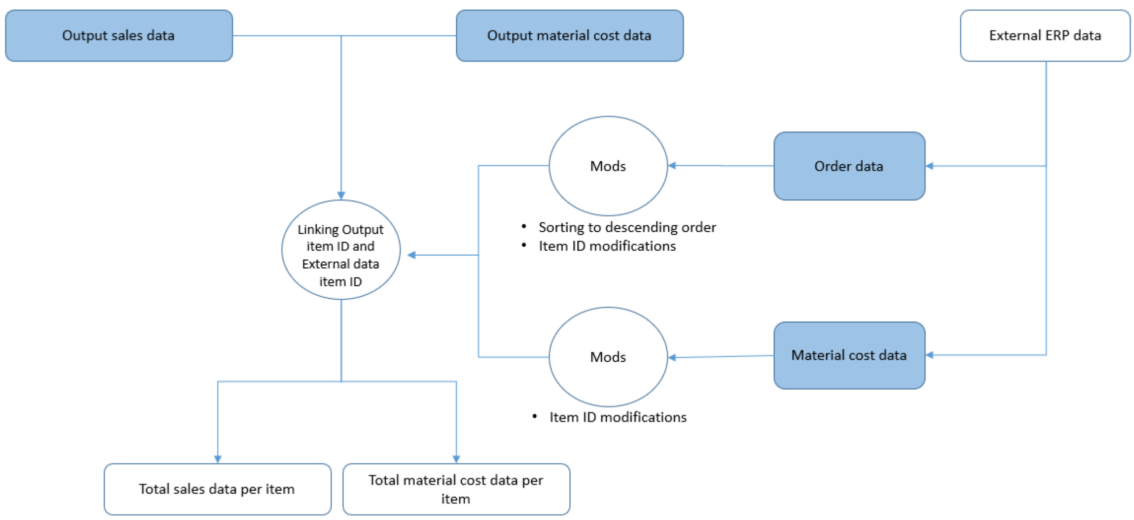
To verify the program and its various aspects, the code was used with multiple copies of the master forecast data from the customer during the creation as well as in the later using. Few modifications were made to the output sheet to the form of the data as the customer’s data package was shown to change slightly depending of the forecasting period. In addition, a decision was made with the management staff of the commissioning organisation to limit the forecasting period to certain level to lower the impact of the changing of the master data. This decision was also backed up by the fact that the last few months in the customer’s forecast weren’t that accurate and the inclusion of these months to the forecast model was not obligatory.

This version of the code was decided to be the final version to be used in the model as the issues found earlier were solved and the program ran in more efficiently and reliably with multiple master data packages. After the code was deemed final, the creation of the other aspects of the model was started. These included the links to the external ERP data in the file to provide the item names, prices and material costs for the periods. More of these aspects will be discussed in the next subchapter.

4.4 External data links

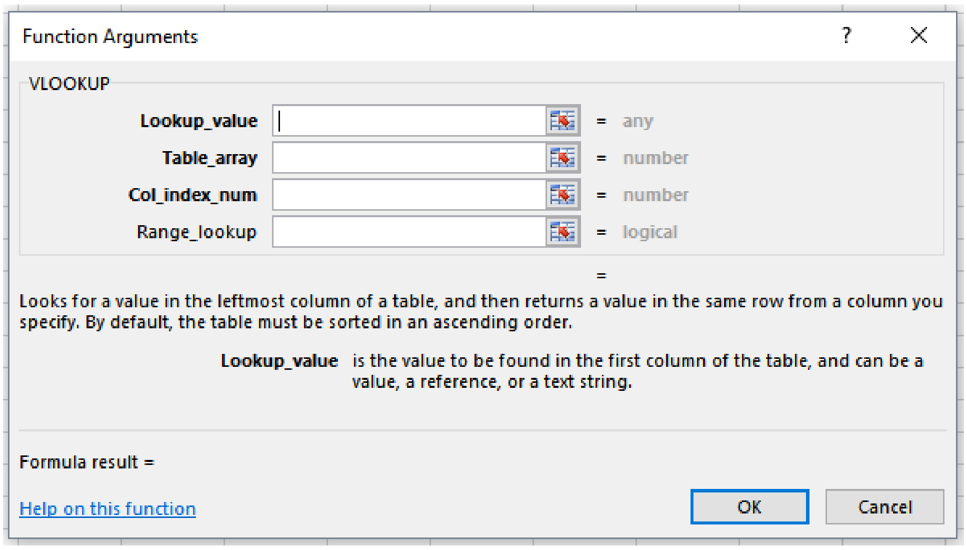
As shown in the chapter 4.2, major part of the model is linking the external ERP data and the customer sales forecast data to one another to produce the revenue and material cost information needed. The needed data from the ERP system includes further item information, such as item name, item group, sales price and material costs needed in the production of the item. These are found in the ERP system in their respective tables that could be filtered to needed accuracy and exported to Excel files. The selected data files were:

1. Order data per item
2. Item master data
3. Material master data
4. Production order master data



Picture 15. Principles of the external data linking

The principles of the ERP data linking are shown in Picture 15 above. The linking is done with the Item ID which are mostly the same in the ERP data as well as in the customer sales forecast data. More about this issue is discussed later in this chapter. When the ERP data is exported to Excel files and copied to the model to their respective sheets the link can be done with simple VLOOKUP -function in Excel shown below in Picture 16.

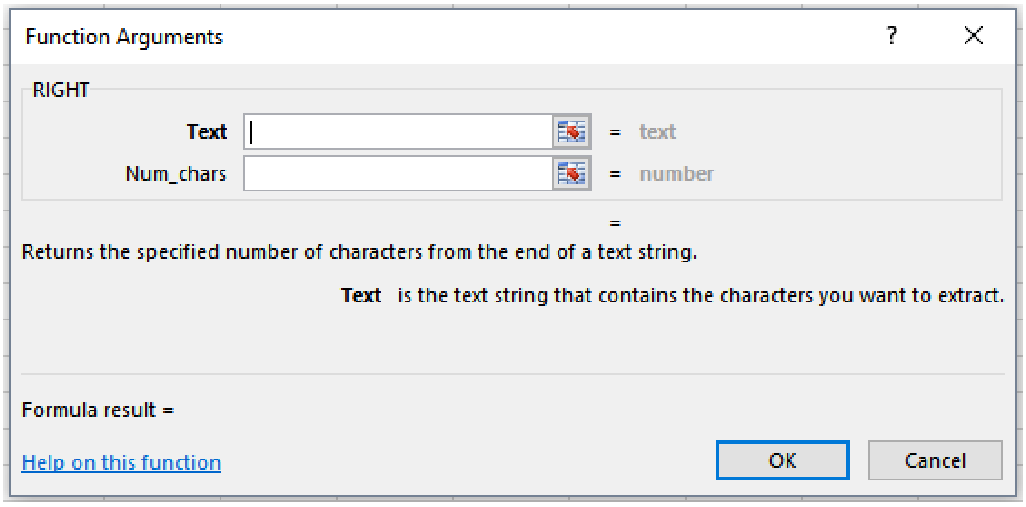


Picture 16. VLOOKUP function arguments

The function searches the “Lookup_value” data, in this case the Item ID, from the chosen “Table_array”, master data sheet, from the selected column, “Col_index_number”, and returns the wanted value that is related to the Item ID. The “Range_lookup” term can be chosen from “FALSE” and “TRUE” so the function returns the closest match or the exact match. “FALSE” returns exact match and “TRUE” the closest match. In this case the exact value is needed. This function is used in all of the links between item ID and item name, sales price and material costs.

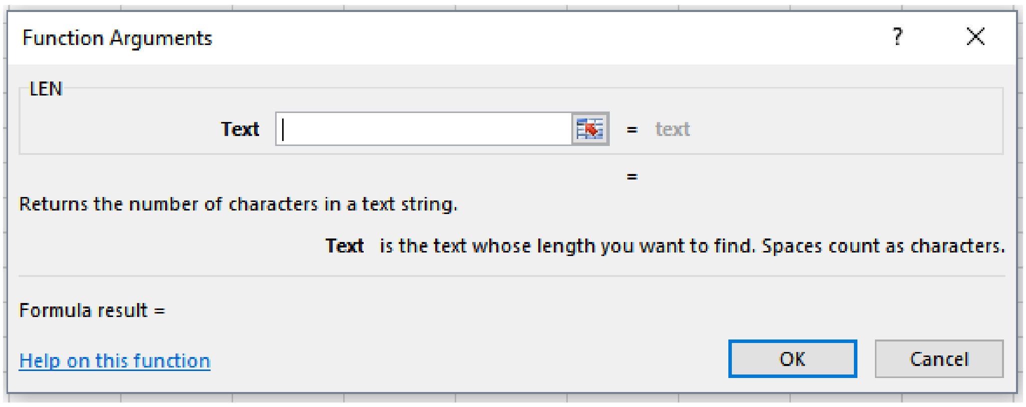
As the VLOOKUP function returns the first value that corresponds to the search value, the master data sheets had to be modified. In order to get the latest sales price from the order data, the data package had to be formed in a way that the orders are sorted in a descending order. This way the VLOOKUP function returns the latest sales price to the Output sheet. This is only needed with the order data as the item master data’s order doesn’t affect the outcome of the lookup. The sorting is done in the ERP system as the data is extracted and before the package is exported to Excel files. Of course, this could be also done in Excel.

The issue with linking the data packages with the Item ID is, that the ID is not exactly the same in the order data and the customer forecast data. The ERP system includes an identification letter in front of the Item ID to separate different business units from one another. This was needed earlier in the commissioning organisation, as there were more business units. This identification letter had to be removed to allow the VLOOKUP function to find the needed data. This is done with Excel functions RIGHT and LEN.



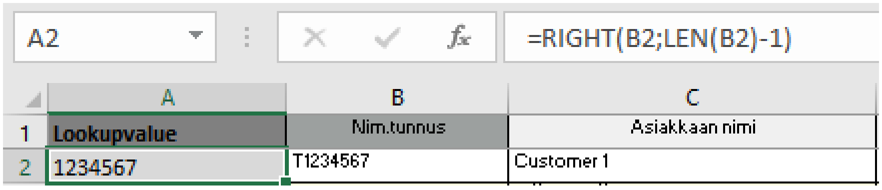
Picture 17. RIGHT function arguments

The RIGHT function, shown above, returns the value starting from the right side of the text from the selected cell with length of needed characters. The cell from which the data is extracted has to be in a text format, number values cannot be processed. Fortunately, the Item ID is in text format. If this wasn't the case, this could be alleviated with simple formatting in the automatic copying process. However, The RIGHT function could not be used on its own as the length of the Item IDs change per item. Because of this another function had to be embedded to the RIGHT function to change the number of characters the RIGHT function extracts. This is done with the LEN function. The LEN function, below in Picture 18, returns the length of the text in the selected cell.



Picture 18. LEN function arguments

In order to remove the first identification letter from the Item ID, in this case TPAAE124743 as shown below in picture 5, one character is removed from the returned value of the LEN function. This value is then used in the RIGHT function to extract number characters minus the first character. In this example the final value that is used in the VLOOKUP is PAAE124743. The final function is shown below. After the Item ID has been matched to the customer forecast data Item ID, the item names, production order IDs and the latest sales prices can be searched with the modified Item ID and matched to the customer forecast. The final extraction formula and result is shown below in Picture 19.



Picture 19. Example of the final extraction of the Item ID

For the material cost master data, the process was more complex as the Item IDs in the whole ERP database are more diversified compared to the customer forecast and the order data. The issues were found out during the creation piece-by-piece when matching process was done. In addition to the identification letter “T” the Item IDs included more information that isn’t needed for the functions to work. These had to be removed as well. The basic principle behind the corrections were the same as earlier.

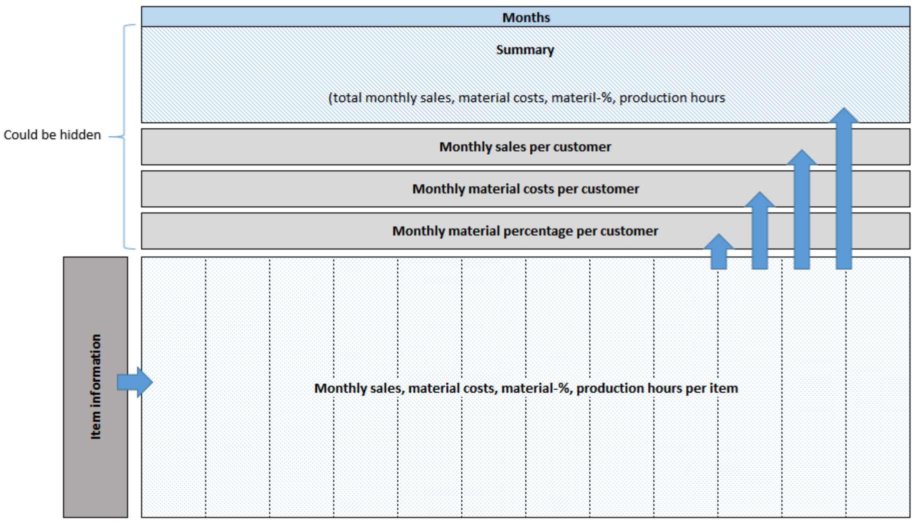
4.5 Forming the forecast

Later in the creation process it became apparent that the customer’s forecasts could not give the full picture of the forecasted sales. After couple of update runs, the predicted revenue and the material costs for the commissioned organisation were under the long-time average. At first, this was thought to be a result of incorrect or missing price and material cost data, but after comprehensive check through the model this was confirmed not to be the case. The only remaining possibility behind the discrepancy was then in the customer’s forecast and that it didn’t give the full picture of the forecasted orders and sales.

In order to create a more accurate forecast, it was decided that a separate data table was necessary. The whole table is shown in the Appendix 3. This table was to be the final forecasting method of the model and the earlier data sheets would be used as a basis for this data table. The table would include the customers’ forecasts, but so that it could be then modified based on the past experience on unit per unit basis. This data table would also include the standard production hours per unit that the production would take for the respective unit. These standard hours are included in the unit price and as such give valid information for the user of the possible capacity needed for the production. This was additional information to the basic purpose of the model, but it was deemed important and easy enough to incorporate at this stage. The production hours include the activities used in the production through the whole process. The basic structure of the final forecast table includes following:

1. Every active unit and their information
    a. Unit ID
    b. Unit price
    c. Standard production hours
    d. Material cost
    e. Material cost percentage calculated from unit price and material cost
2. Monthly sales
3. Total yearly sales
4. Monthly sold standard hours
5. Total yearly sold standard hours
6. Sales per customer
7. Material costs per customer
8. Material cost percentage per customer

The structure is shown in the picture 20 below. The full forecast table consists of multiple smaller data tables. The purpose of this is to give the user the best possible information of the items, sales and costs and that the forecast could be modified on an accurate level on item by item basis. This allows the forecast to be as accurate as possible as the items can be forecasted with modifications to the sold units on a monthly level.



Picture 20. Final forecast table

The left side of the table includes the item information: item ID, unit price, material cost, material cost percentage and production hours. These are listed on item per item and customer basis. The middle of the table shows the monthly sales in form of both units sold and revenue, material costs as well as the production hours per item in the month. The item information is linked to this part of the table and when the sold units forecast is updated the total item sales change. In total the final forecast table included about 200 different units across all the current customers. This would then give the possibility to form accurate forecasts on unit basis. The item information was collected from the external ERP data in the same way as in the previous examples with the VLOOKUP function using the Unit IDs. As the process is very similar as in the chapter 4.4, it isn't covered further.

Picture 21 shows an example of two different items used in an imaginary forecast. The Item 1 is one of the Customer 1's products and it belongs to a Group 1 with sales price if 30 000,00 EUR and material cost per unit of 15 000,00 EUR which corresponds to a material percentage of 50,0 %. The Item 2 belongs to a Customer 2 and it has sales price of 20 000,00 EUR with material cost of 8 000,00 EUR. The production hours per item are shown below the price and material cost on production phase basis. The item 1 has total production hours of 325 with the most time consumed in Production phase 1 and the rest spent in phases 3 and 4.

	Cust	Item ID	Item group	M	Item name
Fct	Customer 1	T11223344	Group 1	Y	Item 1
Pc	Customer 1	T11223344	Group 1	Y	Item 1
Sales price	Customer 1	30 000,00			
Sales	Customer 1				
Mat %	Customer 1	50,0 %			
Mat	Customer 1	15 000,00			
Production phase 1	Customer 1	300,00			
Production phase 2	Customer 1	0,00			
Production phase 3	Customer 1	10,00			
Production phase 4	Customer 1	15,00			
Production phase 5	Customer 1	0,00			
Production phase 6	Customer 1	0,00			
Production phase 7	Customer 1	0,00			
Production phase 8	Customer 1	0,00			
Production phase 9	Customer 1	0,00			
Production phase 10	Customer 1	0,00			
Production phase 11	Customer 1	0,00			
h total	Customer 1	325,00			
Fct	Customer 2	T22334455	Group 2	Y	Item 2
Pc	Customer 2	T22334455	Group 2	Y	Item 2
Sales price	Customer 2	20 000,00			
Sales	Customer 2				
Mat %	Customer 2	40,0 %			
Mat	Customer 2	8 000,00			
Production phase 1	Customer 2	200,00			
Production phase 2	Customer 2	0,00			
Production phase 3	Customer 2	50,00			
Production phase 4	Customer 2	20,00			
Production phase 5	Customer 2	0,00			
Production phase 6	Customer 2	0,00			
Production phase 7	Customer 2	0,00			
Production phase 8	Customer 2	0,00			
Production phase 9	Customer 2	0,00			
Production phase 10	Customer 2	0,00			
Production phase 11	Customer 2	0,00			
h total	Customer 2	270,00			

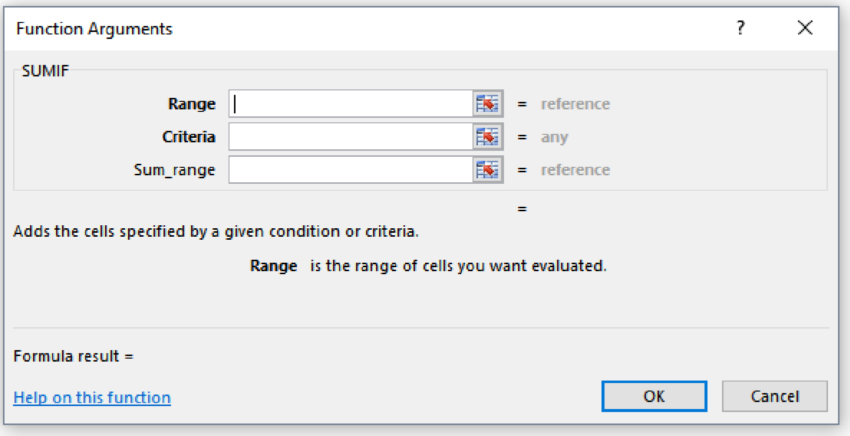
Picture 21. Item data in the final forecast table

The upper part of the table shows the summary of the total monthly sales, material costs and production hours. This summary table is shown below in Picture 22. In this example forecast the total units for the year are 27 as shown in the “Pc” row on the table. The total sales for the year are 630 000,00 EUR divided monthly to January, February, March, April and June. The total material cost to produce these items is 279 000,00 EUR which corresponds to a material percentage of 44,3 %. Total production hours are 6 935 divided to the different production phases according to the item data.

	Act	Act	Act	Fct	Fct	Fct	Fct	Fct	Fct	Fct	Fct	Fct	Fct
	201801	201802	201803	201804	201805	201806	201807	201808	201809	201810	201811	201812	2018 total
Pc	7	2	6	5	0	7	0	0	0	0	0	0	27
Sales	160 000,00	60 000,00	120 000,00	150 000,00	0,00	140 000,00	0,00	0,00	0,00	0,00	0,00	0,00	630 000,00
Sales price	50 000,00	30 000,00	20 000,00	30 000,00	0,00	20 000,00	0,00	0,00	0,00	0,00	0,00	0,00	150 000,00
Mat %	43,8 %	50,0 %	40,0 %	50,0 %	0,0 %	40,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	44,3 %
Mat	70 000,00	30 000,00	48 000,00	75 000,00	0,00	56 000,00	0,00	0,00	0,00	0,00	0,00	0,00	279 000,00
Production phase 1	1 600,00	600,00	1 200,00	1 500,00	0,00	1 400,00	0,00	0,00	0,00	0,00	0,00	0,00	6 300,00
Production phase 2	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Production phase 3	270,00	20,00	50,00	50,00	0,00	50,00	0,00	0,00	0,00	0,00	0,00	0,00	440,00
Production phase 4	50,00	30,00	20,00	75,00	0,00	20,00	0,00	0,00	0,00	0,00	0,00	0,00	195,00
Production phase 5	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Production phase 6	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Production phase 7	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Production phase 8	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Production phase 9	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Production phase 10	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Production phase 11	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
h total	**1 920,00**	**650,00**	**1 270,00**	**1 625,00**	**0,00**	**1 470,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**6 935,00**
							400 000	1 400 000	1 350 000	1 300 000	1 250 000	1 000 000	14 177 433
Sales	**160 000,00**	**60 000,00**	**120 000,00**	**150 000,00**	**0,00**	**140 000,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**630 000,00**
Mat %	**43,8 %**	**50,0 %**	**40,0 %**	**50,0 %**	**0,0 %**	**40,0 %**	**0,0 %**	**0,0 %**	**0,0 %**	**0,0 %**	**0,0 %**	**0,0 %**	**44,3 %**

Picture 22. Total sales, material costs and production hours table

The values are calculated using “SUMIF” function, shown below, in Excel that calculates the sum in the selected range if some certain criterion is met. The input arguments of the function are shown below. “Range” is the criteria range, in this case the column with the customer name on the item information table, “Criteria” is cell reference to a cell with the selected customer name and finally “Sum_range” is the area that will be evaluated and summed if the criterion is met.



Picture 23. SUMIF function arguments

Below the summary part are the tables that show the sales, material costs and material costs percentages per customer according to the main monthly item data, shown below in Pictures 24 and 25. These are also calculated using the “SUMIF” function according to the item forecast. In the example, the total sales of 630 000,00 EUR are divided to two customers: 270 000,00 EUR for the Customer 1 and 360 000,00 EUR for the Customer 2. The material costs of 279 000,00 EUR are divided 135 000,00 EUR for Customer 1 and 144 000,00 EUR for Customer 2.

Sales per customer	201801	201802	201803	201804	201805	201806	201807	201808	201809	201810	201811	201812	2018 total
Customer 1	60 000,00	60 000,00	0,00	150 000,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	270 000,00
Customer 2	100 000,00	0,00	120 000,00	0,00	0,00	140 000,00	0,00	0,00	0,00	0,00	0,00	0,00	360 000,00
	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Picture 24. Sales per customer

Material costs per customer	201801	201802	201803	201804	201805	201806	201807	201808	201809	201810	201811	201812	2018 total
Customer 1	30 000,00	30 000,00	0,00	75 000,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	135 000,00
Customer 2	40 000,00	0,00	48 000,00	0,00	0,00	56 000,00	0,00	0,00	0,00	0,00	0,00	0,00	144 000,00
	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	70 000,00	30 000,00	48 000,00	75 000,00	0,00	56 000,00	0,00	0,00	0,00	0,00	0,00	0,00	279 000,00

Picture 25. Material costs per customer

Finally, below these tables is the main item forecast data table to which all of the aforementioned tables are based on. The main item forecast table is shown in Picture 26 below. The item forecast shows the sales, material costs and production hours per phase for the item. As discussed earlier, the data was linked to the item information table as a base reference. To give the user more information and room to modify the forecast, the unit numbers per month were differentiated between the customer’s forecasted units and the user’s units. This was done with just additional rows in the data table, one for the customer’s data and one for the user’s data. These could be then used to show both the customer’s forecast and the modified forecasted units from which the sales forecast is then calculated. This differentiation also allows the monitoring and comparison of the forecast and actual sales.

In the example forecast, the grey row below the months is the units forecasted by the customer and the yellow row below shows the user view on the matter. For the most part the user agrees with the customer, but January forecast has been upped by one unit from customer's forecast of 1 to 2 units. The total units forecasted to be sold on the year for the Item 1 are then 8 according to the customer and 9 according to the user. The total sales are calculated using the sales price from item information table, which for the Item 1 is 30 000,00 EUR. The calculation is done using the user's forecast rather than the customer's forecast, the customer forecast is used as a reference and base for the user's forecast. By multiplying the units with the unit price, the total sales for the year for the Item 1 are 270 000,00 EUR as in the sales per customer table shown earlier. The material cost per month are also calculated using the data in the item information table. This for the Item 1 is 30 000,00 EUR. The total material costs are calculated with the same principle as the total sales. This is repeated for the production hours.

2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018
201801	201802	201803	201804	201805	201806	201807	201808	201809	201810	201811	201812	2018 total
1	2		5									8
2	2		5									9
30 000,00	30 000,00	0,00	30 000,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	90 000,00
60 000,00	60 000,00	0,00	150 000,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	270 000,00
50,0 %	50,0 %	50,0 %	50,0 %	50,0 %	50,0 %	50,0 %	50,0 %	50,0 %	50,0 %	50,0 %	50,0 %	50,0 %
30 000,00	30 000,00	0,00	75 000,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	135 000,00
600,00	600,00	0,00	1 500,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	2 700,00
0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
20,00	20,00	0,00	50,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	90,00
30,00	30,00	0,00	75,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	135,00
0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
650,00	650,00	0,00	1 625,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	2 925,00

Picture 26. Item 1 forecast

To make the Worksheet and the forecast table usable, the smaller tables could be hidden to give the user clearer view of the item data below. Excel has a grouping function that groups selected columns or rows and these groups could then be hidden or revealed together. This helps to keep the user interface from getting too cluttered and hard to use. Also the data can be filtered by customer, item, price, group or name to allow the user to find the information that is needed.

These five tables shown, summary, item information, sales and material costs per customer and item forecast, form the full forecast that the user uses to make his/her forecast using the customer's forecast that was modified in the automated process. At this point the forecast model was ready for full use for the commissioning organisation. The data in this model would then be used to make the full company sales pipeline forecast discussed back in the chapter 4.1 and reported to the management and Board of Directors.

5 Conclusions

Based on the theoretical aspects and the creation process of the model, few conclusions of the whole project can be given. This chapter gives a summary of the process and the model's reliability as well as was the objective of thesis achieved with the final state of the product. In the end of this chapter few self-reflections are given regarding to the process and learning during the creation of the model.

5.1 Achievement of the objectives and reliability of the results

The theoretical base to this thesis is based on recognised sources and theories and as such, the sources can be evaluated to be reliable with the context of this thesis. With required theories shown in the chapters 1 and 2 and knowing the final end-result of the project, the author can be convinced that the objectives of this thesis have been achieved with required accuracy and reliability.

The main objective of this thesis was to create a forecasting model for the commissioning organisation to be used in the monthly forecasting process. This objective can be confirmed to be achieved as the final product is in regular use in the commissioning company and it has been successfully used in the forecasting process. The sub objectives of more accurate forecast, reduced manual work and reduced errors in the forecasting process are evaluated according to the results that the model has produced during this use. The improvement of the accuracy of the forecasting process was one the main interest of the commissioning organisation and this objective has been monitored during the whole project.

The final model has been used in multiple rounds of financial forecasts during the spring of 2018 before the finalisation of this thesis. During these forecasting rounds, the earlier forecasts that the model has produced have been compared to the actual sales and costs incurred from the monthly operations. In these comparisons, no significant deviations have been found in the item level data regarding the unit prices or material costs. The unit prices for the items were at the forecasted level, which was to be expected as the forecast sales prices were derived from the actual invoicing to the customer and thus wouldn't change on a monthly basis normally. For the material costs, the deviations were on the range of 0,5 to 1,0 percentage points from the forecasted material percentage. This was investigated to be derived from the nature of the rolling average of the material costs in the ERP system or slight changes to the materials used for the production. Overall this was acceptable level for the deviations, although the accuracy could be and will be developed further in the future.

Although deviations have been shown on the total customer level, these deviations have been incurred from the deviations in the forecasted units per month and not from the functions of the model and the deviations have not been large in absolute numerical value or in relation to the total sales. The source or reasons behind the changes are derived from the user's view of the monthly sales of the items and the unit quantities, which are not influenced by the functions of the model. As stated in the chapter 4.5, the customer forecasted units are used as a basis for the user's forecast. As the base data for the forecasts is now automated to be extracted from the ERP data, which eliminates the possibilities of human errors in the transferring of the data, the errors in the forecast can only incur from the use of the final forecast table shown in the chapter 4.5. The automated process created using the VBA language has been tested and used with multiple runs without significant issues or debugging. The code, therefore, can be stated to be reliable and it can be used with confidence by the commissioning organisation.

The manual work has been also reduced from the earlier processes. Although, as the process has been made more accurate with the model with the additions of the ERP and customer data to the forecasting process, some additional work is created. This is, from the viewpoint of the author as well as the commissioning organisation, an acceptable trade-off for the more accurate and reliable forecast. When the results can be relied on and they can be used in different contexts, the work related to this process is not invaluable.

The final sub objective was to create an easy-to-use user interface that would be concise enough to give the needed information without leaving valuable data out. As the model has been used in multiple forecasting rounds, the interface has been tested in multiple different scenarios ranging from searching a particular item to valuation of total sales for a single item group. The interface can be confirmed to be relatively easy and simple enough to be used for extracting this information, but some further development is necessary to make the filtering process more manageable. These future development ideas are discussed in more detail in the chapter 5.2.

5.2 Future development and use in the organisation

As with all projects, the development never usually stops when the main project is finalised. The model will be updated in the future with new items and customers when new business cases are agreed. As the item information is linked to the ERP data in the workbook, the prices and material costs as well as the production hours can be and are updated monthly to keep the forecast as accurate as possible. In addition, the capacity data will be developed further to allow the management to get more information of the production and the resources needed in the long-term decision-making and for other forecasting needs.

At this point as the model is formed and tailored around the specific organisation, the implementation of the model to the Group's other business sites is not easily done. The data links and the structure of the model have to be modified to the specific site's operations and systems to make the model usable. This means that most likely the model created will be used with the organisation that it was created for. However, this does not exclude the possibility that the basic principles of the model, its functionality or some of its features could not be used in the other business sites in their forecast process developments.

As discussed in the chapter 5.1, the final forecasting table could be developed further to allow the user to get the information needed from the tables conveniently without extra effort. For example, a total sales level for item groups, the same way as is done for customers and their sales and material costs, could be a valuable addition to the model. This would give important information for the management regarding the profitability, volume and costs of particular item group. This addition does not require significant effort from the administrator of the model as the process is the same as with the per customer tables. Only issue with the additional tables is the available space that could be shown at each moment on the users monitor. At this point, the current tables are taking a considerable amount of space from the monitor and this was alleviated with the use of the grouping and hiding function in Excel. However, the grouping and hiding are not the most convenient ways of address this issue, as it makes glancing through the data harder. The answer to this conundrum could be that the summary and per customer tables are moved to a separate worksheet in the model leaving the item data table on its own sheet. This would give more room for the summary tables and at the same time allow more development to the item data table.

As mentioned earlier, the capacity data additions are one the main topics in future development. The standard working hours were added to the forecast table for the items in the creation process as this was estimated to be easy enough to implement. The capacity data will be developed further in the future, as the mind-set of the company's management is that the next step for the forecasting process is to make the capacity monitoring and personnel cost forecasting process more accurate as well as more efficient. The company employs various amounts of rented employees and the share of own to external workforce is important and current topic. As the basis for the development of the capacity forecasting as per item basis is now implemented to the forecasting process, this updated and the modifications to the forecasting model should be easy to make.

Further development in the cost forecasting side of the model includes the addition of indirect material costs related to the production as well as personnel costs. As discussed in the theoretical part of the thesis, costs are divided into direct and indirect costs. At this point, the model only includes the direct material costs incurred from the production but in the future, the company's management's plan is to include indirect costs to the model to ensure more accurate forecast and profitability data. The company's steel prices are tied to the international MEPS steel price index updated by MEPS International Ltd, which is a supplier of steel market information. It monitors the steel market regularly and provides information as well as insight of the changes in consumption and production of steel. (MEPS 2018.) The material costs update would also include a way to integrate the MEPS index changes to the model for more accurate forecast of the steel prices and thus costs from the company's production.

As the capacity data is already added to the model, the costs incurred from labour can be included to the model using the current hourly rates of the company. These costs would include the direct personnel costs related to the production but also the indirect costs from production steps that are not shown in the item data per phase. These include, for example, white-collar work that is not shown in the direct production phases but is still part of the total hourly rates for the production. This would give the management a view of the personnel costs incurred from the standard production hours of the items and also the level of indirect costs related to the production. Although this would not give the full picture of the personnel costs, as the hours to which the calculations would be based on are the standard production hours, the data will be useful for the management for the capacity monitoring. Of course, further development could include the actual hours from the production for each month as a post-calculation to enable comparison of the actual and forecasted capacity data as is done for the sales and material costs in the current version of the model.

The last currently discussed development topic is the monitoring of the inventory level and the changes in inventory. The model could include data of the current inventory level for the company on a monthly basis and calculate the effects of the production to the inventory with the forecasted production data. Inventory is one of the biggest factors that influence the monthly results for the company as the production consumes variable amounts of materials from the inventory and variable numbers of work in progress items as well as finished goods are booked to the inventory each month. The model could give valuable information and estimates of the inventory changes to be taken into account in the full profit and loss forecasting process. The target company's management considers these ideas and development options regularly and the ideas could be implemented during the daily operations along with the other current projects.

5.3 Evaluation of the thesis process

This thesis and its objectives were beneficial for both the author and the organisation. As at the start of the process the author had a limited experience in actual financial modelling as well as in other financial operations of a company, this thesis was a valuable project to be handled by the author. The results advanced the commissioning organisations forecasting process with good results, which has been brought forth by the target company's manager and the Group's Group Controller. This thesis was a first step in a larger project of developing of the company's financial operations and after the beginning of the thesis process, multiple new projects have been started regarding, for example, inventory handling, capacity and item workflow management.

Although the theoretical framework's depth, at least for the business processes and cost accounting side, for the thesis was delimited based on the theories needed for the product, few new insights were gained from the research. Especially the VBA theories gave the author few extra details about the language that could be used in future projects. The thesis topic gave the author valuable experience in finding, extracting and developing the data available in the company's systems and processes from which the data is derived from. At the start of the process, the operations and practises as well as the systems were slightly obscure to the author but as the project proceeded, it gave the author the possibility to study the functions and learn about the target company's processes. This gave the author good base to build his competence and skills relating to the business finance environment.

Taking the author's background and starting point with the co-operation with the Group into account, the whole thesis project was handled efficiently from start to finish. The schedule was kept, and although certain steps took longer than planned, the whole model was finished on time for the full use. As discussed earlier the project was started in summer of 2017, in June 2017 to be more exact, and the final model was revealed for full use in January 2018. The thesis report itself was written later in the model's creation process in fall of 2017. This decision was made because at that point the model's development had proceeded far enough to allow the author to write about the creation process. Prior to that, the theoretical part of the thesis was planned and partly started but the actual writing began later. The writing process was continued in tandem with the model's final creation steps. The process advanced firmly and steadily during the process without any significant stalling. The communication with the thesis supervisor was, at least from the point of view of the author, clear and potential issues were discussed promptly when they incurred and solved with mutual understanding. Overall, it could be said that the whole process was valuable and it helped in the future development of the author's professional skills as well as the author's career.

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Appendix

Appendix 1. Sub 1 - Order data

```
Sub OrdData()

Dim i As Integer
Dim x As Integer
Dim LR As Long

    Application.ScreenUpdating = False

    Worksheets("Customer 1 data").Activate

    LR = Cells(Rows.Count, 2).End(xlUp).Row

    MsgBox ("Last row is " & LR)

    myResponse = MsgBox("Correct?", vbYesNo)
    If myResponse = vbNo Then Exit Sub



'Material desc'

    x = 5

    For i = 8 To LR
        If Worksheets("Customer 1 data").Cells(i, 1).Value <> "" Then
            Worksheets("Orders").Cells(i - x, 1).Value = Worksheets("Customer 1 data").Cells(i, 1)
            Worksheets("Orders").Cells(i - x, 2).Value = Worksheets("Customer 1 data").Cells(i, 2)

        Else
            x = x + 1
        End If
    Next



'Quant'

    x = 5

    For i = 7 To LR
        If Worksheets("Customer 1 data").Cells(i, 1).Value <> "" Then
            Worksheets("Orders").Cells(i - x, 6).Value = Worksheets("Customer 1 data").Cells(i, 5)
            Worksheets("Orders").Cells(i - x, 7).Value = Worksheets("Customer 1 data").Cells(i, 6)
            Worksheets("Orders").Cells(i - x, 8).Value = Worksheets("Customer 1 data").Cells(i, 7)
            Worksheets("Orders").Cells(i - x, 9).Value = Worksheets("Customer 1 data").Cells(i, 8)
            Worksheets("Orders").Cells(i - x, 10).Value = Worksheets("Customer 1 data").Cells(i, 9)
            Worksheets("Orders").Cells(i - x, 11).Value = Worksheets("Customer 1 data").Cells(i, 10)
            Worksheets("Orders").Cells(i - x, 12).Value = Worksheets("Customer 1 data").Cells(i, 11)
            Worksheets("Orders").Cells(i - x, 13).Value = Worksheets("Customer 1 data").Cells(i, 12)
            Worksheets("Orders").Cells(i - x, 14).Value = Worksheets("Customer 1 data").Cells(i, 13)
            Worksheets("Orders").Cells(i - x, 15).Value = Worksheets("Customer 1 data").Cells(i, 14)
            Worksheets("Orders").Cells(i - x, 16).Value = Worksheets("Customer 1 data").Cells(i, 15)
            Worksheets("Orders").Cells(i - x, 17).Value = Worksheets("Customer 1 data").Cells(i, 16)
            Worksheets("Orders").Cells(i - x, 18).Value = Worksheets("Customer 1 data").Cells(i, 17)
            Worksheets("Orders").Cells(i - x, 19).Value = Worksheets("Customer 1 data").Cells(i, 18)
            Worksheets("Orders").Cells(i - x, 20).Value = Worksheets("Customer 1 data").Cells(i, 19)
            Worksheets("Orders").Cells(i - x, 21).Value = Worksheets("Customer 1 data").Cells(i, 20)
            Worksheets("Orders").Cells(i - x, 22).Value = Worksheets("Customer 1 data").Cells(i, 21)
            Worksheets("Orders").Cells(i - x, 23).Value = Worksheets("Customer 1 data").Cells(i, 22)
            Worksheets("Orders").Cells(i - x, 24).Value = Worksheets("Customer 1 data").Cells(i, 23)
            Worksheets("Orders").Cells(i - x, 25).Value = Worksheets("Customer 1 data").Cells(i, 24)
            Worksheets("Orders").Cells(i - x, 26).Value = Worksheets("Customer 1 data").Cells(i, 25)
            Worksheets("Orders").Cells(i - x, 27).Value = Worksheets("Customer 1 data").Cells(i, 26)
```

```
        Else
            x = x + 1
        End If
    Next

    Worksheets("Control Panel").Activate

    Application.ScreenUpdating = True

    MsgBox ("Update complete")


End Sub
```

Appendix 2. Sub 2 - Forecast data

```
Sub FctData()

Dim i As Integer
Dim x As Integer
Dim LR As Long

    Application.ScreenUpdating = False

    Worksheets("Customer 1 data").Activate

    LR = Cells(Rows.Count, 2).End(xlUp).Row

    MsgBox ("Last row is " & LR)

    myResponse = MsgBox("Correct?", vbYesNo)
    If myResponse = vbNo Then Exit Sub


    x = 5


'Headline'

    Worksheets("Forecasted").Range("F2:AA2").Value = Worksheets("Customer 1
data").Range("E7:Z7").Value


'Material desc'

    For i = 8 To LR
        If Worksheets("Customer 1 data").Cells(i, 1).Value <> "" Then
            Worksheets("Forecasted").Cells(i - x, 1).Value = Worksheets("Customer 1 data").Cells(i, 1)
            Worksheets("Forecasted").Cells(i - x, 2).Value = Worksheets("Customer 1 data").Cells(i, 2)

        Else
            x = x + 1
        End If
    Next

'Quant'

    x = 5

    For i = 8 To LR
        If Worksheets("Customer 1 data").Cells(i, 1).Value = "" Then
            Worksheets("Forecasted").Cells(i - x, 6).Value = Worksheets("Customer 1 data").Cells(i, 5)
            Worksheets("Forecasted").Cells(i - x, 7).Value = Worksheets("Customer 1 data").Cells(i, 6)
            Worksheets("Forecasted").Cells(i - x, 8).Value = Worksheets("Customer 1 data").Cells(i, 7)
            Worksheets("Forecasted").Cells(i - x, 9).Value = Worksheets("Customer 1 data").Cells(i, 8)
            Worksheets("Forecasted").Cells(i - x, 10).Value = Worksheets("Customer 1 data").Cells(i, 9)
            Worksheets("Forecasted").Cells(i - x, 11).Value = Worksheets("Customer 1 data").Cells(i, 10)
            Worksheets("Forecasted").Cells(i - x, 12).Value = Worksheets("Customer 1 data").Cells(i, 11)
            Worksheets("Forecasted").Cells(i - x, 13).Value = Worksheets("Customer 1 data").Cells(i, 12)
            Worksheets("Forecasted").Cells(i - x, 14).Value = Worksheets("Customer 1 data").Cells(i, 13)
            Worksheets("Forecasted").Cells(i - x, 15).Value = Worksheets("Customer 1 data").Cells(i, 14)
            Worksheets("Forecasted").Cells(i - x, 16).Value = Worksheets("Customer 1 data").Cells(i, 15)
            Worksheets("Forecasted").Cells(i - x, 17).Value = Worksheets("Customer 1 data").Cells(i, 16)
            Worksheets("Forecasted").Cells(i - x, 18).Value = Worksheets("Customer 1 data").Cells(i, 17)
            Worksheets("Forecasted").Cells(i - x, 19).Value = Worksheets("Customer 1 data").Cells(i, 18)
            Worksheets("Forecasted").Cells(i - x, 20).Value = Worksheets("Customer 1 data").Cells(i, 19)
            Worksheets("Forecasted").Cells(i - x, 21).Value = Worksheets("Customer 1 data").Cells(i, 20)
            Worksheets("Forecasted").Cells(i - x, 22).Value = Worksheets("Customer 1 data").Cells(i, 21)
            Worksheets("Forecasted").Cells(i - x, 23).Value = Worksheets("Customer 1 data").Cells(i, 22)
            Worksheets("Forecasted").Cells(i - x, 24).Value = Worksheets("Customer 1 data").Cells(i, 23)
            Worksheets("Forecasted").Cells(i - x, 25).Value = Worksheets("Customer 1 data").Cells(i, 24)
            Worksheets("Forecasted").Cells(i - x, 26).Value = Worksheets("Customer 1 data").Cells(i, 25)
```

```
        Worksheets("Forecasted").Cells(i - x, 27).Value = Worksheets("Customer 1 data").Cells(i, 26)

      Else
        x = x + 1
      End If
    Next


    Worksheets("Control Panel").Activate

    Application.ScreenUpdating = True

    MsgBox ("Update complete")


End Sub
```

Appendix 3. Forecast table

	A	B	F	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1				Act	Act	Act	Fct	Fct	Fct	Fct	Fct	Fct	Fct	Fct	Fct	Fct
2	Nbr of items	2		201801	201802	201803	201804	201805	201806	201807	201808	201809	201810	201811	201812	2018 total
3			Pc	7	2	6	5	0	7	0	2	0	0	0	0	29
4			Sales	160 000,00	60 000,00	120 000,00	150 000,00	0,00	140 000,00	0,00	60 000,00	0,00	0,00	0,00	0,00	690 000,00
5			Sales price	50 000,00	30 000,00	20 000,00	30 000,00	0,00	20 000,00	0,00	30 000,00	0,00	0,00	0,00	0,00	180 000,00
6																
7			Mat %	43,8 %	50,0 %	40,0 %	50,0 %	0,0 %	40,0 %	0,0 %	50,0 %	0,0 %	0,0 %	0,0 %	0,0 %	44,8 %
8			Mat	70 000,00	30 000,00	48 000,00	75 000,00	0,00	56 000,00	0,00	30 000,00	0,00	0,00	0,00	0,00	309 000,00
9			Production phase 1	1 600,00	600,00	1 200,00	1 500,00	0,00	1 400,00	0,00	600,00	0,00	0,00	0,00	0,00	6 900,00
10			Production phase 2	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
11			Production phase 3	270,00	20,00	50,00	50,00	0,00	50,00	0,00	20,00	0,00	0,00	0,00	0,00	460,00
12			Production phase 4	50,00	30,00	20,00	75,00	0,00	20,00	0,00	30,00	0,00	0,00	0,00	0,00	225,00
13			Production phase 5	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
14			Production phase 6	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
15			Production phase 7	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
16			Production phase 8	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
17			Production phase 9	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
18			Production phase 10	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
19			Production phase 11	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
20			**h total**	**1 920,00**	**650,00**	**1 270,00**	**1 625,00**	**0,00**	**1 470,00**	**0,00**	**650,00**	**0,00**	**0,00**	**0,00**	**0,00**	**7 585,00**
21																
33			**Sales**	**160 000,00**	**60 000,00**	**120 000,00**	**150 000,00**	**0,00**	**140 000,00**	**0,00**	**60 000,00**	**0,00**	**0,00**	**0,00**	**0,00**	**690 000,00**
46																
69			**Mat %**	**43,8 %**	**50,0 %**	**40,0 %**	**50,0 %**	**0,0 %**	**40,0 %**	**0,0 %**	**50,0 %**	**0,0 %**	**0,0 %**	**0,0 %**	**0,0 %**	**44,8 %**
92																
93																

	A	Cust	Item ID	Item gro	M	Item name	2018 201801	2018 201802	2018 201803	2018 201804	2018 201805	2018 201806	2018 201807	2018 201808	2018 201809	2018 201810	2018 201811	2018 201812	2018 2018 total
96	Fct	Customer 1	T11223344	Group 1	Y	Item 1	1	2		5				2					10
97	Pc	Customer 1	T11223344	Group 1	Y	Item 1	2	2		5				2					11
98	Sales price	Customer 1	30 000,00				30 000,00	30 000,00	0,00	30 000,00	0,00	0,00	0,00	30 000,00	0,00	0,00	0,00	0,00	120 000,00
99	Sales	Customer 1					60 000,00	60 000,00	0,00	150 000,00	0,00	0,00	0,00	60 000,00	0,00	0,00	0,00	0,00	330 000,00
100	Mat %	Customer 1	50,0 %				50,0 %	50,0 %	50,0 %	50,0 %	50,0 %	50,0 %	50,0 %	50,0 %	50,0 %	50,0 %	50,0 %	50,0 %	50,0 %
101	Mat	Customer 1	15 000,00				30 000,00	30 000,00	0,00	75 000,00	0,00	0,00	0,00	30 000,00	0,00	0,00	0,00	0,00	165 000,00
102	Production phase 1	Customer 1	300,00				600,00	600,00	0,00	1 500,00	0,00	0,00	0,00	600,00	0,00	0,00	0,00	0,00	3 300,00
103	Production phase 2	Customer 1	0,00				0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
104	Production phase 3	Customer 1	10,00				20,00	20,00	0,00	50,00	0,00	0,00	0,00	20,00	0,00	0,00	0,00	0,00	110,00
105	Production phase 4	Customer 1	15,00				30,00	30,00	0,00	75,00	0,00	0,00	0,00	30,00	0,00	0,00	0,00	0,00	165,00
106	Production phase 5	Customer 1	0,00				0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
107	Production phase 6	Customer 1	0,00				0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
108	Production phase 7	Customer 1	0,00				0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
109	Production phase 8	Customer 1	0,00				0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
110	Production phase 9	Customer 1	0,00				0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
111	Production phase 10	Customer 1	0,00				0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
112	Production phase 11	Customer 1	0,00				0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
113	h total	Customer 1	325,00				650,00	650,00	0,00	1 625,00	0,00	0,00	0,00	650,00	0,00	0,00	0,00	0,00	3 575,00
114	Fct	Customer 2	T22334455	Group 2	Y	Item 2	5		4			5							14
115	Pc	Customer 2	T22334455	Group 2	Y	Item 2	5		6			7							18
116	Sales price	Customer 2	20 000,00				20 000,00	0,00	20 000,00	0,00	0,00	20 000,00	0,00	0,00	0,00	0,00	0,00	0,00	60 000,00
117	Sales	Customer 2					100 000,00	0,00	120 000,00	0,00	0,00	140 000,00	0,00	0,00	0,00	0,00	0,00	0,00	360 000,00
118	Mat %	Customer 2	40,0 %				40,0 %	40,0 %	40,0 %	40,0 %	40,0 %	40,0 %	40,0 %	40,0 %	40,0 %	40,0 %	40,0 %	40,0 %	40,0 %
119	Mat	Customer 2	8 000,00				40 000,00	0,00	48 000,00	0,00	0,00	56 000,00	0,00	0,00	0,00	0,00	0,00	0,00	144 000,00
120	Production phase 1	Customer 2	200,00				1 000,00	0,00	1 200,00	0,00	0,00	1 400,00	0,00	0,00	0,00	0,00	0,00	0,00	3 600,00
121	Production phase 2	Customer 2	0,00				0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
122	Production phase 3	Customer 2	50,00				250,00	0,00	50,00	0,00	0,00	50,00	0,00	0,00	0,00	0,00	0,00	0,00	350,00
123	Production phase 4	Customer 2	20,00				20,00	0,00	20,00	0,00	0,00	20,00	0,00	0,00	0,00	0,00	0,00	0,00	60,00
124	Production phase 5	Customer 2	0,00				0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
125	Production phase 6	Customer 2	0,00				0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
126	Production phase 7	Customer 2	0,00				0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
127	Production phase 8	Customer 2	0,00				0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
128	Production phase 9	Customer 2	0,00				0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
129	Production phase 10	Customer 2	0,00				0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
130	Production phase 11	Customer 2	0,00				0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
131	h total	Customer 2	270,00				1 270,00	0,00	1 270,00	0,00	0,00	1 470,00	0,00	0,00	0,00	0,00	0,00	0,00	4 010,00