COSTS ANALYSIS AT A SAUSAGE MANUFACTURER X

Bachelor assignment for 'Industrial Engineering and Management BSc'

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Management Summary

X is a meat wholesaler in Paramaribo, Suriname. The company has circa 55 employees and has three departments. A Slaughterhouse, the raw meat factory and the sausage factory. This research is about the costs of the products in the sausage factory. X wants to expand their sales to the Caribbean, because Suriname is in a recession and X needs to export their products to survive.

The costs calculations at X are outdated because of the drop of the Surinam Dollar in mid-2016. Because of this drop, some ingredients of the sausages have increased a lot in purchase price, which X neglected in earlier cost calculations.

In this research, the direct costs are the most important parts. Circa 70%, of the total costs are the raw materials, derived from the receipts. The considered costs include the losses of raw materials, the employee costs, the machine costs and the losses in production and inventory as well. Finally, the costs that are not assigned to products become the indirect overhead costs.

The raw materials are derived from the receipts. The costs of these raw materials are derived from a list of raw materials with the most recent purchase prices. The most recent prices are derived from the purchase orders from the book keeping system of X. The lost materials are derived from the difference in the total used raw materials and the total used raw materials that were expected to be used. Differences between the real and expected used raw materials will occur when the inventories are counted. The labour costs are derived from the costs per minute per employee and the time employees have to work on a batch. The machine costs are based on the time a process group uses the machine, as a fraction of the total time the machine was occupied and multiplied by the depreciation of the machine in a year. The inventory losses of the products are based on the differences in the in expected produced kilos of a product and the number of products that is booked in the booking system as the produced kilos. The inventory losses of the products are also based on the differences between the expected and the real inventory of the products. For making the costs calculation round, the overhead costs consists of all other costs that are not included in the named costs above.

At this moment, this research does not include the calculations of all costs. It was not possible to calculate all the costs because of a lack of data and information. The excel tool is also a deliverable of this research and functions as the model that transforms the input, i.e. the data to the output, i.e. the prices per product. The excel tool is designed in such a way that X can use the model while operating. When the management fills the model with the data, excel calculates the most recent prices automatically.

The excel tool is frequently filled with the production numbers, the purchase orders and the sales orders. With this information, the management calculates the missing costs in this research. Those information sources gives more possibilities for X to turn data into knowledge. Based on these sources, the company is able to analyse their sales numbers per month, plan their production a couple weeks in advance, have insight in their inventory, purchasing an efficient number of raw materials, analyse their production numbers and analyse the changes in price compared to the old prices.

With all this knowledge, X should be able to ask the right price for a product when they want to expand their sales to the Caribbean. Besides the costs calculations, the excel tool provides a lot of important information to the management team of X. With that knowledge, the team is able to make decisions based on the available data in the company.

Preface

After three months and some months after my experience in Suriname, here is my bachelor thesis for my BSc of 'Industrial Engineering and Management'. My experiences in Suriname gave me experiences I will never forget and I will take them with me forever. During my time I had some troubles finding my spot in the city and in an environment I didn't knew at all. I went from my social live in Enschede to a life where I did not knew anyone. After some acclimatisation, I had a wonderful time and met great people.

First, I want to thank the people of X for their support during my time in Suriname. They supported me in housing and if I had any kind of troubles I could always go to them for advice. I also appreciate their willingness to help me in my research. Sometimes it was hard to gather data but the people were always willing to help. The people I also want to thank are friends and family in the Netherlands and in Suriname who supported me in the time, I had difficulties with finding my place in Suriname or with writing this thesis. I also want to thank Marco Strijks for opening doors to go to Suriname for this research. Most of all, I want to thank my supervisors, Ipek Seyran-Topan and Toon de Bakker, for their great support during the writing of my thesis. I always felt they were both willing to help me and took my questions seriously. Both took initiative in supporting me and were always available for questions. That helped me a lot.

I hope this research, and specially the excel tool which is attached to this research will help X take decisions more based on data and to grow as a business in and outside Suriname. I hope you enjoy reading.

Kind regards,

Tom de Koning

BSc student 'Industrial Engineering and Management'

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1. Introduction

This research has been conducted for X N.V., a meat wholesaler in Paramaribo, Suriname. X has three buildings in which it operates. The slaughterhouse, the raw meat factory and the sausage factory. In the slaughterhouse, they slaughter the living animals, mainly pigs. In the raw meat factory, they process the slaughtered pigs and the purchased raw meat to final products. The sausage factory is the most promising part of X. It has been in operation from 2014 and they are making ca. 65 different sausages. This research is limited to the sausage factory of X.

1.1 Company profile

[part deleted]

Process in the sausage factory

In the sausage factory, the processes for many products are the same to other products. In total, 15 different processes are identified. All products go through one of those fifteen processes when being made. A list of these processes and the flow of these processes between activities is attached in Appendix A. The time estimations further in this research, are based on these processes.

Financial situation

X had a profit margin of approximately x.x% in 2016. With a turnover of xx.x million x, which is approximately €x.x million, X is a healthy company. Nevertheless, Suriname is in a recession and in the past year, the SRD devaluated substantially. Because of this, prices expressed in SRDs of ingredients from Europe and the U.S. have increased. The sausage factory is good for approximately xx% of the turnover and X expects the share of the total turnover of the sausage factory to increase. This xx% turnover is important for the profit of X because the products had an average of 55% gross margin in 2016, one of the highest gross margins of all product groups of X. Over 2016, almost 68% of the costs of the sausage factory were Raw material costs, 12% Employee costs, 7.4% equipment and building costs and xx% of other remaining costs. These numbers are visualised in Figure 1.

[figure deleted]

Figure 1: Costs composition over 2016 of the sausage factory of X

Cultural aspects

The culture of this Surinam company differs considerably from the culture of Dutch companies. Companies in Suriname have a highly hierarchal structure. The opinion of a superior is mostly leading and there is less room for discussion than in companies in The Netherlands. X is modernising, they want their employees to be critical and to give them the feeling they can discuss things with a superior. Still, the management team takes many decisions itself. Employees ask for agreement on decisions because of the fear of losing their jobs in the time of recession Suriname is in currently. This results in little initiative of employees and fear to do something wrong, although X encourages employees to take initiative themselves.

1.2 Problem analysis

Current situation

In the current situation, X calculates the costs in excel. An example is given in Figure 2, in which the cost price documentation of the 'Ardenner boterhamworst' is given. For a single batch, they first add the amount of a certain ingredient in kilos in column B, and in column C, they add the price per kilo. The amount of kilos multiplied by the price per kilo results in a gross cost price per batch, given in cell D28. Then, they add the packing materials and the costs per kilo in SRD are calculated in cell D36. Subsequently, they calculate the desired selling price by multiplying the costs per kilo by the desired margin + 1. The current costs per kilo are also given, but there is no clear and accurate calculation behind it.

In Table 1, costs like labour, production and other overhead costs have not been taken into account. In some other calculations of prices, they consider these costs. How these costs are calculated exactly is unknown.

Table 1: Cost price calculation of the 'Ardenner boterhamworst', dated 22-07-2016.

[Table deleted]

Causes of the problem

X wants to increase their sales of the products they make in the sausage factory because of the relative high gross margin of the sausage factory (approximately xx%). Because of the fall of the Surinam Dollar (SRD) mid 2016, in which it lost at least half of its value, Suriname is in a recession now. X buys many raw materials from the US and Europe, therefore some costs have risen significantly last year. To survive this recession, X wants to increase their sales by exporting to the Caribbean, where they can get the more valuable USD or Euros for their products. For maximizing the profit while increasing the sales, X wants a better insight in the costs per product. At this moment, there is a lack of insight because there has never been a calculation of the costs based on a method. The administration adjusts prices to average prices, which causes incorrect costs calculations. The exchange rates fluctuate more than before and are for that reason more unpredictable than before. The causes of the problem are summarised in Figure 3, the 'Cause-effect' diagram of the core problem. Based on the causes, the core problem is visualised in Figure 2, which is that there is no accurate and dynamic costs calculation tool available. The 'dynamic' part represents the possibility to change exchange rates in the calculation and to adjust purchase prices to the most recent prices.
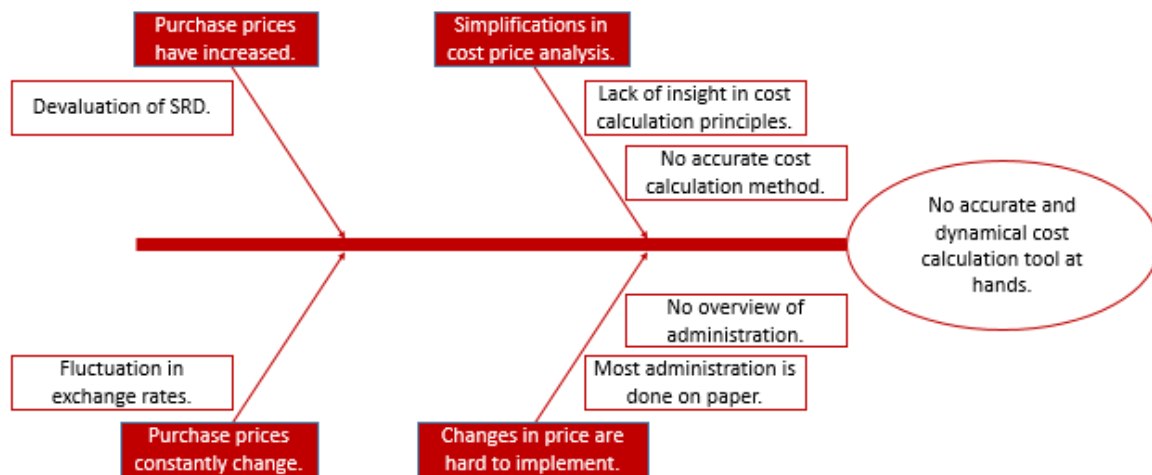
Figure 2 Cause-effect diagram of the main problem

Limitation of the problem

Because of the limited amount of time available for this research, namely 10 weeks, the research is limited. The costs calculation includes the costs of making a product, like raw materials, employee costs and machine costs. In this research, the remaining costs, that are not directly assigned to products, are overhead costs. Not all products can be analysed, five products are selected for the analyses. The argumentation of this selection is given below.

For selecting, the products to analyse the sales data of 2016 are investigated. The products are analysed based on the amount of turnover and the amount of sales of that product in 2016. See Table 2. The selected products are marked in bold in Table 2.

Table 2: Analysis of the sales data of 2016.

[Table deleted]

It turned out that there were no large differences between the percentage of the number of sales and the percentage of turnover of a product compared to the total of 2016, see Figure 3. Based on the most diverse processes, namely the process groups: 'x, 'x', 'x', 'x' and 'x' are analysed, those are processes that differ from each other and have a significant contribution to the total amount of sales. Analysing these products, 'x', 'x', 'Keukenham', 'x' and 'x', results in the analysis of xx.x% of the total turnover and xx.x% of the total amount of sales of the sausage factory.

	WL26	WL14	WL16	WL40	WL44	WL08	WL13	WL67	WL24	WL17	WL19	WL04	WL28	WL89	WL06	Others
% Total Sales	22.7%	9.3%	6.9%	4.6%	3.9%	3.9%	3.7%	2.8%	2.4%	2.4%	2.4%	2.3%	2.2%	2.1%	2.1%	26.5%
% Total Turnover	17.7%	7.1%	7.8%	7.0%	2.5%	1.8%	3.7%	2.1%	3.4%	2.6%	2.7%	2.5%	2.0%	2.2%	1.8%	33.1%
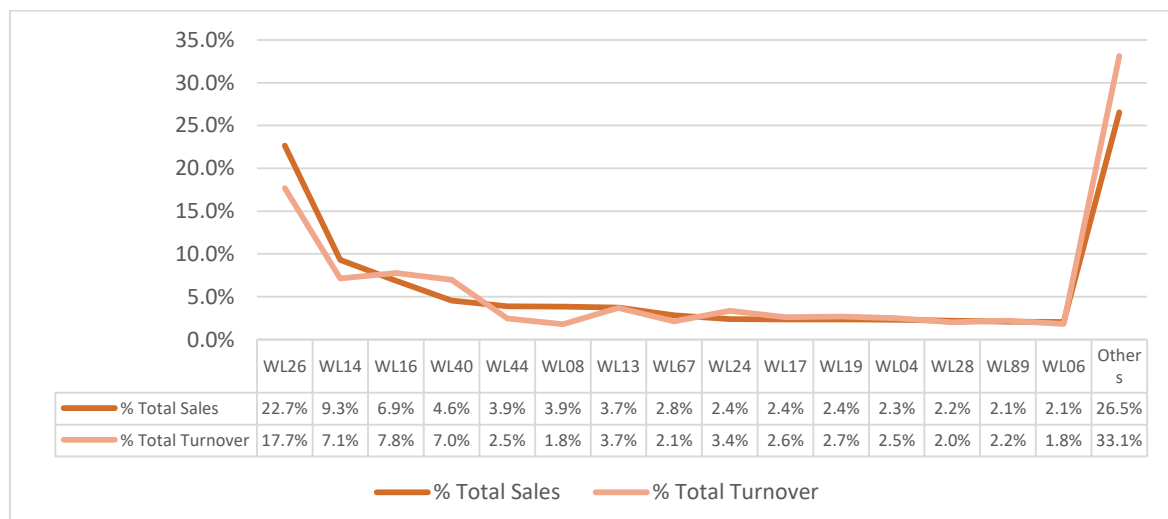
Figure 3: Graph of difference in % of Sales and % of Turnover per product of the sausage factory [Table name deleted]

Research question

The problem description results in the following main questions and sub questions. These are formulated so that in the end, they will contribute to the solution of the problem of X, namely their lack of insight in the costs per product.

Main question:

"How can X N.V. maintain the costs calculations of the products made in the sausage factory?"

Sub questions:

1. What is the current situation of the costs calculation and the costs at X?
2. What is the most suitable allocation method for calculating the product costs in the sausage factory of X?
3. Which direct and indirect costs should X take into account?
4. Which data does X need to analyse the costs?

For answering the main question, first there has to be a clear insight in the current situation at X. Limitations and possibilities in the research should be clear to make a cost calculation that fits in the capabilities of X. Then a research method can be chosen based on a literature review. When the research method is known, it has to be decided which costs should be included in the research method and how these cost should be calculated. Based on the costs that should be considered, it can be determined which data X should have to calculate the costs per product. That will finally result in an explanation how X can perform and maintain a costs calculation for their products in the sausage factory.

1.3 Conclusion

X wants to base their management decisions more and more on data but still, it is hard to transform those data into knowledge. Because of the recession in Suriname and the desire to expand sales, X needs an accurate costs calculation method. In this research, the costs of five products are analysed it has to result in a method and tool to calculate the current costs of a product in a structural way, so it is suitable for now and for in the future.

2. Literature review

In this chapter, the appropriate method to analysing the costs are determined. Some different kind of costs are described, the four considered methods as possible costs calculation methods are described and finally the decision of choosing the method is made.

Based on quick research, the Activity Based Costing (ABC) from Cooper & Kaplan (1991), the alternative on ABC named Time Driven Activity Based Costing (TDABC) from Kaplan & Anderson (2003), the Traditional approach from Drury (2012) and the Material Flow Cost Accounting (MFCA) method based on research from Kokubu & Kitada (2010) are selected for further analysis. In this chapter, these methods are investigated as possible methods for X.

2.1 Types of costs: Direct and Indirect costs

In this research, there is a distinction made between direct and indirect costs. If more costs can be identified as direct costs, there will be less indirect costs. With more direct costs, the costs calculations will be more accurate.

Direct costs

According to Drury (2012), direct costs represent those costs that can be specifically and exclusively identified with a particular cost object. In a manufacturing organization as X, the cost object is a product, physical observation can be used to measure the quantity consumed by each individual product and the cost of direct materials or labour can be directly charged to them.

Indirect costs

Those indirect costs cannot be identified specifically and exclusively with a given cost object. They consist of indirect labour, materials and expenses according to Drury (2012). The term 'overhead costs' is also widely used instead of 'indirect costs'. In this research, overheads include all the costs apart from direct labour and material costs.

2.2 Allocation methods

Traditional method

The oldest of the four methods and one of the more simplistic is the traditional method. This method works with one cost driver per cost pool, e.g. the machine hours for assigning the costs of the machines to products. Most of the time, the direct costs are calculated for a product, a percentage of those direct costs is added for the overhead costs. According to Kloock & Schiller (1997) a cost-accounting system should provide information, which enables management to: (i) make short-term decisions; the most important short-term decisions are concerned with the allocation of resources and the pricing of products. (ii) To control and evaluate performance; actual costs differs from the planned costs and (iii) To support aspects of external reporting; a cost accounting system facilitates inventory valuation in accordance with the traditional accounting.

According to Drury (2012), a standard costing system is most suitable for companies with repetitive operations and for which the required input to produce each unit of output can be specified. For X, that is the case in the sausage factory. Because all sausages are made in a specific process with a specific receipt, those procedures do not change very often. In the method described in Drury (2012),

it is possible to calculate the costs per product based on the bill of materials. Some variances in costs could occur. These variances can cause a product to be less or more expensive. A standard costing system provides information for many different purposes according to Drury (2012). It shows for example the costs of inefficiencies, it is possible to set challenging targets which individuals are motivated to achieve and it can set budgets to evaluate managerial performance.

Limitations and advantages of the traditional method

A traditional way of cost accounting ignores long-run effects of decisions. Besides that, the traditional method does not fully reflect the demand on a company's resources for making a product. That is an important difference from the traditional approach compared to the ABC and TDABC methods. Another disadvantage of the traditional method is that the costs are based on direct costs. A change in the direct costs changes the total costs via direct and via indirect costs because of the overhead percentage over the direct costs, according to Hundal (2007). Therefore, the manager has to interpret the final costs carefully.

The simplicity of this method is an advantage for the company, because X is a company in a developing country. Based on the fact that they already have difficulties with common business matters, like inventory planning and production planning, this simplicity is important for X. A standard costing system can act as a control device, according to Drury (2012). The variances of direct costs are analysed in detail, which gives useful feedback for the management of X.

The Activity Based Costing (ABC) method

Cooper & Kaplan (1988) introduced the Activity Based Costing (ABC) method. They stated, "Virtually all of a company's activities exist to support the production and delivery of today's goods and services. They should therefore all be considered product costs." The ABC method first assigns overhead costs to activities and then to products, orders or customers, based upon their consumption of the different activities according to Everaert, et al. (2008). According to Cooper & Kaplan (1988) a company with high ratio of factory costs to total costs want a system that emphasizes tracing manufacturing overhead to products. At X, the ratio of manufacturing overhead costs is not very high, but the ABC method can bring more advantages, especially about information for the management.

According to the ABC-method, the expenses incurred to produce individual units of a particular product should be separated from the expenses needed to produce different products or to serve different customers. Independent of how many units are produced or sold Cooper & Kaplan (1992). In the research of Cooper & Kaplan (1992), they identified a 'Hierarchy of Factory Operating Expenses'. In that hierarchy, they subscribe expenses to specific activities. These activities are set down in a hierarchy from Facility, Product, Batch and Unit activities. Via these activities, assigning costs to specific products becomes more accurate than the traditional way of accounting. With ABC, they assign costs through a cost driver per activity. For example, the "number of orders" could be an activity driver and with the total costs for orders, it will result in a cost driver rate of costs per order. In the ABC-method, the resource expenses assigned to an activity are determined through interviews, time logs, and direct observation of the amount or percentage of time people spent on various activities, according to Kaplan & Anderson (2003).

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Limitations and advantages of ABC

Updating the data for an accurate cost price calculation requires new rounds of interviews and surveys to reflect changes in a company's operations. Consequently, ABC models are often not maintained and their cost estimates soon become obsolete (Kaplan & Anderson, 2003). Research from a case study (Ratnatunga, Tse, & Balachandran, 2012) shows that commonly cited reasons for failures in adopting and implementing the ABC model come up at the start-up phase. First, it takes a long time to collect data and the data collection requires significant resources commitments; second, the model requires too many activities and cost drivers for organizational complexity, thus requiring high data processing capacities; and third the model does not recognize unused capacity in the statements of time.
On the contrary, the ABC is a detailed way of cost accounting. It assigns costs to more drivers of costs than only products volumes. The ABC method calculates costs of a specific customer, clients, orders, etcetera, which gives valuable information about where profits in the company come from.

The Time-driven Activity Based Costing (TDABC) method

The Time-driven Activity Based Costing method (TDABC) is an alternative of the ABC method; it emphasizes more on simplicity of data gathering, and considers unused capacity. Kaplan and Anderson came with this method after they recognised the limitations of the ABC method (Kaplan & Anderson, 2003). The new, time-driven approach allows for more heterogeneity in activities, orders and customer behaviour without placing burdensome demands for calculating activity, product and customer costs (Kaplan & Anderson, 2003). The time-driven ABC procedure uses an estimation of the time required each time the activity is performed. This unit time replaces the process of interviewing people to learn what percentage of their time they spent on all the activities in an activity dictionary. With the TDABC method, times estimates can be obtained either by direct observation or by interviews. Precision is not critical; rough accuracy is sufficient because gross inaccuracies in unit time estimates will eventually be revealed either in unexpected surpluses or shortages of committed resources (Kaplan & Anderson, 2003). With TDABC, they define the time per activity as a function of several time drivers. For example, the following equation presents the required time to package an item:

Packaging Time = 0.5 + 6.5 (if special handling required) + 0.2 (if shipping by air).

In this example, the equation exists of a standard time of .5 minutes and two time drivers when the activity differs from the normal activity.

The essence of the Time-driven ABC method is the measurement and management of the organization's capacity. For this purpose, TDABC systems require two estimates:

1. The unit cost of supplying capacity (Unit Cost Estimate), and
2. The consumption of capacity (unit times) by the activities the organization performs for products, services and customers (Unit Time Estimate).

Limitations of TDABC

The two required estimates for analysing costs with TDABC brings limitations as well. Resource are directly linked to activities with ABC; with TDABC, the resources and costs are pooled at a higher level, e.g. a whole department. With TDABC, the costs of an activity is calculated by multiplying the expected time per activity by the costs per minute of a cost pool. This upscaling of the pools makes the costs per product depend on the time consumed per product per cost pool. When resources per activity and the use of the activities per product vary a lot, the upscaling of the cost pools could cause considerable simplifications. According to Namazi (2016) a significant assumption underlying the TDABC is that in the equation explained above, there exists a proportionality linear relationship between resource costs

and the cost driver consumption. Therefore, that linear relationship is very important for the validity of this method.

On the other hand, when that linear relationship exists, the TDABC method is an easier way of calculating the costs than the ABC method. When some operations change, only the time estimations of those operations have to be changed instead of interviewing employees about all operations.

The Material Flow Cost Accounting method (MFCA)

According to Kokubu & Kitada (2010), MFCA is a method that traces physical flows and stocks of materials in process, and then calculates their cost by multiplying material quantifies by unit price. Besides the products costs, it highlights the costs of material losses. It identifies opportunities to reduce relative consumption of materials. The basic theory is visualised in Figure 4, from Kokubu & Kitada (2010). In this illustration, MFCA provides information about the amount of waste and stimulates the management to reduce waste.

```
Input(100kg)              Production          Output(80kg)
Material cost        →      process       →   Product
        $1,000                                Material cost
Processing cost                                        $800
        $600                                  Processing cost
Total    $1,600                ↓                       $480
                                              Total  $1,280
                      Output(20kg)
                      Waste (Material loss)
                      Material cost    $200
                      Processing cost  $120
                      Total            $320
```
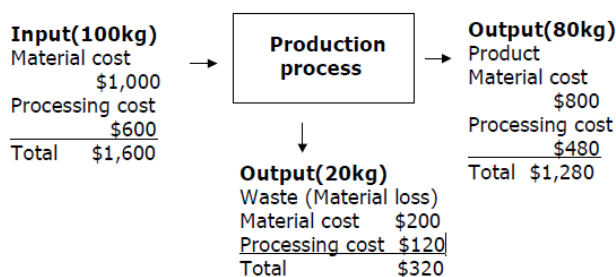
Figure 4: Illustration of the MFCA method

Limitations and advantages of MFCA

A disadvantage of the MFCA method is that it focusses on the losses in the production process. Normally that is not a bad thing, but in this case study, it only gives partly valuable information because it compares the differences between input and output. If the differences are significant, the management still has to find out where the differences occur in the process. The processes at X are too small and are performed parallel from each other sometimes, therefore analysing the waste per step in the production process asks a lot of effort from the management team. An advantage of the MFCA, is that it becomes clear in which production process losses of raw materials occur. The knowledge acquired from MFCA can be used for evaluation of equipment or in substituting new raw materials in order to reduce losses. Another advantage according to Nakajima (2004) is that in the MFCA, it does not fix a cost standard but it directly looks at the volume of materials.

2.3 Choice of method

For choosing the right method to use, the methods are analysed on the preferences and the situation of X at this moment and in the near future. The decision is made based on these preferences.

Decision criteria for X

For the management team it is important that the model is easy to sustain when activities change or are added in the process. If that means that not all costs are considered, then it is fine. Besides the easiness of maintaining, the model should be easy to apply for another production department, which X is currently building. X wants to expand their sales by exporting to the Caribbean, and with that in mind; the capacity of the factory is interesting knowledge for in the near future.

All methods have their limitations and advantages. In Table 3 below, a quick overview of these limitations and advantages is given. The overview gives insight in how the methods meet the preferences of X.

Table 3: Referring the methods to the preferences of X

	Traditional	ABC	TDABC	MFCA
Complexity	Easy to implement	Hard to implement, very data driven	Hard to implement, data driven but easier than ABC	Easy to implement, but does not give very specific information
Correctness of costs calculation	Based on direct costs, overhead is not detailed. Therefore, the model is less correct	Good, most costs are assigned to products based on the consumption of resources	Good, same case with ABC but then based on times per activity. Capacity costs can be calculated as well	The costs are based on direct costs and losses of materials. Less correct than (TD)ABC, comparable with the Traditional method
Maintaining	Easy to maintain because of the easiness of the model and the link with the bookkeeping system	Time consuming to maintain because of the way of data gathering	Has to be updated when processes change	Easy to maintain, only production numbers, purchase orders and receipts are needed
Capacity	No strong indication of capacity	No indication of the capacity	Capacity is calculated for the departments or cost pools	Gives no indication of the capacity

All methods have some limitations and some strong characteristics. The ABC and TDABC methods give more insight in the costs, e.g. where they arise. Therefore, the overhead costs in the costs calculation are minimised. The traditional approach does not give that detailed information about costs. The MFCA method is also easy to implement and to maintain, but does not provide thorough information about the costs. The more detailed the information about the costs, the more effective X can change the managing of the business. However, in this case, X is busy managing the common business questions. A complex model gives X more information, but there is a possibility that a lack of understanding arises. In addition, the time for converting these data into knowledge and changes in the company could be a problem, because X has to focus on other issues, in the current situation. The level of complexity is very important for X. Because Suriname is a developing country, the level of education is less than in

western countries. A more complex model needs more information. X administrates some information about invoices of purchasing and selling, but not all data are reliable. Besides that, some information will probably not be available. The complexity also influences to which extent model is easy to maintain, a simplistic traditional model is easier to maintain, especially with the data that the company gathers. With the TDABC, the indication of the capacity is most accurate, but if it includes estimations of the time needed for a product, the traditional model gives some information about capacity as well.

In conclusion, the traditional method is the most suitable method that provides enough information for the management team to improve the operations at X, but it does not put a large burden on the management team for gathering data.

2.4 Conclusion

The traditional method best suits for a costs calculation for X at this moment. Because of the high percentage of direct costs at X and the simplicity of the traditional method. The traditional method is easy to maintain and can give a lot of extra information about the factory with the available data at X.

3. Methodology

In this section, the methodology of the traditional method and how it fits in the situation of X will be described, as well as which costs are worth considering. For every costs group, an example of the calculation is given. The examples are based on the product 'x'. A chicken sausage which is smaller than usual what makes it a good sausage for the BBQ.

3.1 The allocation method

With the traditional method of costs accounting, the total costs are mainly based on the direct costs, the indirect costs, are a percentage of the direct costs. The high percentage of direct costs to the total costs at the sausage factory of X makes this method accurate enough. Although, when more costs are directly assigned to products, the percentage of indirect costs becomes lower and the calculation improves.

Those costs are Raw materials costs, losses of raw materials, employee costs, machine costs and losses of sale products. In the end, the remaining costs are bundled in overhead costs. Figure 5 is the visualisation of the breakdown of the costs calculation.

Raw material costs	• Based on receipts.	
Losses on raw materials	• Based on theoretical used materials and real used materials.	
Employee costs	• Based on employee time per product and costs per employee per time entity.	Direct costs
Machine costs	• Based on usage time per product and costs divided by total time used.	
Losses on products	• Based on difference between theoretical and real inventory.	
Overhead costs	• All undefined costs as a percentage of the direct costs.	Indirect costs

Figure 5: Breakdown of costs calculation

For further explanation of the equations and the calculations, after the explanation of the calculating the costs and the calculations an example is given. The ''Product Y'' is used for the example, see Figure 6.

[Figure deleted]

Figure 6: Picture of the ''Product Y'', ready for sale

Raw material costs

The standard costs for the product are based on the bill of materials, based on the optimal quantity of the used products according to Drury (2012). Also according to Drury (2012), the 'inevitable' costs should be included in the standard bill of materials. The inevitable losses on raw materials are not known at X, those costs are not considered in this part of the costs calculation. The real raw material

costs are, based on the management financials, 67.5% of the total costs of the sausage factory. The receipts are the basis of the costs of the raw materials per product, the prices per raw material are derived from the book keeping system of X in 'Exact-Online'. In 'Exact-Online' they keep track of their sales, purchases and financial administration. In the end, the total raw material costs of a product are calculated with the Equation 1:

Note: k is the raw material for a product. There are K ingredients in a product.

Note: p is the product which is analysed

$$Raw\ material\ costs\ per\ kilo\ per\ product\ p$$
$$= \sum_{k=1}^{K} \frac{(Quantity\ of\ Ingredient\ k\ per\ batch * Costs\ of\ Ingredient\ k\ per\ Entity)}{BatchSize\ of\ product\ p} \tag{1}$$

An example of the calculation of one raw material costs per kilo per product is given in Equation 2.

$$Costs\ of\ Raw\ Material\ 'RM\ z'\ of\ 'product\ y'\ per\ kilo = 0.30 * 0.77 = \$\ 0.23 \tag{4}$$

Finally, all the costs of the raw materials per kilo per product are summed and that results in the total 'Raw material costs per kilo per product', see equation 1.

In Table 4 below, all ingredients on the Bill of Materials (BOM) of the ''Product Y'' are given in the second column of Table 4. The number of raw materials are given in the third column the raw materials, based on the batch size in kilogram (kg) in the fourth column. In the fifth column, the raw materials are divided by the batch size, which results in the number of ingredients in kg or in pieces per kilogram of a batch.

Table 4: Screenshot of the calculation of the raw material per kilo per product

ProductName	Raw Material with code	RawMaterial (kg)or(piece)	Batchsize (kg)	Kg-Piece/KgBatch
BBQ worst Naturel (Kip)	Frzn Chicken MDM - KM00007	36.00	120	0.30
BBQ worst Naturel (Kip)	krm tbv BBQ worst kip naturel - KR00259	11.16	120	0.09
BBQ worst Naturel (Kip)	Frzn Chicken Tenders (kippenhaas) - KM00001	36.00	120	0.30
BBQ worst Naturel (Kip)	Kippen vellen - KL00001	36.00	120	0.30
BBQ worst Naturel (Kip)	Natural hog casings long shorts 28/30 - ZM00008	2.40	120	0.02
BBQ worst Naturel (Kip)	Krimpzak 300x450 bodemnaad - VR00064	66.00	120	0.55
BBQ worst Naturel (Kip)	Nitriet pekelzout - KR00120	2.40	120	0.02
BBQ worst Naturel (Kip)	Ijswater - KR00152	10.00	120	0.08

For example, the number of kg of the raw material 'Frzn Chicken MDM' for the product ''Product Y'' are 0.30kg, see Equation 2, which is derived from Equation 1:

$$Kg\ of\ Raw\ Material\ of\ 'Frzn\ Chicken\ MDM'in\ 'producty' = \frac{36}{120} = 0.30kg \tag{3}$$

In Table 5, the calculation of the costs of the ingredient per kilo is calculated. The Kgs or Pieces per 'Kg of batch' are given in the first column of Table 5. The purchase price of the raw material per kilo or per piece is given in third column. The values of the first and the third column are multiplied with each other and that results in the 'Price per kilo of a raw material of the receipt', as part of Equation 1. It results in Equation 4.

$$Costs\ of\ Raw\ Material\ 'RM\ z'\ of\ 'product\ y'per\ kilo\ =\ 0.30 * 0.77 = \$\ 0.23 \tag{4}$$

Finally, all the costs of the raw materials per kilo per product are summed and that results in the total 'Raw material costs per kilo per product', see equation 1.

Table 5: Costs of the ingredients of ''Product Y'' per kilo

[Table deleted]

$$Raw\ Material\ costs\ per\ kilo\ of\ 'Product\ y' = \$1.75 \tag{5}$$

Because X works with receipts based on batches, the input of quantities are based on batches and in the end, for calculating the price per kilo the costs per batch are divided by the batch size. The standard prices are obtained from the 'Purchase orders', in the calculation in excel, in that excel tool the most recent price of the products are used. That recent price is the most accurate one and it is important to use the most recent price because of constantly changing prices in Suriname and the currently high fluctuations of the SRD.

Costs of losses of raw materials

The inevitable losses on raw materials are not taken into account in the calculation of the raw material costs in the 'Losses of raw materials'. The losses on raw materials based on the standard quantity that should be used minus the actual quantity that is used (Drury, 2012). The total quantity of raw material losses can be calculated based on the purchased raw materials, the receipts of the products, the production volumes and the inventory counted. That results in the following formulas:

Note: k is the raw material for a product. There are K ingredients in a product.

Note: p is the product which is analysed

$$Expected\ Used\ RM_k \tag{6}$$
$$= \sum_{k=1}^{K} (Receipts\ with\ Quantity\ of\ RM_k\ per\ Batch$$
$$* Batchproduction\ of\ Receipt_p\ )$$

$$Real\ Used\ RM_k =\ Expected\ Used\ RM_k + (\ Expected\ Inventory\ RM_k \tag{7}$$
$$-\ Counted\ Inventory\ RM_k)$$

$$\%Losses\ Raw\ Material(RM)_k = \frac{Real\ Used\ RM_k - Expected\ Used\ RM_k}{Expected\ Used\ RM_k} \tag{8}$$

What differs from this formulas from the method used in Drury (2012), is that these costs are not multiplied by the standard price. In the excel tool, in the end the costs of the losses of raw materials are calculated based on the most recent price. The most recent price is used for this calculation because most often at X the most recent price also becomes the new standard price. In the end, that will result in the 'Total material variance'.

In this example below, the costs for one ingredient of the ''Product Y'' is chosen. Assume that X produced two batches of this product only, which equals 240 kg. Based on Table 4, we know that X would use 36 kg per batch and 0.30 kg per kilo of the 'Frzn Chicken MDM'. That means X should have

used 72 kg of MDM for the production. That results in Equation 7, which is part of the summation of Equation 4.

$$Theoretically\ Used\ 'Frzn\ Chicken\ MDM' = 36*2 = 72kg \tag{9}$$

Assume X had no begin inventory and bought 80kg of the 'Frzn Chicken MDM', then the inventory should still be 80 - 72 = 8 kg. But, X counts the real inventory and there is only 3 kg left. The real used 'Frzn Chicken MDM' is then calculated, see Equation 8, which is based on Equation 5.

$$Real\ Used\ 'Frzn\ Chicken\ MDM' = 72 + (8-3) = 77 \tag{10}$$

And that is used as input for the calculation of the '% Losses of Raw Material n', the losses of 'Frzn Chicken MDM' is given in Equation 11, based on Equation 8.

$$\%\ Losses\ of\ 'Frzn\ Chicken\ MDM' = \frac{77-72}{72} = 6.9\% \tag{11}$$

The price per kilo of 'Frzn Chicken MDM' in the receipt for one kilo of ''Product Y'' is $0.23 (see Table 5). With the losses of 6.9% for the 'Frzn Chicken MDM', the costs of the losses are

$$Costs\ losses\ on\ Raw\ Material\ 'Frzn\ Chicken\ MDM' = \$0.23*6.9\% = \$\ 0.016 \tag{12}$$

In this example, the assumption is made that the overall losses on raw materials are 10% for the ''Product Y'' on the total raw material costs of Equation 4, then the losses on raw materials are:

$$Losses\ on\ Raw\ Materials\ for\ 'producty' = \$1.75*10\% = \$0.18 \tag{13}$$

Because of lack of data, this is a fictive example. So the numbers used in this calculation are not based on real numbers.

Employee costs

The employee costs are based on total employee costs of the sausage factory. The costs are calculated from the total employee costs per month divided by the total expected production minutes per month. Then the costs per minute are calculated. In the excel tool, there is not a standard wage rate but the actual wage rate based on actual costs and available time is used. The labour inefficiency costs are assigned to the overhead costs because it won't be possible to calculate the labour efficiency variance per product. Finally, the costs per process group are calculated by multiplying the total minutes an employee has to work on a batch by the costs per minute. The following formulas are used:

$$Employee\ costs\ per\ Minute = \frac{Total\ employee\ costs}{Total\ worked\ production\ minutes} \tag{14}$$

$$Employee\ costs\ per\ kilo\ per\ product = \frac{Employee\ minutes\ per\ Batch * Employee\ costs\ per\ Minute}{Batch\ size} \tag{15}$$

In practice in the excel tool, it results in the following formulas to come to the employee costs per kilo per product. Below there is an example of the calculation of the employee costs for the process group ''Product Y''. In

Table 6, first, the total costs per category are given and then the total worked hours by the production

$$Employee\ costs\ per\ kilo\ of\ the\ 'product\ y'\ in\ SRD = 2.35 * 0.37 = 0.87\ SRD \tag{18.1}$$

$$Employee\ costs\ per\ kilo\ of\ the\ 'product\ y'\ in\ USD = \frac{0.87}{7.3} = \$0.12 \tag{18.2}$$

employees together. Based on that knowledge, the excel tool calculates the 'Employee costs per Minute' based on Equation 14 (see 4.1 Sheets for costs calculation). In 2017 the costs per minute where calculated, see Equation 16.

$$Employee\ costs\ per\ Minute\ in\ 2017 = \frac{162.50 * 1000}{7,366.65 * 60} = 0.37\ SRD \tag{16}$$

Based on the numbers in Table 7, the 'Employee costs per kilo per product can be calculated. For the process group 'BBQ worst', the total hours that, employees have spent on producing a batch is 3.92 hours. A batch size is 100 kg at this process group and therefore the employees minutes/kilo, are:

$$Employee\ minutes\ per\ kilo\ of\ the\ 'product\ y' = \frac{3.92 * 60}{100} = 2.35\ minutes \tag{17}$$

Then the employee costs of a kilo in a process group can be calculated (see Equation 18.1 and 18.2) by multiplying the minutes per kilo by the costs per minute, based on Equation 15.

$$Employee\ costs\ per\ kilo\ of\ the\ 'product\ y'\ in\ SRD = 2.35 * 0.37 = 0.87\ SRD \tag{18.1}$$

$$Employee\ costs\ per\ kilo\ of\ the\ 'product\ y'\ in\ USD = \frac{0.87}{7.3} = \$0.12 \tag{18.2}$$

Table 6: Input for calculating the costs/minute per employee

[Table deleted]

Table 7: Calculated Employee minutes/kilo of a process group

ProcesGroup	Employee minutes/kilo	Batch size	Total employee hrs per batch
Machine#			
Machine costs/min (SRD)			
#Employees			
BBQ worst	2.35	100	3.92
Knakworst	6.30	50	5.25
Rookworst	5.10	50	4.25
Kippen/magere ham	1.55	100	2.58
Andere hammen	3.30	100	5.50
Zoutvleesbeleg	3.45	100	5.75
Frikandellen	3.50	60	3.50
Vleesworsten	1.00	500	8.33
Gerookte kippen	0.70	300	3.50
Gerookte producten	0.90	250	3.75
Grilworst	3.05	100	5.08
Kookworstsoorten	1.00	100	1.67
Rauwe soorten	0.69	80	0.92
Gehaktballen	10.89	45	8.17
Snackballen	3.67	60	3.67

This way of calculating the employee costs does not assign all employee costs to products, because of efficiency losses. There is a budgeted time for a specific number of production, the actual time that is needed for the production changes the 'Employee costs per minute' Another simplification in the 'Employee costs' is the costs of the managers. The costs of the managers of the sausage factory is namely included in the employee costs. The available production minutes are based on the production employees who work in the factory. Although the total labour variance is not calculated because of the assumed constant time per product, the theoretical productivity can be calculated.

Machine costs

In the Excel tool, the machine costs are based on the purchased value of the machines. Normally, the machine costs are based on the replacement value. Although, X bought the machines in Euros and because of the drop of the SRD, the depreciation period becomes too high with the current value. To calculate a price in which X can compete in their market, they want to calculate the machine costs based on the purchased value of the machines, with a depreciation of 10 year and a residual value of 10%. The expected life cycle of the machines could not be derived from specifications, so it is derived from estimations of the production- and financial manager.

The machine costs are totally assigned to the process groups, based on the current depreciation of a book year and the time usage of a machine by producing a batch in a process group. The costs are calculated with the following formulas:

Note: x indicates the 'Machine', there are X machines.

Note: y indicates the 'Process group', there are Y process groups.

$$Occupied\ time\ of\ Machine_x\ by\ Process\ group_y \hspace{3cm} (19)$$
$$= Time\ per\ Process\ group_y\ of\ Machine_x\ per\ Batchsize * Batches$$

$$(20)$$

$$Total\ Occupied\ time\ of\ Machine_x = \sum_{y=1}^{Y} Occupied\ time\ of\ Machine_x\ by\ Process\ group\ _y$$

$$Costs\ of\ Machine_x\ per\ minute = \frac{Depreciation\ of\ current\ Book\ year\ of\ Machine_x}{Total\ Occupied\ time\ of\ Machine_x} \hspace{1cm} (21)$$

$$Total\ Machine\ costs\ per\ kilo\ of\ Process\ group_y \hspace{3cm} (22)$$
$$= \sum_{x=1}^{X} \frac{Costs\ of\ Machine_x\ per\ minute * Occupied\ time\ of\ Machine_x by\ Process\ group_y}{Batch\ size_y}$$

The machine costs per process group are also calculated in the excel sheet 'Resources'. Below is an example of the calculation of the machine costs for the 'cutter machine' for the 'BBQ worst' process group. In the 'Resources' sheet is a table with the required time per machine per process group, see Table 8. The time a batch of a product of the process group 'BBQ worst', occupies the 'cutter machine' is 20 minutes, according to Table 8. When the number of batches of 'BBQ worst' is, for example, 8, the occupation of the cutter machine by this process group is calculated based on Equation 20, which results in Equation 23.

$$Occupied\ time\ of\ 'Cutter\ machine'by\ 'product\ y' = 20 * 8 = 160\ minutes \hspace{1cm} (23)$$

Table 8: Part of the table with the time estimations for the activities per process group. Positioned in the 'Resources' sheet

ProcesGroup	Employee minutes/kilo	Batch size	Total employee hrs per batch	Voorbereiding	Malen	Cutteren
Machine#					1	2
Machine costs/min (SRD)					2.34	4.87
#Employees				1	1	1
BBQ worst	2.35	100	3.92	5		20
Knakworst	6.30	50	5.25	15		15
Rookworst	5.10	50	4.25	15		15
Kippen/magere ham	1.55	100	2.58	30	10	
Andere hammen	3.30	100	5.50	30		
Zoutvleesbeleg	3.45	100	5.75	120		
Frikandellen	3.50	60	3.50	15		15
Vleesworsten	1.00	500	8.33	20	30	
Gerookte kippen	0.70	300	3.50	30		
Gerookte producten	0.90	250	3.75	30		
Grilworst	3.05	100	5.08	15		20
Kookworstsoorten	1.00	100	1.67	15		20
Rauwe soorten	0.69	80	0.92	15		30
Gehaktballen	10.89	45	8.17	15	10	
Snackballen	3.67	60	3.67	15	10	

With Equation 20, the total time the cutter machine is occupied is calculated. That is the summation of Equation 19, the occupied time of a machine for all process groups. Assume the total occupied time on 3190 minutes per year in this example. The depreciation is xx.xxx,00 SRD per year, the costs for using the Cutter machine for only one minute is calculated based on Equation 21, and finally results in Equation 24 for the 'Cutter Machine'.

$$Costs\ of\ 'Cutter\ Machine'per\ minute = \frac{xx.xxx}{xxxx} = x.xx\ SRD \qquad (24)$$

The total machine costs are calculated with the summation of Equation 22, the costs of a machine multiplied by the occupied time of the machine by process group producing a batch of products and divided by the batch size. For 'x=cutter machine' Equation 18 results in Equation 25.

$$'Cutter\ Machine'costs\ per\ kilo\ of\ 'producty' = \frac{3.95*20}{100} = 0.79\ SRD \qquad (25)$$

Finally, Equation 22 is complete with the summation of all the costs per kilo 'BBQ worst' of the machines. Which is a sumproduct calculation of the costs per minute of a machine and the usage of the machine for one batch per process group, divided by the batch size. That results in the machine costs per kilo, showed in Table 9.

Then the total machine costs for the product ''Product Y'' are based on the process group 'BBQ worst', (the exchange rate USD/SRD is 7.30):

$$Machine\ costs\ for\ 'product\ y'.50\ SRD = \frac{1.50}{7.30} = \$0.21 \qquad (26)$$

Table 9: Calculated machine costs per kilo per process group

[Table deleted]

Costs of losses on products

Because of several reasons, the sum of the final products that are sold and the number of products in inventory could be less than the produced number of a final product. Those differences cause a loss on products. For example, these could be production losses and perishability of products. These losses

are calculated by inventory losses and production losses. The input for the calculation of the production losses are the production and the 'purchase' numbers. In the bookkeeping system, the produced final products are booked as purchase orders. Dividing the purchase numbers by the initial production numbers gives the efficiency of the production of the final products. The inefficiency of the production represents the production losses. The inventory losses are calculated by the difference between real and theoretical inventory, calculated the same way as the inventories of the raw materials. In the end, the losses on final products can be calculated by multiplying the production efficiency by the inventory losses. That results in a production volume ratio, which differs slightly from the production volume ratio of Drury (2012), because this ratio is based on the production volumes instead of the hours used. The total '% Product losses' is calculated with the '%Production losses' and the '% Inventory losses' as input. The inventory losses are only based on the kilos of product that came in the inventory after production. This results in the following formulas:

Note: p is the product which is analysed.

$$\%Production\ losses = 1 - \frac{Purchased\ kilo's\ of\ Product_p}{Produced\ kilo's\ of\ Product_p} \tag{27}$$

$$\%Inventory\ losses = 1 - \frac{Absolute\ losses\ on\ Inventory}{Purchased\ products} \tag{28}$$

$$\%Products\ losses = \%Production\ losses + (1 - \%Production\ losses) * \%Inventory\ losses \tag{29}$$

Because of a lack of data, an example of the total losses on final products is only possible with fictive numbers. So this example has fictive numbers, in excel, when the data is available, the losses are calculated in the 'inventory' sheet. Assume X produced 500 kg of ''Product Y', in theory they should book 500 kg as purchased ''Product Y''. In practice, they book 450 kg, The production loss is calculated based on Equation 27, see Equation 30.

$$\%Production\ losses\ 'BBQ\ worst\ naturel\ (Kip)' = 1 - \frac{450}{500} = 10\% \tag{30}$$

So there is a production loss of 10% of the production of ''Product Y'', 450 kg goes in stock after an initial production of 500 kg. Assume the beginning inventory was zero, and X has sold 150 products. The theoretical inventory should than be 450-150 = 300 kg. If the real inventory is 255 kg, there is a loss on inventory of 30 kg because of perishable products or differences in inventory calculations. The inventory losses are calculated based on Equation 23, see Equation 26.

$$\%Inventory\ losses\ 'product\ y' = 1 - \frac{45}{450} = 10\% \tag{31}$$

Finally, the total losses on final products can be calculated based on Equation 29, see Equation 32.

$$\%Products\ losses\ 'product\ y' = 10\% + (1 - 10\%) * 10\% = 19\% \tag{32}$$

So, the losses on ''Product Y'' are 28%, which is absolute 500*0.19= 95. The sum of the absolute losses in production is 50 kg and the losses on inventory is 45 kg.

That results in extra costs for ''Product Y''. Before the costs are based on raw material costs (5), losses on raw materials (13), employee costs (18) and machine costs (26).

For the ''Product Y'' those costs are cumulative (1.75+0.18+0.12+0.21) $2.26. The costs of the losses on production and inventory should be calculated over the cumulative costs of the costs groups above. So the losses on the product ''Product Y'' are calculated in Equation 33.

$$Losses\ on\ 'product\ y' = \$2.26 * 19\% = \$\ 0.43 \qquad (33)$$

Overhead costs

For making the calculation complete, the overhead costs are remaining costs which are not assigned to products. In that way, the calculation assigns all costs to products. Because X wants to base the costs calculation mainly on the direct costs, the overhead costs are a percentage of the total costs and they are assigned to other products based on that percentage. That results in the following formulas:

$$Overhead\ costs = Total\ costs - Assigned\ Raw\ Material\ costs - Raw\ Material\ losses\ costs \quad (34)$$
$$- Assigned\ Employee\ costs - Assigned\ Machine\ costs$$
$$- Assigned\ losses\ on\ product\ costs$$

For calculating the overhead costs, only the assigned costs are considered. Then it is certain the calculation is based on 100% of the costs.

$$\%\ Overhead\ costs = \frac{Overhead\ costs}{Assigned\ costs} \quad (35)$$

$$Overhead\ costs\ per\ product = Assigned\ costs\ per\ product * \%Overhead\ costs \quad (36)$$

If the overhead costs are assumed to be 20%, the ''Product Y'' overhead costs are based on the previous calculated costs, see Equation 37:

$$Overhead\ costs\ product\ y = \$2.69 * 20\% = \$\ 0.54 \quad (37)$$

In the end, the costs calculation per product per kilo is:

$$Costs\ per\ product\ per\ kilo\ (pp\ pk) \quad (38)$$
$$= (Raw\ Material\ costs\ pp\ pk + Losses\ on\ RM\ costs\ pp\ pk$$
$$+ Employee\ costs\ pp\ pk + Equipment\ costs\ pp\ pk$$
$$+ Losses\ on\ Products\ pp\ pk) * (1 + Overhead\%)$$

Finally, the costs of making one kilo of ''Product Y'' costs are $ x.xx See Table 10.

Table 10: Break down of costs of the ''Product Y''

Costs group	Equation	Costs in $
Raw material costs	5	x.xx
Losses on raw materials	13	x.xx
Employee costs	1	x.xx
Machine costs	26	x.xx +
Subtotal	-	x.xx
Losses on product	32	x.xx +
Subtotal	-	x.xx
Overhead costs	37	x.xx
Total costs per kilo ($)		**x.xx**

Table 11: Calculated costs of ''Product Y''

[Table deleted]

3.2 Validity of method

The costs calculation for X is based on the most recent prices and bill of materials, assuming that X inserts the purchase orders and updates the receipts when changes occur. The costs are based on that recent knowledge. Therefore, the calculation neglects the price variances. Although the differences in prices compared to the price of the begin of the year are calculated in the excel tool. The calculation of the overhead costs corrects the neglecting of these variances in price. This could result in a small underestimation of the costs per product per kilo.

3.3 Conclusion

In this case study, the costs calculation is based on the direct costs per product with an additional overhead percentage. Most costs are direct costs and this research tries to uncover the direct costs as well as the costs directly linked to the direct costs, such as the losses of raw materials that are directly linked to the costs of a specific raw material. The costs calculation considers all costs with the overhead costs being the unassigned costs, expressed as a percentage.

4. Explanation of Excel tool

In this chapter, the working of the Excel tool is explained. The Excel tool consists of 17 sheets with many links between the sheets. Most of the time, the links are made with formulae in excel. If it was necessary, VBA is used. Screenshots of the sheets can be found in Appendix B.

4.1 Sheets for costs calculation

The basis for the costs calculation are the receipts, the prices per ingredient, the machines, time estimations for employees per batch and the purchase orders, sales orders and production numbers. Below, all sheets used for the costs calculation are described.

RecepturenTable

In the sheets for the receipts table, all receipts are put in a table. So, the whole BOM is summarized in this sheet. This sheet is updated by making changes in the receipt via the 'Inputsheet', it pulls information from the sheet 'IngredientsPriceList'. This sheet gives information for calculating the raw material costs of a product.

IngredientsPriceList

In this sheet, all ingredients are given with their code that is used in the book keeping system of X. This sheet is updated by the information from the sheet 'InsertPurchaseOrders'. The sheet gives information for the sheet 'RecepturenTable'. It also shows whether prices have been risen or fallen compared to the beginning of the book year. The recent prices are necessary for updating the costs of the raw materials.

Resources

In this sheet, all machines and time estimations for the employees and for the machines needed per process group can be found. This sheets receives information about costs from the 'Inputsheet' and gives information about specific costs to the sheet 'ProductsPrices'. With this sheet, the costs per employee and the machine costs are calculated for a specific product.

InsertPurchaseOrders

From this sheet, the purchase orders are processed and the information in this sheet flows to other sheets. The data is inserted from the book keeping system and with a push on a button, the data is processed and then deleted. It updates the prices in 'IngredientsPriceList' and the inventory in the 'Inventory' sheet. The information from this sheet is necessary for calculating the losses on raw materials and the losses on products.

InsertSalesOrders

From this sheet, the sales orders are processed and the information in this sheet flows to other sheets. The data is inserted from the book keeping system and with a push on a button, the data is processed and then deleted. It updates the data in sheet 'SalesData' and in the 'Inventory' sheet. The information from this sheet is also necessary for calculating the losses on raw materials and the losses on products.

ProductionBook

In this sheet, all production batches are summarized and this time not deleted. The data comes from the administration in the factory. It gives input for the inventory in the 'Inventory' sheet and for the production analyses in the sheet 'ProductionAnalyses'. Again, the information from this sheet is also necessary for calculating the losses on raw materials and the losses on products.

ProductsPrices

In the sheet ProductsPrices, the breakdown of costs per products is given in a table. That gives information about the breakdown of the costs of a product.

PriceChanges

In the sheet 'PriceChanges', the differences in prices is visualised. In a graph, the old costs calculation, the new calculated costs the sell price of a product per kilo is given. That gives insight in the differences in calculations and whether or not a product is sold with loss or with profit.

4.2 Additional sheets

Besides the sheets and the calculations for the calculating the costs, I added more sheets which gives the management of X more insight in the data of the sausage factory. They can use that data to make better decisions and manage the activities in the factory in a better way.

Additional features

The additional features get a lot of knowledge out of the data of X. With these features, X can make better decisions with respect to the activities in the sausage factory. Because of the additional sheets, X can better analyse their production numbers. With that knowledge, they get more insight in the performance of the employees in the factory. They can also analyse the sales per product. With that knowledge, they can better predict how much they will sell in coming periods. Because of the production and sales numbers and the receipts, the Excel tool gives also knowledge about the inventories of the raw materials and the final products. With the knowledge about the inventory combined with the knowledge about sales, X is better able to buy enough raw materials for a specific period. Based on the predicted sales and the inventory of the final products, the Excel tool calculates on which date a final product goes out of stock. That is a valuable input for the production planning of X. The Excel tool gives also information about price changes of raw materials, efficiencies based on expected production times and the changes in costs calculations. Below, all additional sheets are explained, screenshots of the sheets can be found in Appendix B.

Inputsheet

On the 'Inputsheet', all costs per month are inserted, the exchange rates are changed and the costs/minute for an employee is calculated. From this sheet, the user can also decide which costs he wants to take into account. On this sheet, the composition of assigned costs is also calculated in percentages. With the buttons, the counted inventories can be inserted.

Dashboard

On the dashboard sheet, there are a table and four graphs. The table gives information about the prices per product. It includes the costs, the selling price, the margin, number of sales and the total contribution to the profit. The graphs visualize the sales per month in SRD, the sales per month in kilos, the total production per month in kilos and the productivity per month. Especially the productivity is interesting. The productivity is based on the production numbers and the time it takes for employees to make a batch. Currently, the productivity is very low, between the xx% and xx%. Because the time employees have to clean the factory etcetera is included in the available time for the calculation of the productivity, it is not surprising that the productivity is low. Still, the productivity seems to be very low. The management team can look into the productivity but has to take into account that it is based on time estimations and normally the productivity cannot reach a percentage higher than circa 85%.

Production planning

Excel calculates how much has to be produced of a specific product, based on predetermined period. The user can always change that predetermined period. The calculation is based on the predicted sales per month, a fraction of the months that fall in the period and the current inventory. Excel also calculates the predicted day a product goes out of stock. With this information, the production manager has better insight in which products has to be produced. Of course, the production manager has to alter the prediction if the demand or the inventory differs from the information in the excel sheet. The manager also has to take into account how long It takes for the products to perish.

Inventory

This inventory sheet is important for the costs calculation and is already mentioned in the report. Because of the possibility to insert the counted inventory, the calculation of the inventory of products and raw materials can be very accurate. That information is used in the 'ProductionPlanning' sheet and the 'SpicesOrdering' sheet. With this knowledge, X is able to better manage their inventory.

Spices ordering

The number of spices that has to be ordered depends on the receipts of the products and the expected production of a product. The calculations on the production planning sheet give input for the expected production for a specific period. Based on the raw materials the necessary kilograms is calculated per raw material. That necessary kilograms minus the inventory gives the amount of raw materials X has to order for a specific period. The interpretation is important because losses of raw materials are not included in this calculation. The management team has to think about the final amount of raw materials to order.

Sales analyses of the sell products

The sheet 'SalesData' gives input for this sheet. In this sheet, there is a pivot table. The management team can alter the dimensions and the products in the pivot table, to get more information about the number of sales per product in the past years and months. Analysing the number of sales is important for the expected sales that is used as input for the production planning. If the management team wants more information about the sales per product, they can use the 'SalesAnalysesOne' or the 'SalesAnalyesAll' sheet. On that sheet the can see the results of the sales analyses per product in graphs, based on the data from the sheet 'SalesData'. The sheet 'SalesBook' summarizes the sales data about the book year of the Excel tool, from that sheet, the data can be copied to the 'SalesData'.

Production analyses

In the sheet 'ProductionAnalyses', the production of the whole year is analysed. Per product, per product group and per process group. In this sheet, no graphs are added, because the information most interesting compared to other years. When the user compares the data to previous years, it is interesting to make graphs from the data.

4.3 Strengths of the excel tool

First of all the cells in which the management has to fill in information are kept to the minimum with vba codes, vlookups, sumifs, sumproducts, etcetera. The cells in which the user has to fill in something are filled with a light yellow color. Protecting some sheets was not possible because all sheets have to be altered from time to time.

The cells in which the manager or an employee has to insert values that should be a specific name or a predetermined amount of numbers are restricted with data validations. Most of the time, the exists of dropdown lists from a table.

The uses of table makes sure that if rows are added, formulas, ranges and links are automatically updated. For example, the pivot table in the 'SalesAnalysesAll' sheets, the data source is the table in the 'SalesData' sheet. Additionally, all tables and lists are named, so it is easy to find from which table information comes in a formula.

With the inserting of orders from Exact-online to the Excel tool, it could happen that some orders are missing. Excel automatically stores the date of the last inserted order. The next time the user inserts purchase orders, excel gives a message that those orders are already inserted. The user manually has to change the order number of the last inserted order. With that knowledge, the user is able to insert only the orders with a higher order number than the stored one. The same counts for the sales orders.

4.4 Disadvantages of excel tool

General disadvantages

The price of the ingredients and the changes in currency rates, changes the costs per product. It does not change the historical total costs of the sausage factory. Therefore, the prices per product are up-to-date but the expected costs based on the production volumes could differ from the real costs of the factory. The '%Overhead Costs' solves this but it results in average costs per product over the last year. Therefore, the costs calculation could be less accurate at the end of the year, compared to the calculation at the beginning of the year. Therefore, it could be better to base the costs calculation without the overhead costs. Instead of those overhead costs, they could use a standard overhead percentage over the direct costs. During the year, X can judge whether their percentage of overhead costs seems to be accurate or not.

Sheet specific disadvantages

The production planning is based on linear sales per day, with seven days per week. Therefore, the date a product goes out of stock is always an estimation based on simplifications. The calculated planned production per product in the production planning is not changed into batch sizes. The reason for giving only the number of kilos is that it makes the calculation more transparent. The user has to calculate it to batches by his own. Then the user can decide how many batches he wants to make on a specific day by his own. The excel tool neglects the fact that producing more batches at the same time could be cheaper because of setting-up times. To overcome this disadvantages, the user should think about unexpected sales, the batch sizes and the expiration dates of the batches. The Excel tool gives an indication and the user should make the decision about how much of which products should be produced.

The difference in inventory is only calculated when the user fills in the 'counted inventory userform' from the 'Inputsheet'. Therefore, the losses on inventory of products and raw materials is always a step behind compared to the real situation. X has to find a balance between being a step behind and putting effort in calculating the inventory.

All disadvantages are hard to erase, in the recommendations stands a recommendation for implementing the Excel tool in the book keeping system 'Exact-Online', which probably is less likely to have certain mistakes.

4.5 Conclusion

The Excel tool exists of some sheets that are necessary for the calculating of the costs per product. Other sheets give additional information for the management of X. That makes it possible to analyse the costs per product, calculate efficiencies, make a production planning, calculate how much raw materials have to be bought, analyse the production and to analyse the sales data. Those sources of information gives the management the possibility to manage the sausage factory based on data. That can solve the problem of going out of stock with raw materials and with sell products. The performance of the current year can also be compared to the performances of previous years. Almost all the basic desired information for a manager of a factory is summarized in this Excel tool.

5. Analysis: Traditional costing method at X

The analysis of the costs at X is based on the traditional costing method with theoretical support of Drury (2012). The costs calculation is based on excel and on the data from the administration of X, the input from production employees and the production and financial managers.

5.1 Validation of data collection and overall case

The gathering of data caused some validation issues. Sometimes, data were not available or incorrect. The excel tool will solve these problems in the end, but at the moment the calculation is not complete yet.

Costs and lacking data

The costs of the sausage factory are based on the management financials of the financial manager. The other daily data are the purchase orders, the sales orders and the production numbers. X keeps track of these data. To keep the costs calculation simple, it is mainly based on data X already uses. Therefore, the main input of the excel tool are all sales orders, purchase orders and production numbers.

Some costs are not analysed because of lacking information of 2016, like the losses costs and the real percentage of overhead costs. The excel tool is modelled in such a way that it calculates those costs automatically. These costs are correct when X inserts all the information about a period. For the analyses of the costs of 2016, that was not possible because of missing beginning inventories, production numbers and receipts.

Validity of costs estimations

The time that production employees spend on several activities per process are gathered with an interview between the production manager and the production employees. Together they filled in a table with the processes on the vertical axe and the activities on the horizontal axe. The production employees gave an indication of how long an activity took in minutes in a process. After they filled in the table completely, the production manager checked the summation of all times per process. Together we concluded that the times were plausible.

In this research, the losses of raw materials were considered as well. For the losses of raw materials, the inventory at the beginning of 2016, the final inventory of 2016, the production of 2016 and the receipts were necessary. A part of that information was not available in the bookkeeping system and even an indication of the losses was not possible. Therefore, these costs are neglected in the analysis of the costs of 2016. These costs will be calculated automatically in the excel tool over time, when the information is added. This counts for the losses in production and inventory as well.

I derived the receipts of the products from the receipts book of 2014; the book was partly outdated because of changed ingredients. All the changes have been changed in the receipts in the Excel. The direct costs, like packaging material, were not considered in the receipts book, in the Excel these costs are added.

Maintaining costs for machines are not taken into account because the financial manager assumed them nihil. These assumptions were checked by looking in the bookkeeping system, and there is no reason to doubt this assumption. Second, the financial manager will put these costs in overhead costs the coming years. There is no indication that the maintaining costs will increase substantially compared to the total costs the coming years. Therefore, these costs are taken as overhead costs in this research.

The employee costs also include the costs for the management of the sausage factory. The time estimations are based on the time of the production employees per process group. The production manager is not significantly busier with one or another process group; therefore, this assumption doesn't affect the costs per product substantially.

5.2 Explanation of the Excel tool

In this paragraph, it is explained how the calculations of the costs, from Chapter 3, are calculated in the Excel tool. The extended explanation of what a user has to do for updating the excel tool and to understand the working of the excel tool, consider the Excel tool manual in Appendix C.

Raw Materials

For calculating the raw materials, excel needs all ingredients of a product and the current prices per entity of those ingredients.

The receipts of the products are summarized in the sheet 'ReceiptsTable'. The current prices for the ingredients in the receipts are positioned in the sheet 'IngredientsPriceList'. Of course, if receipts or prices change, it has to be changed in the excel tool as well. The receipts are changed via the 'change receipt' user form, see Figure 7. For changing the prices in the excel tool, X can paste purchase orders from the book keeping system 'Exact-Online' in the sheet 'InsertPurchaseOrders'. When the user pushes on a button, excel changes the prices of the ingredients to the price used on the purchase orders. See also Appendix C.

Figure 7: UserForm for changing the receipt of a product

Losses of raw materials

The 'losses of the raw materials' are calculated by the inventory sheet, see Figure 8. The input of the calculation are the 'Theoretical Used' and the 'Real Used' number of kilos of raw material, see Figure 8. The theoretical used raw materials is calculated based on the receipts in the sheet 'RecepturenTable' (see Figure 9) and the production numbers are derived from the sheet 'ProductionBook', see Figure 10.

Real inventory	Total used in Theory	Theoretical inventory	Counted inventory	Difference	%Inventory losses
-	2106.77	-2106.77			0.0%
-	811.3	-811.3			0.0%
-	416.13	-416.13			0.0%

Figure 8: The losses on a raw material is calculated in the sheet 'Inventory' with the theoretical and really used raw materials

Code	ProductName	Raw Material with code	RawMaterial (kg)or(piece)	Batchsize (kg)
WL00004	BBQ worst Naturel (Kip)	Frzn Chicken MDM - KM00007	36.00	120
WL00004	BBQ worst Naturel (Kip)	krm tbv BBQ worst kip naturel - KR00259	11.16	120
WL00004	BBQ worst Naturel (Kip)	Frzn Chicken Tenders (kippenhaas) - KM00001	36.00	120
WL00004	BBQ worst Naturel (Kip)	Kippen vellen - KL00001	36.00	120
WL00004	BBQ worst Naturel (Kip)	Natural hog casings long shorts 28/30 - ZM00008	2.40	120
WL00004	BBQ worst Naturel (Kip)	Krimpzak 300x450 bodemnaad - VR00064	66.00	120
WL00004	BBQ worst Naturel (Kip)	Nitriet pekelzout - KR00120	2.40	120
WL00004	BBQ worst Naturel (Kip)	Ijswater - KR00152	10.00	120

Figure 9: Screen capture of the receipt of ''Product Y'' of the sheet 'RecepturenTable'

Date	Week	Month	Year	Batchnumber	Expiration date	Product	Productgroup	#Kilos
01/01/2016	1	1	2016	17025001	19/09/2017	Kippen Frikandel	0	15965
01/01/2016	1	1	2016	17025001	20/09/2017	Keukenham	0	12117
01/01/2016	1	1	2016	17025001	21/09/2017	Magere Schouderham	0	8058
01/01/2016	1	1	2016	17025001	22/09/2017	Gerookte kippen	0	6555
01/01/2016	1	1	2016	17025001	23/09/2017	Bruinebonen spek	0	6078
01/01/2016	1	1	2016	17025001	24/09/2017	Kippenvleesworst	0	5994

Figure 10: Screen capture of a part of the production book of the sheet 'ProductionBook'

Employee costs

The employee costs exists of two parts. First, the costs per minute of an employee and second the total minutes an employee works at a batch of a product, see Equation 15. The employee costs per minute are calculated based on the data of the 'Inputsheet', see Figure 11. In the 'Inputsheet', excel divides the total employee costs by the total minutes the employees worked on production. That gives the costs per minute. In the sheets 'Resources' the total time an employee spends for a batch is given. Multiplying that time in minutes by the costs per minute gives the total employee costs for a batch. Finally, the costs for the batch are divided by the batch size, which results in the employee costs per process group per kilo.

[Figure deleted]

Figure 11: The costs/minute are calculated based on the worked hours and the costs of the employees (x1000)

Machine costs

The machine costs are calculated based on the information on the 'Resources' sheet, as input for Equation 22. The total time a machine is occupied in theory, is based on the numbers in the table about the process groups. Based on the number of batches that is made, derived from the production numbers, excel calculates the total expected time a machine is occupied. The depreciation of that year

is based on the depreciation per year multiplied by the fraction of the year that is passed. That results in a machine costs per kilo per process group.

Losses on products

The losses on products are based on the production losses and the inventory losses, see Figure 12Figure 12: Result of losses on products (fictive). The production losses are calculated by dividing the total kilos purchased of a specific product by the total kilos produced of a product. The total production of a product is derived from the sheet 'ProductionBook', see Figure 10 and the total purchased is derived from the 'InsertPurchaseOrders' sheet. The inventory losses are calculated by dividing the real inventory by the theoretical inventory. The theoretical and the real inventories are derived from the 'inventory' sheet, see Figure 13.

%Inventory losses	Production Losses %	Total losses %
4.5%	-10%	-5%

Figure 12: Result of losses on products (fictive)

Real inventory	Theoretical inventory
208.23	203.23

Figure 13: Real and theoretical inventory columns of the inventory sheet

Overhead costs

The overhead costs are calculated on the 'Inputsheet'. The total assigned costs to products is calculated as a percentage of the total real costs given in the 'Inputsheet'. The remaining costs are given as a percentage of the total costs. That percentage becomes the overhead costs percentage. In the end, the direct costs calculation per product is multiplied by (1+% Additional overhead costs), see Equation 38. That completes the costs calculation.

5.3 Results of calculation

In this research, five products are selected for comparing the differences in price for the old and the new prices. These products are selected based on their different characteristics, see section

1.2 Problem analysis. The differences in prices are given in Figure 6. With the blue bar as the costs of the old calculation, the orange bar as the new calculation of the costs and the grey bar as the current selling price of the product. An important note to mention is that the calculated costs are based on the Raw material costs, the employee costs per product and the machine costs per product. Therefore, these costs are probably underestimated and should be higher because of the losses of raw materials and products and the overhead costs. Based on the distribution of costs in section 'Company profile', the calculated costs are the sum of the raw material costs, half the equipment costs (the machines count for 50% of the equipment costs), and circa 20% of the employee costs because of an average productivity of 20%. That would then be 67.5% + 12.0%*0.2 + 7.4% * ½ = 73.6%. So, the expected calculated costs per product based on the distribution of the costs is 73.6% of the old costs calculation. Below, the new calculations are compared with the old costs per kilo.

The calculated costs of the product ''Product Y'' are 70% of the old calculation. This is very close to the old calculation, because of the 'costs of losses of products' and the 'overhead' costs, who are not included in the calculation.

The calculated costs of the 'x' or 'x' are 89% of the old calculation. Although, there are 4 prices missing in the receipt of the 'x', the costs of these ingredients are not included in the calculation. The missing costs of those ingredients are small compared to the total costs of the product, so that does not affect the calculation significantly. The calculated price is higher than the old price, the reason for that is probably that the ingredient 'Frzn Chicken' has gone from SRD 3.68 to SRD 10.45, because of the drop of the SRD mid-2016. Therefore, this calculation seems plausible, but it also proves that a structured calculation is necessary for X.

The calculated costs of the 'x', a ham sort, is 20% higher in the new calculation than in the old calculation. One ingredient causes most of the costs of the ham, the current price of that ingredient is comparably with the old costs. So probably, the costs of the ham were miscalculated or the price of that one ingredient is risen compared to the price they took in the old calculation. A rise in price of the other ingredients cause not such a difference in the price. The employee and the machine costs are 8% of the new calculation, which is expected with this calculation that neglects the costs of losses and overhead.

The calculated costs of the 'x', are 63% of the old calculation. That is a remarkable difference. The employee and the equipment costs does not cause a lot of change in the price, namely. The price calculated with the average costs of the book keeping system of the three most important ingredients, makes the price go to even 55% of the old calculation. It looks likes X overestimated the costs of the 'Kippengrillworst naturel'.

The final product, 'x', which is the most sold product of the sausage factory, had an accurate calculation of the costs. In the new calculation, the costs are 76% of the old calculation. This is very close to the expected 73.6%, so the calculation of 'x' was probably accurate.

Generally, this research shows that the costs calculations of X were already quite good. Some costs are overestimated and some are underestimated. No reason is given in this research for the overestimated products in the old costs calculations. The main and most obvious reason for underestimated costs calculations is the rise in costs of products because of the drop of the SRD. The relative higher cost estimations compared to the old costs calculation is probably caused by the fact that the machine and employee costs are assigned to the products in a more structured way.

A good point for X Is that the selling prices of the sausages are circa 150% to 250% {254%, 253%, 162%, 234%, 202%} higher than the calculated costs/kilo. Therefore, X is probably not selling products with losses.

The main differences in the method of finding costs, is that the analysis used in this research is based on current prices that are updated and the machine and employee costs are (more accurate) calculated. In the previous calculation, not all prices were up to date and costs besides the raw material costs were estimated more based on assumptions.
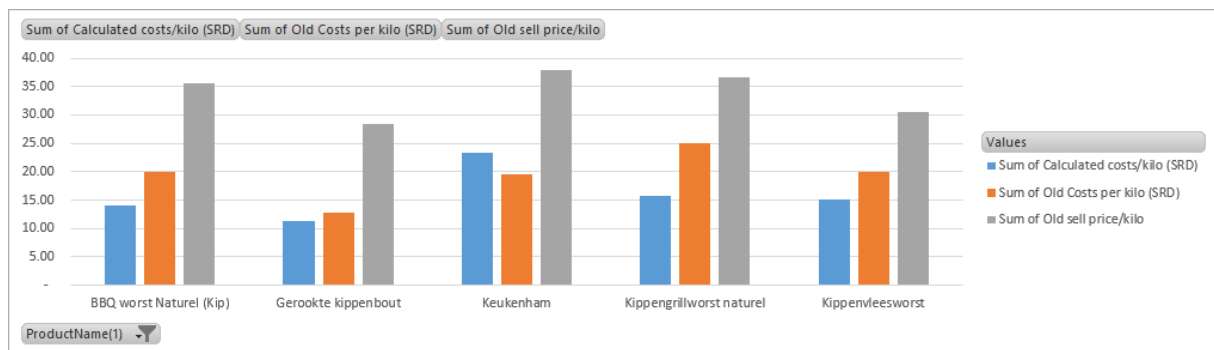
Figure 14: Differences in old and new cost calculation

5.4 Conclusion

The costs calculation at X is currently not complete, X has to use the Excel tool and gather and insert the data they have. Based on all these data, the costs calculation becomes complete over time. That will give more insight in the costs, and the management of X is then able to focus on the inefficiencies that occur. Based on the calculation of costs of some selected products, there is no indication that X sells products with losses. Perhaps some prices could be better priced, the management team can answer that question when all data is inserted in the Excel tool. The costs calculation is more extended than before and it therefore gives more information about where costs come from and where costs could be reduced.

6. Conclusions

In this research, the costs calculation of the products made in the sausage factory of X N.V. are analysed. Not all costs are considered in this research, but a framework has been built to put X in a position they can take into account the costs described in this research.

6.1 Referring to research questions

In the current situation, the costs per product are calculated based on most of the ingredients of the products. Costs for employees and machines are denied in most calculations. The selling price is calculated with an overhead and profit percentage over the costs of the ingredients. In the past years, the direct costs where circa xx% of all costs of the sausage factory. The most suitable allocation method for calculating the costs per product of all products produced in the sausage factory is a traditional method. That method is easier to implement than other methods and sufficient for X. Other methods, like the ABC, TDABC and MFCA, are more complex and therefore probably more precise, but they are harder to implement and to maintain. With the traditional method, the direct costs are considered and the overhead costs are based on a percentage of the total costs. The direct costs consists of the raw materials, the losses on raw materials, employee costs, the machine costs and the losses on production and inventory. The summation of these costs delivers the total direct costs and the other costs are considered as overhead costs. For calculating these direct costs per product and to maintain the calculation X needs the most recent data about quantities and prices. X needs the purchase orders for updating the prices of raw materials, the sales orders and counted inventory to analyse the losses on inventory, the production numbers to analyse the losses in production. X needs also data about the different processes for producing a product, like time estimations and resources. All that data can be inserted as input in an Excel tool. The Excel tool is aligned with the book keeping system of X, therefore it is easy to insert the purchase orders, sales orders and production numbers, counted inventory and to update the processes. So, with inserting the data in the Excel tool, X can maintain the costs calculations of the products that are made in the sausage factory.

6.2 Final conclusion

With the build Excel tool that is easy to keep up to date, X is able to get an instant calculation of the costs per product. The Excel tool gives the current prices of all products and therefore the calculation of the costs is as up to date as X wants. The Excel tool gives the composition of the costs for a product, that gives insight in were costs can be reduced. Furthermore, the Excel tool gives additional information about inventory, production planning, purchasing of raw materials, sales analyses and production analyses. That makes it better possible for X to make decisions based on data than before.

7. Recommendations

At X, there is a drive to improve. Improvements in the product design, to make more products to serve more customers. Moreover, improvements in making management decisions based on gathered data. The excel tool is the result of this research and goes further than only a costs calculation.

The first recommendation is based on the additional features of this excel tool. For a good working excel tool, the data of the production book, the purchase- and sales orders should be correct. If those are correct, the management has to update this tool circa every two or three weeks or when they make a management decision. For example when they want to order spices. X can make sure the data administration is correct by explaining to their employees that it is important to be precise and to look to the results over time. If unexpected results occur, that could be an indication of incorrect data.

At the start of using this excel tool, X should count the inventory quite often. Because based on that knowledge, they can verify whether the receipts are correct or if there are products or raw materials that have a lot loss.

A site note of recommending the use of this excel tool is that the management team has to think about interpretations. Some parts of the excel tool are based on simplifications, therefore the information in the excel tool gives an indication and does not give the whole truth. Careful implementation based on the information of this excel tool is required.

For the long run, X should use the book keeping system Exact-Online for all the information that the excel tool gives now. The book keeping system is able to give more information that is more accurate and probably less sensitive for mistakes than the excel tool is.

Based on the productivity and the recession Suriname is in, X should proceed with increasing the sales outside the borders of Suriname, like the Caribbean. Perhaps the productivity rises when the production has to rise. Because now, employees are walking from location to location in the factory to do small parts of their work. When employees can stand on their spot, at a machine, the productivity will probably rise. Increasing sales also causes a higher percentage of direct costs, assuming that it does not rise above the capacity. The higher the percentage of direct costs, the traditional costing method becomes more suitable. When the sales almost expand the capacity, X should do a bottleneck analysis to expand capacity with little changes in the production process first.

In a couple of years, X probably has enough data to analyse the sales. Another bachelor student could make an algorithm for predicting the sales of a product. Based on a good sales prediction, a bachelor student could make a more expanded production planning. When the capacity seems to be too low, a student could make a bottleneck analysis.

8. Discussion

8.1 Limitations

In the research of this case study, some theoretical methods are considered as potential applicable methods to calculate the costs at X. Although many methods for calculating the costs exists, some methods are not considered because of they were found less applicable based on a quick view.

In the executed method of research, the costs of setting-up times, maintenance, processing orders and administrating orders are neglected. This research included those costs in the overhead costs, assuming those costs are inserted in the overhead costs in the management financials. Therefore, X cannot use this costs calculation to measure the performance of processes.

The employee and machine costs are based on estimations of times. These estimations are expected averages, real times can differ during the production of products. X should be careful with the interpretation of all results derived from these estimations.

All orders X inserts, updates information in the excel tool. When not all orders are documented in the book keeping system or faults occur in the order, the calculations are based on wrong values. Starting each year with a clean sheet narrows the change of these failures.

8.2 Evaluating the model

The model exists of a lot of information and the model links some information to each other. Faults in information or between links cause structural wrong information, which can cause structural wrong interpretations of the results. After using the model a couple of months, X should evaluate the working and the precision of the model. Then the model becomes one that X believes in and can build on.

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Appendices
Appendix A

Processes in the sausage factory

ProcesGroup
BBQ worst
Knakworst
Rookworst
Kippen/magere ham
Andere hammen
Zoutvleesbeleg
Frikandellen
Vleesworsten
Gerookte kippen
Gerookte producten
Grilworst
Kookworstsoorten
Rauwe soorten
Gehaktballen
Snackballen

Figure 15: All defined process groups at the sausage factory
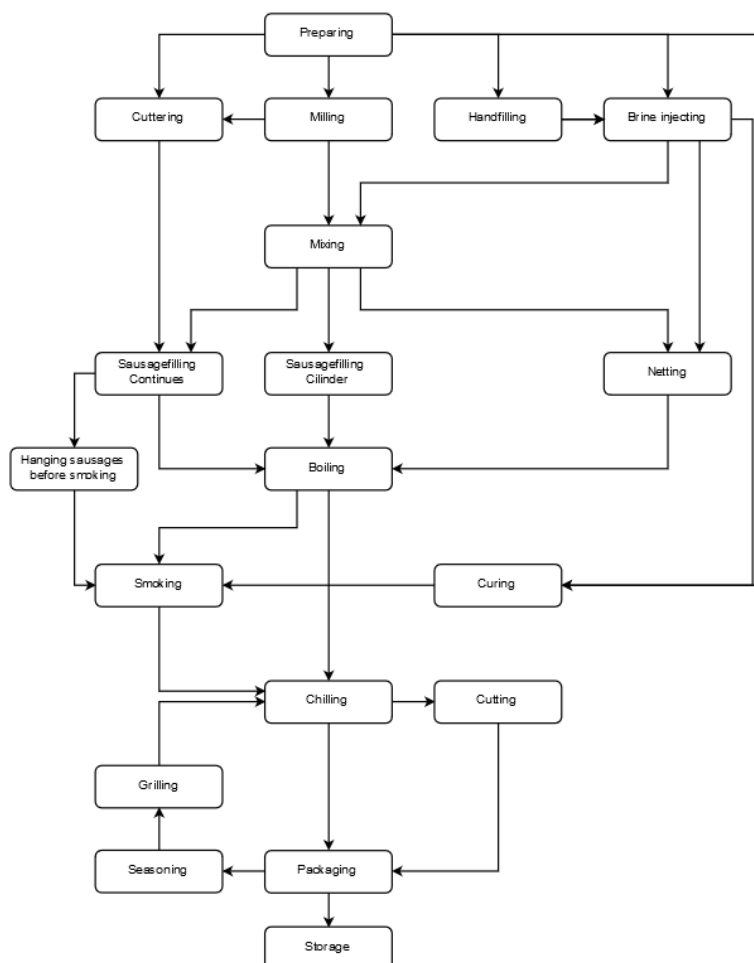

Figure 16: Flow of the sausage factory from activity to activity

Appendix B

Screenshot: sheet 'RecepturenTable', part of the table of all receipts.

[Table deleted]

Screenshot: sheet 'IngredientsPriceList', part of the table of the prices for all products.

[Table deleted]

Screenshot: sheet 'Resources', employee and machine costs per process group.

[Table deleted]

Screenshot: sheet 'Resources', part of table for calculating the employee and machine costs.

ProcesGroup	Employee minutes/kilo	Batch size	Total employee hrs per batch	Voorbereiding	Malen	Cutteren
Machine#					1	2
Machine costs/min (SRD)					2.32	4.85
#Employees				1	1	1
BBQ worst	2.35	100	3.92	5		20
Knakworst	6.30	50	5.25	15		15
Rookworst	5.10	50	4.25	15		15
Kippen/magere ham	1.55	100	2.58	30	10	
Andere hammen	3.30	100	5.50	30		
Zoutvleesbeleg	3.45	100	5.75	120		
Frikandellen	3.50	60	3.50	15		15
Vleesworsten	1.00	500	8.33	20	30	
Gerookte kippen	0.70	300	3.50	30		
Gerookte producten	0.90	250	3.75	30		
Grilworst	3.05	100	5.08	15		20
Kookworstsoorten	1.00	100	1.67	15		20
Rauwe soorten	0.69	80	0.92	15		30
Gehaktballen	10.89	45	8.17	15	10	
Snackballen	3.67	60	3.67	15	10	

Screenshot: sheet 'Resources', table for calculating the depreciation of the machines.

[Table deleted]

Screenshot: sheet 'InsertPurchaseOrders', the button for processing the purchase orders with the last ordernumber and last update. A part of the headers are visible.

	A	B	C	D	E	F	G
1	Last ordernumber :						
2	Latest update:	01/01/2017			Insert Purchase Orders		
3		Artikelomschrijving	Magazijncode	Regelnummer	Eenheid	Aantal besteld	Aantal ontvangen
4		3543					
5	Paste the data with headers in cell A3	Soepgroenten	3	1	Gram	30.00	30.00
6							
7		3545					
8	KL00007	Hele kip	3	1	Kilogram	462.29	462.29
9							
10		3546					
11	KL00020	Kippen lever & Niertjes	3	2	kg	10.00	10.00
12	KL00007	Hele kip	3	1	Kilogram	533.50	533.50
13							

Screenshot: sheet 'InsertSalesOrders', the button for processing the sales orders with the last ordernumber and the last date and some headers are visible.

[Table deleted]

Screenshot 'ProductionBook', all headers are visible.

Date	Week	Month	Year	Batchnumber	Expiration date	Product	Productgroup	#Kilo's
19/01/2017	3	1	2017	17025001	19/09/2017	Vleesworst Surinaams	0	350
19/12/2017	51	12	2017			Achterham gekookt/gerookt	Varken	200
01/01/2017	1	1	2017			Achterham gekookt/gerookt	Varken	200
02/01/2017	1	1	2017			Ardennerspek	Varken	200
03/01/2017	1	1	2017			Gerookte Varkensfillet	Varken	200
04/01/2017	1	1	2017			BBQ worst Naturel (Kip)	Kip	200
05/01/2017	1	1	2017			BBQ worst Cajun (Kip)	Kip	200
06/01/2017	1	1	2017			BBQ worst Smokey Joe (varken)	Varken	200
07/01/2017	1	1	2017			Procureurham gerookt	Varken	200
08/01/2017	2	1	2017			Bloedworst	Varken	200

Screenshots 'ProductsPrices', the breakdown of costs of a product.

[Table deleted]

Screenshot 'Inputsheet'.

[Table deleted]

Screenshot 'Dashboard', four graphs and a table with all products with their price and margins.

[Table deleted]

Screenshot 'ProductionPlanning', part of the table with the expected out of stock date and the number of kilos to produce in the predetermined period.

ProductName	Inventory	Expected Sales Period	Expected Out-Of-Stock date	To Produce (kg):
Achterham gekookt/gerookt	0	746.71	22/09/2017	747
Ardennerspek	0	206.45	05/07/2017	206
Gerookte Varkensfillet	0	91.68	05/07/2017	92
BBQ worst Naturel (Kip)	0	1,744.71	05/07/2017	1,745
BBQ worst Cajun (Kip)	0	200.26	05/07/2017	200
BBQ worst Smokey Joe (varke	0	1,319.65	05/07/2017	1,320
Procureurham gerookt	0	-	02/03/2018	-
Bloedworst	0	1,686.52	05/07/2017	1,687
Boterhamworst	0	1,111.68	05/07/2017	1,112
Gegrilde hammen	0	-	02/03/2018	-
Varkens Frikandel	0	3,745.81	05/07/2017	3,746
Ardenner Boterhamworst	0	-	02/03/2018	-
Gerookte kippen	0	3,985.00	05/07/2017	3,985
Gerookte kippenbout	0	5,866.94	05/07/2017	5,867

Screenshot 'Inventory', the real, expected and differences in inventory. Part of the table for calculating all numbers about the inventory.

ProductName	Real inventory	Total purchased	Total used in Theory	Theoretical inventory	Begin Inventory	Counted inventory	Difference	%Inventory losses
Achterham gekookt/gerookt	-	380	2696	-1936	380	90		0.0%
Ardennerspek	-	377.78	590	-212.22	0 124		-714	-189.0%
Gerookte Varkensfillet	-	185.8	242	-56.2	0	50		0.0%
BBQ worst Naturel (Kip)	-	2398.41	4402	-2003.59	0	100		0.0%
BBQ worst Cajun (Kip)	-	275.55	475	-199.45	0	3000		0.0%
BBQ worst Smokey Joe (varken)	-	1729.46	3208	-1478.54	0	7		0.0%
Procureurham gerookt	-		0	0	0			0.0%
Bloedworst	-	2595	4945	-2350	0			0.0%
Boterhamworst	-	1672.89	2940	-1267.11	0			0.0%
Gegrilde hammen	-		0	0	0			0.0%
Varkens Frikandel	-	275.95	9360	-9084.05	0			0.0%

Screenshot 'SpicesOrdering', one of the two tables in 'SpicesOrdering' were the number of needed kilos per spice is given.

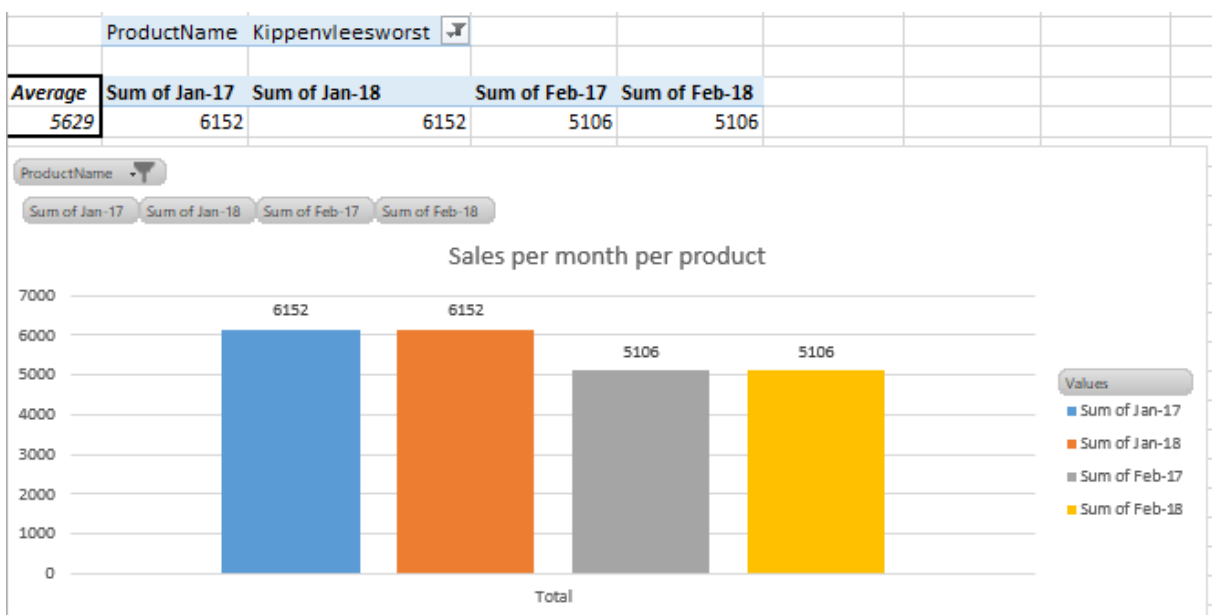| Kruid	#Kg needed	#Kg to Order	Bedrag ($)	Current Inventory
Kippen vellen - KL00001	934.4	-	$ -	2,777.41
Kippen bouten - KL00002	0.0	-	$ -	-
Drum sticks - KL00003	0.0	-	$ -	-
Borst m/been - KL00004	0.0	-	$ -	-
Borst File - KL00005	0.0	-	$ -	1,752.55
Dijfile - KL00006	0.0	-	$ -	-
Hele kip - KL00007	0.1	-	$ -	83,188.75
Kippen poten - KL00008	0.0	-	$ -	47.75

Screenshot 'SalesData', with some data about the total of 2017 and some months in 2017.

ProductCode	ProductName	Total 2017	Jan-17	Feb-17	Mar-17
WL00001	Achterham gekookt/gerookt	2696	778	287	507
WL00002	Ardennerspek	590	118	123	118
WL00003	Gerookte Varkensfillet	242	34	63	37
WL00004	BBQ worst Naturel (Kip)	4402	712	791	865
WL00005	BBQ worst Cajun (Kip)	475	41	26	186
WL00006	BBQ worst Smokey Joe (varken)	3208	725	622	737
WL00007	Procureurham gerookt	0	0	0	0
WL00008	Bloedworst	4945	1148	886	780
WL00009	Boterhamworst	2940	506	540	574

Screenshot 'SalesAnalysesAll', with some products and the sales of the first months of 2017.

	A	B	C	D	E
1					
2	Average	Row Labels ▼	Sum of Jan-17	Sum of Feb-17	Sum of Mar-17
3	449	⊟ Achterham gekookt/gerookt	778	287	507
4		WL00001	778	287	507
5	-	⊟ Ardenner Boterhamworst	0	0	0
6		WL00012	0	0	0
7	98	⊟ Ardennerspek	118	123	118
8		WL00002	118	123	118
9	79	⊟ BBQ worst Cajun (Kip)	41	26	186
10		WL00005	41	26	186
11	734	⊟ BBQ worst Naturel (Kip)	712	791	865
12		WL00004	712	791	865

Screenshot 'SalesAnalysesOne' a graph with sales data about one product.

	ProductName	Kippenvleesworst ▼			
Average	Sum of Jan-17	Sum of Jan-18		Sum of Feb-17	Sum of Feb-18
5629	6152	6152		5106	5106

Sales per month per product

Screenshot 'ProductionAnalyses', part of one table in the production analyses sheet.

Production per ProductGroup						
ProductGroup	2017	Jan-17	Feb-17	Mar-17	Apr-17	
Kip	400	400	0	0	0	
Varken	2000	1800	0	0	0	
Rund	0	0	0	0	0	
Mix	0	0	0	0	0	
Zouterij	0	0	0	0	0	

Screenshot 'PriceChanges', a graph with the old costs, the calculated costs and the sell price per product.

[Table deleted]

Appendix C

Manual for the excel tool.

0. Start-Up Excel Tool

Every year, X has to work with a clear excel tool. Therefore, it has to start-up the new excel tool to make it ready to use in the new year.

To start it up, the user has to execute the steps of chapters, 1.2, 2.6, 6.2, 6.4, 7.2, 10.2 and 13.2 of this manual.

1. Dashboard
1.1 Introduction

On this dashboard, the prices and margins per product are given in a table and the results in KPIs of the last five years. Those KPIs are 'Sales/month in SRD', 'Sales/month in Kilo', 'Total Production/month in Kilo' and the 'Productivity/month'.

1.2 Inserting historical numbers

The data of the graphs are summarized at the right of the graphs. The data of the current year are automatically calculated. The data of the years before have to be inserted by manually. Normally, the user should be able to copy these numbers from the Excel tool of the year before.

The user can fill in the numbers in the yellow filled cells, as seen in Figure 17.

Figure 17: Filling in the monthly KPI numbers

2. Inputsheet

2.1 Introduction

In this sheet, the most important input is given. Like the costs, the exchange rates and which costs excel has to take into account. The user is free to change the positions of the tables in this sheet.

2.2 Inserting Exchange rates

In this box in Figure 18, the user inserts the exchange rates. These exchange rates have influence on the costs per kilo of the imported raw materials. These costs influence the price per kilo of many products.

Exchange rates		
	EUR/SRD	SRD 8.40
EUR	EUR/USD	$ 0.90
SRD	USD/SRD	SRD 7.30
USD	USD/USD	$ 1.00

Figure 18: Changing exchange rates

2.3 Taking costs into account

The user of the excel tool can choose which costs he/she wants to take into account. As seen in Figure 19, a '1' takes the costs into account and a '0' does not take the costs into account. This gives room for the interpretation of the results. If some results are not very plausible because of insufficient data or extreme occasions, the user can choose to neglect some calculated costs.

Costs taken into account (1=on, 0=off)	
Raw Materials	1
Employee costs	1
Machine costs	1
Losses RawMateria	0
Losses Production	0
Overhead	0

Figure 19: Choosing which costs are taken into account

2.4 Calculating workhours

The worked hours per month are important for calculating the productivity. Therefore, the user has to calculate how much hours the production employees have worked in the sausage factory, see Figure 20. That number has to be filled in in the 'Worked hours' per month, in Figure 21.

The user is free to change the formula in the 'Workhours calculation'.

Workhours calculation	
Employees	8
Hours per week	42.5
Hours per month	1,473.33

Figure 20: Calculating the worked hours per month

[Table deleted]

Figure 21: Inserting the worked hours per month

2.5 Percentage of total costs

The calculation of the percentage of the total costs is based on the production and sales volumes. So these are the percentages as the calculation of the excel tool expects them to be, see Figure 22. That gives information about how the percentages based on the output of the factory reflects to the real percentages of the costs. The user can also see how much percentage of the costs are taken into account if some costs are not taken into account, see chapter 2.3.

The overhead costs can go below zero, because the excel calculates the results based on recent prices. Therefore, the costs of, for example, the raw materials could be more than expected. And the Overhead costs brings the sum of the percentages always to 100%.

Percentage of Total costs	
Raw Materials	#DIV/0!
Employee costs	#DIV/0!
Machine costs	#DIV/0!
Losses RawMaterials	#DIV/0!
Losses Production	#DIV/0!
Overhead	#DIV/0!

Figure 22: Overview of the Percentage of the costs compared to the total costs

2.6 Fill in the year

The year the excel tool is about, can be changed in this sheet, see Figure 23. In some other sheets, the year also changes.

2017
Costs 2017 (x1000 SRD)

Figure 23: Change the year of the excel tool

2.7 Inserting the costs of the sausage factory

The costs of the sausage factory are derived from the financial management summary directly. That makes it easy to insert the costs of the sausage factory. The costs are inserted per month, see Figure 24.

2017						Costs Sausagefactory Varross N.V.											
Costs 2017 (x1000 SRD)			1		2		3		4		5	6	7		8	9	10	11	12
	Total SRD	Total %	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug			Sept	Oct	Nov	Dec
Raw Material Costs	SRD -	#DIV/0!														
Employee costs	SRD -	#DIV/0!														
Building and equipment	SRD -	#DIV/0!														
Operational overhead	SRD -	#DIV/0!														
Utility	SRD -	#DIV/0!														
Interest	SRD -	#DIV/0!														
Total	SRD -	#DIV/0!	SRD -	SRD -	SRD -	SRD -	SRD -	SRD -	SRD -	SRD -			SRD -	SRD -	SRD -	SRD -

Figure 24: Inserting the factory costs per month

2.8 Change receipt button

Via the button in Figure 25, the receipt of a product can be changed via the userform as in Figure 26. First, the user has to select the product, then all ingredients are given and can be changed. All ingredients have to inserted in kilos or pieces per batch size, including the packaging materials. The user updates the receipt via the button 'Update receipt'.
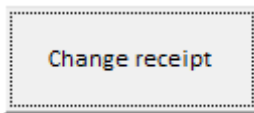
Figure 25: Button for changing receipt

Figure 26: UserForm in which a receipt can be changed

2.9 Counted Inventory buttons

With the counted inventory buttons, seeFigure 27, the user can insert the number of ingredients currently in stock. It is important that the production numbers, purchase orders and sales orders are up to date till the date of the counted inventory. Otherwise, the inventory is compared with out dated numbers, which causes faults in the counting. In the UserForm, the user has to insert the Product, the counted inventory and the date. The date has to be in the format DD-MM-YYYY.
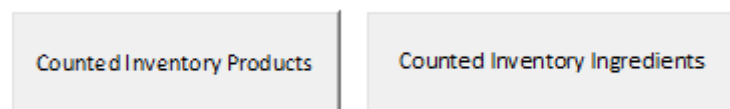

Figure 27: Counted Inventory buttons

2.10 Calculate workbook

It could occur that excel does not calculate the workbook when a small change is made. To know for sure that the whole workbook is up-to-date, the user can click on the 'Calculate workbook' button, see Figure 28.
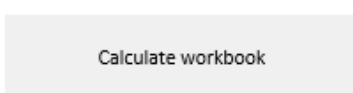

Figure 28: Calculate whole workbook button

3. InsertPurchaseOrders
3.1 Past the orders

The orders, with headers should be copied from the exported file from 'Exact-Online' in cell A3. The user should include the headers while copying the orders. The user has to make sure that the following headers are included in this order: Artikelcode / Artikelomschrijving / Magazijncode / Regelnummer / Eenheid / Aantal besteld / Aantal ontvangen / Aantal gefactureerd / Orderbedrag / Valuta / Factuurbedrag / Orderbedrag (SRD) / Leverancier.

3.2 Check on missing/overlapping orders

Before the user presses on the button, the user should first check if he/she is not inserting orders that are already inserted or if there are orders missing that have not been inserted yet and are not included in the copied orders from chapter 3.1. The user can check this with the 'Last ordernumber' and the 'Latest Update', see Figure 29.

Figure 29: Last ordernumber and Latest update of the purchaes orders

3.3 Press Insert Purchase Orders button

If the user is sure there are no orders missing and no overlapping orders, the user can press the button in Figure 30. When the user presses the button, the orders will be deleted if VBA up-dated the excel sheet. So, the user has to be sure, before pressing the button.
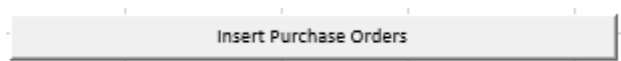

Figure 30: The button for inserting the purchase orders

4. InsertSalesOrders
4.1 Past the orders

The orders, with headers should be copied from the exported file from 'Exact-Online' in cell B2. The user should include the headers while copying the orders. The user has to make sure that the following headers are included in this order: Nr. / Per. / Datum / Bkst.nr. / Omschrijving / Relatie / Bedrag / Artikel / Aantal / Grootboekrekening / Dagboek.

4.2 Check on missing/overlapping orders

Before the user presses on the button, the user should first check if he/she is not inserting orders that are already inserted or if there are orders missing that have not been inserted yet and are not included in the copied orders from chapter 4.1. The user can check this with the 'Last ordernumber' and the 'Latest Update', see Figure 31.

Figure 31: Last ordernumber and Latest update of the sales orders

4.3 Press Insert Sales Orders button

If the user is sure there are no orders missing and no overlapping orders, the user can press the button in Figure 32. When the user presses the button, the orders will be deleted if VBA up-dated the excel sheet. So, the user has to be sure, before pressing the button.
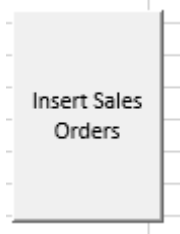

Figure 32: Button for inserting the sales orders

5. ProductionBook
5.1 Introduction

The ProductionBook is updated by an employee in the sausage factory. He sends his administration of the production numbers to the user of the excel tool.

5.2 Insert production runs

Only the headers 'Date / Batchnumber / Expiration date / Product / #Kilos' have to be inserted, see Figure 33. The other headers are automatically filled by excel. While inserting the production batches, the user has to check on missing and overlapping production batches.

Date	Week	Month	Year	Batchnumber	Expiration date	Product	Productgroup	#Kilos
	0	1	1900				#N/A	
	0	1	1900				#N/A	

Figure 33: Headers of the production book

6. ProductionPlanning
6.1 Introduction

The production planning gives an indication about how much of a product has to be made for having enough in stock for a specific period. It are all indications, based on expected sales.

6.2 Insert Expected Sales

The user inserts the expected sales per month per product manually, see Figure 34. The sheets 'SalesAnalysesAll', in chapter 9, can be used to predict the sales of the coming year. The expected number of sales per month can always be changed during the year. The user also has to insert the expected sales of the first two months of the next year. That is important for calculating the 'expected out of stock date' at the end of the year.

Figure 34: Inserting the expected sales per month per product

6.3 Fill in the desired period of planning

The user can fill in the period about which excel has to calculate how much has to be produced. That period has to be in weeks, but could, of course, be a decimal if the user wants it to be a decimal number. Excel automatically calculates the start and the end date. The start date is based on the current date and the end date on the current date plus the period in weeks. See Figure 35.

Coming period in weeks:	7
Start date:	24/07/2017
End date:	11/09/2017

Figure 35: Inserting the period for calculating the necessary production

6.4 Change the upper and below dates of the month

For calculating how much of a month is included in the period, the user has to change the upper and below dates of a month. The user has to do this as part of the start-up of the excel tool. Normally, only the years of the dates have to be changed. See Figure 36.

Expected sales:	2017					
1	2	3	4	5	6	
31	28	31	30	31	30	
01/01/2017	01/02/2017	01/03/2017	01/04/2017	01/05/2017	01/06/2017	01/07/
31/01/2017	28/02/2017	31/03/2017	30/04/2017	31/05/2017	30/06/2017	31/07/
0	0	0	0	0	0	
0%	0%	0%	0%	0%	0%	2

Figure 36: Changing the upper and lower bounds of the months of the book year

6.5 Press Calculate Out of Stock Dates button

When the period is determined, the dates are correct and the expected sales inserted, the user can press the 'Calculate Out of Stock' button. Excel shows the current inventory, the expected sales in the given period, the number of Kgs that X has to produce for the given period and when the product goes out of stock probably.

7. Inventory
7.1 Introduction

This sheet has connections with the insert purchase/sales order sheets. The user cannot change the position or the order of the columns of the tables.

7.2 Insert the Begin Inventory

The calculation of the inventory always needs a begin inventory. Otherwise, the calculation of the current inventory is wrong, until a counted inventory is inserted. The 'Begin inventory' has to be inserted at the start-up of the excel tool. Normally, that is ones at the beginning of the year.

7.3 Insert the Counted inventory

The counted inventory can always be inserted during the year. The more often the inventory is counted and inserted, the better the inventory planning becomes. The counted inventory can be inserted from the 'Inputsheet' from chapter 2, with the 'Counted Inventory' buttons.

7.4 Interpretation of results

Based on the counted inventory, the production and sales numbers, the losses of inventories are calculated. The production losses, the inventory losses and the total losses of the raw materials are calculated. When the losses are too high, it could be good not to consider those costs in the calculation of the product prices.

8. SpicesOrdering
8.1 Calculate the expected production per period

The expected production for the period X wants to purchase raw materials, can be derived from the ProductionPlanning sheet from chapter 6. The user has to order the production planning table on productcodes.

8.2 Fill in the expected production

When the products in the production planning sheet are sorted on productcode, the user can just copy the Kgs to Produce and paste them in the 'Expected production (kg)' in the Spices Ordering sheet.

9. SalesAnalysesAll
9.1 Refresh the Pivot Table

First, the user has to refresh the data of the pivot table. By clicking on the pivot table, then 'Analyze' and then 'Refresh data'. See Figure 37.
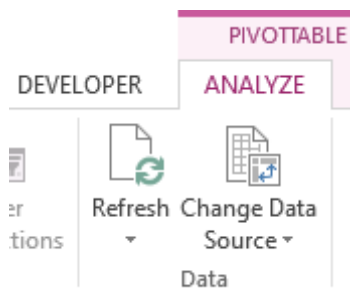

Figure 37: Refreshing the Pivot Table

9.2 Change the input of the table

When the user clicks on the Pivot Table, the user can select the 'PivotTable Fields' at the right of the screen. By selecting the right fields, the user is able to analyse and predict sales of a specific product. See Figure 38.
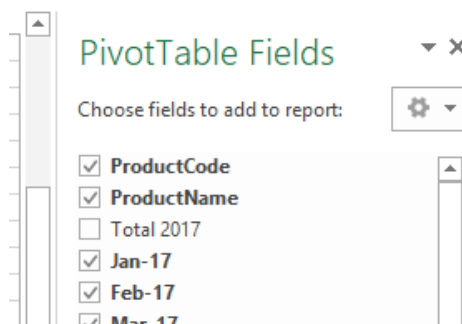

Figure 38: Changing the input for the Pivot Table

10. SalesData
10.1 Introduction

In this sheet, the user can insert the monthly sales of the last years. This forms the input for the sheet 'SalesAnalysesAll' of chapter 9.

10.2 Fill in the data

The user can just copy the data about sales from the SalesBook, see chapter 15. The user has to do that and the end of the year, as part of the start-up of the new excel file for the next year. It is important that the user checks whether the table is expanded to the last column with data. The user is free to change the name of the headers of this table.

11. ProductsPrices
11.1 Introduction

In this sheet, there is a summary about the characteristics of the products. Many other sheets use this sheet as a source for their data.

11.2 Fill in the Product Name

The product name has to be exactly the same as the one in the book keeping system 'Exact-Online'.

11.3 Fill in the Process Group

The process group of a product has to be inserted via a drop down list. That drop down list is derived from the Resources sheet in chapter 14. This ProcesGroup is important because the employee and machine costs are calculated based on those groups.

11.4 Fill in the Product Code

The product code from a product has to be the same as in the book keeping system 'Exact-Online'.

11.5 Fill in the Product Group

The product group has to be inserted via a drop down list. That drop down list is derived from the ProductionAnalyses sheet of chapter 17.

11.6 Fill in the Selling Prices

In Column N, the user can insert the recent selling prices per product. That is important for the input of the dashboard and the calculation of the margin per product.

12. RecepturenTable
12.1 Introduction

In this sheet 'RecepturenTable', the receipts of the products are listed in a table. It is important that there are no error values in the table. The user can't insert columns in the table, it can only add columns at the end of the table.

12.2 Check for error values

If there are error values, the banner at the top of the sheet gives that feedback, see

Figure 39: Error banner

. The user can find these error values by changing the ordering of the table.

Figure 39: Error banner

13. IngredientsPriceList
13.1 Introduction

This sheet includes the table with the prices of all ingredients. The insert purchase/sales orders sheets update the prices.

13.2 Fill in Begin Price Current Year

In column Q, the user has to insert the prices of the ingredients at the beginning of the year. This should be part of the start-up of the excel tool. Based on these prices, the user can see whether the prices have increased compared to the prices of the beginning of the year.

13.3 Check for the Changes in price of Book year

The user has to check for the changes in price in Column R. If there are is a significant change in price, the user can decide to take action on suppliers or on the selling price of products.

14. Resources
14.1 Fill in the Batch Sizes

The user has to fill in the batch sizes per process group in column H. The rest of the values in the table about the process group depends on that batch size.

14.2 Fill in the Process Group table

The processes are separated in activities. Those activities take a several time of minutes. The minutes per activity per process group can be changed in the table of the Process Group. Also, the machines which are needed for an activity are inserted in the table. Only one number can be inserted. If more machines are needed for an activity, there should be a summed row in the machines table of chapter 53

14.3 Fill in the Machines table

The machines table has to be updated when a machine is not in use anymore or a machine is purchased. The purchase value, the depreciation in years have to be added. Every machine needs a number, for the process group table. If more machines are used at an activity, a row has to be added with the summed purchase values of the machines.

15. SalesBook
15.1 Look up the monthly sales

In the SalesBook, the user can look up the number of sales per month per product. The insert sales orders sheet updates the numbers in this sheet.

16. SalesAnalysesOne
16.1   Refresh the Pivot Table

First, the user has to refresh the data of the pivot table. By clicking on the pivot table, then 'Analyze' and then 'Refresh data'. See Figure 37.

16.2   Change the input of the table

When the user clicks on the Pivot Table, the user can select the 'PivotTable Fields' at the right of the screen. By selecting the right fields, the user is able to analyse and predict sales of a specific product. See Figure 38.

16.3   Change the product

The user can change the product, which he wants to analyse by changing the 'ProductName' filter. See Figure 40.
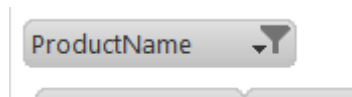

Figure 40: Changing the product analysis

17. ProductionAnalyses
17.1   Analyse the production per Process Group/Product Group/Product

The information about the production of the products is based on the sheet ProductionBook, see chapter 5. The user can see the production numbers per Process Group, Product Group and per Product. The graph about the production per month is given on the Dashboard sheet. If the user wants to make a graph of the production numbers, he can select the data and insert a graph.

18. PriceChanges
18.1   Refresh the Pivot Table

First, the user has to refresh the data of the pivot table. By clicking on the pivot table, then 'Analyze' and then 'Refresh data'. See Figure 37.

18.2   Change the input of the table

When the user clicks on the Pivot Table, the user can select the 'PivotTable Fields' at the right of the screen. By selecting the right fields, the user is able to analyse and predict sales of a specific product. See Figure 38.

18.3   Change the products

The user can change the selection of which products are shown in the graph but selecting the products via the 'ProductName(1)' button in the Pivot Graph. See Figure 41.
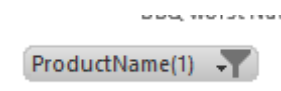

Figure 41: Button for selecting the products shown in the graph