Designing a Cash-Flow Model to assess Service Requests

UNIVERSITY OF TWENTE.

RODELTA®

Bachelor Thesis

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Preface

This report is about an expansion opportunity in the drinking water market. In this market in general, most business that has been done until now was in the area of selling pumps. Rodelta, the company where this thesis has been written at, received requests in the last couple of years from companies operating in the drinking water market with the question if Rodelta can take care of the service (maintenance/repair) of their drinking water pumps. Before I did this thesis, Rodelta was not sure if it was able to handle these applications. My job was to find a systematic way to assess the applications. Therefore, I made a cash-flow model with which Rodelta can assess the requests now and in the future.

I would like to take this opportunity to thank several people who helped me while I was writing my thesis. First of all, I would like to thank Rodelta in Almelo for giving me the opportunity to write this thesis. From the first moment onwards, the employees of Rodelta made me feel at home and supported me where possible. Additionally, I want to thank my colleagues of the 'Sales'-department at Rodelta in special, because they daily made it a pleasure to go the company.

Furthermore, I would like to thank Mr. Trivella for his guidance during the past period. Mr. Trivella has guided me well due to his willingness to help with insights on the subject. If I got stuck during the process of writing my thesis, Mr. Trivella was there to help me out. Also, I want to thank Mr. Lalla for being my second supervisor. With his support and feedback, I have been able to improve the quality of my thesis.

Next to the people mentioned above, I would like to make a special thanks to my supervisor at the company, Bart Essink. Bart has been an excellent supervisor in the last couple of months. From the beginning to the end, Bart made himself available at all time to help me, and to answer all the questions I had. With his continuous enthusiasm towards me and my work, he helped me to get the most out of my time at Rodelta.

I hope this thesis gives the reader useful insights and contributes to the development of the pump business of Rodelta.

Philip Borggreve

Almelo, July 2022

Management Summary

About the Company

Rodelta is a pump manufacturer based in Almelo, the Netherlands. The main activity of Rodelta is engineering, assembly and testing of pumps. The pumps are for the Oil & Gas industry, flood control and drinking water market. Rodelta's area of operation is Europe, Far East and the Middle East. Like many companies they are looking to expand their business.

Problem Identification and Context Analysis

Besides requests for new pumps, Rodelta receives a lot of requests from companies operating in the drinking water market for servicing (maintenance and repair) the pumps. This new type of business can be profitable and therefore interesting for their business model. However, it is not sure if they can handle the content of the requests. As providing service is completely different to selling pumps, Rodelta has limited experience in this field. For this reason, it cannot make an evidence-based decision about whether or not accepting a request would be favourable for the company.

Evaluating this type of requests is currently being done by a quick scan of the expected main costs and the expected profit of a request. This quick scan is nevertheless a hazardous way to assess the requests, since it is full of pitfalls. While executing the quick scan, there is a high risk of forgetting about important cost variables, which would make the calculation invalid. This resulted in a need for Rodelta, and this thesis, to provide a systematic way to assess service requests from the drinkwater market.

Solution

The systematic way will be provided with the help of a cash-flow model, based on the principle of a fixed price contract or cost reimbursable contract. The model includes all the major costs- and revenue components, as prescribed by the cash-flow of Patinkin. The result of generated model has been implemented in Excel/VBA, in order to make sure that Rodelta can assess all the different requests which come from the drinking water market.

Several experiments have been done to validate the model. These test cases resulted in the following conclusions:

- For both the simple and complex requests, the model gives logical and realistic results.
- The material costs which are variable and the chance of a pump breaking down are the variables which contributes the most to the outcome of the model.
- Both a fixed price contract or cost reimbursable contract can be assessed by the model.

Conclusion

A cash-flow model has been made to assess the requests in a valid way. All the different requests which can come can be tested. Also, the model indicates the financial risks which are incurred with accepting the request in terms of VaR and CVaR. Disadvantage is that the chance exists that not all the right variables and parameters are not incurred yet, but these can be added by Rodelta in the future. It is recommended to Rodelta to do so.

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1 Introduction

This chapter will start with an introduction to the company (section 1.1). After that, the problem identification and the research motivation (section 1.2) will be given. Additionally, the research questions (section 1.3) and the research objectives (section 1.4) will be addressed.

1.1 Introduction to the Company

Rodelta is founded in 1946. It is a company which provides the Oil & Gas industry, flood control and drinking water market with all types of pumps. Rodelta is based in Almelo, which is in the east of The Netherlands. The company operates all over the world. It has customers throughout Europe, but also in the Far East and Middle-East.

Rodelta is a relative small company with 35 employees, which are divided over several departments. My supervisor at the company is Bart Essink, which is the Head of the ‘Sales’ department. Bart has studied IEM himself in the past.

Currently, the main line of business of Rodelta is the pump sales. Additionally, it does the maintenance and reparation of various pumps they have placed at multiple pump-plants throughout the world, but it sees the opportunity to expand this part regarding drinking water pumps.

1.2 Problem Description and Research Motivation

Suppose that Rodelta has received an application from Company A which is operating in the drinking water industry. Company A has a big number of pumps throughout The Netherlands. At this moment, the service of the pumps of this company is not systematically organized: maintenance and repair of the pumps are getting done by multiple companies; and sometimes, maintenance is not getting done at all. Therefore, Company A believes the current situation has to change. The company wants to get more reliability in the service of their pumps. Therefore, company A wants a company like Rodelta to provide the service for its pumps, in order to make sure this service is carried out properly and systematically.

Rodelta observes within the drinking water market, more and more companies, like Company A, are asking regulation of the service of their pumps. They do this in the form of a request. A request is a proposition to do a certain job. In this case, the request is a proposition of a company like company A to all the companies like Rodelta, which can maintain/repair drinking water pumps.

In the request, company A asks if Rodelta wants to do the maintenance and occasional repair to a certain amount/type of pumps of company A. The request usually indicates the quantity of pumps, which types of pumps, location of the pumps, and the duration of the contract. Rodelta is not sure if it is able to carry out the service of the pumps of these companies for the following reasons:

- Rodelta doubts if it has enough resources to deal with this kind of applications.
- Rodelta does not have the knowledge to maintain/repair pumps of other companies.
- To repair pumps of other companies, Rodelta needs pump components from these companies, since Rodelta is not able to make these components themselves. This costs money, and Rodelta is not sure if it is worth it to invest this money.

Therefore, Rodelta wants to figure out whether or not it should handle the requests for service activities. This is the action problem that will be dealt with throughout this paper. To do so, there will be considered different scenarios where companies will come with different requests, and it will be determined if Rodelta can fulfil the requests of these companies.

Problem Cluster

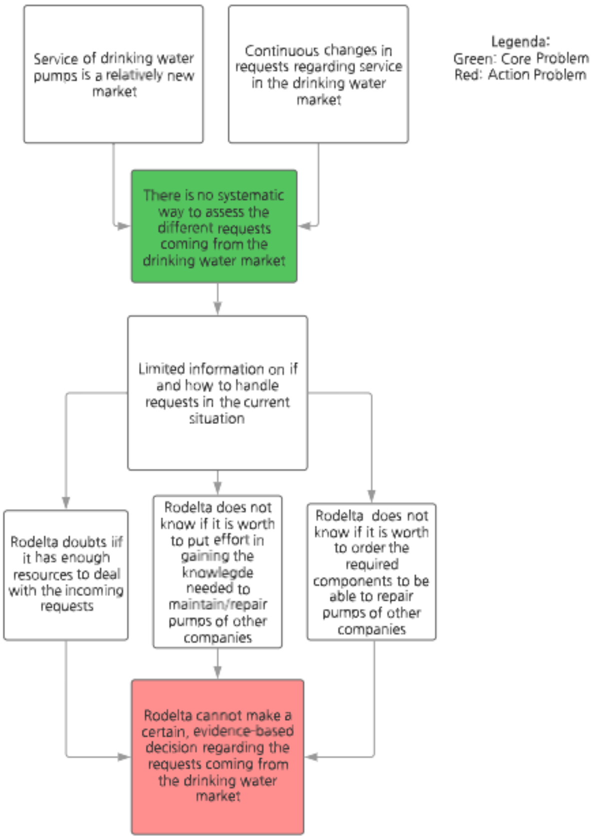

Figure 1: Problem Cluster

Motivation of the core problem

Since the service of drinking water pumps is a relatively new market, Rodelta does not know how to handle the requests from the drinking market yet. Also, because the requests are continuously changing, Rodelta cannot base its decisions on one request which is correctly assessed. The decision regarding one request should would be different from the decision of another request.

Therefore, the current situation needs to be changed. This can also be seen from the problem cluster. Rodelta cannot influence the fact that the service of drinking water pumps is a relatively new market. Furthermore, it is not possible to do something about the fact that the requests from the market are continuously changing. Rodelta can however come up with a systematic way to assess the different requests which are coming from the market. The lacking of this systematic way is therefore the core problem.

Norm vs Reality

The desired situation is that Rodelta can assess the applications with certainty. Rodelta does not want to miss out on the opportunity to do a certain request when it can earn money from this request.

The actual situation is that Rodelta does not know whether or not it can handle the applications. This can cause major losses in money; because the money which Rodelta invested in the applications could be lost. Furthermore, Rodelta can get a bad reputation. This, as a consequence, can jeopardize future contracts and hence decrease profits in the long run.

The measurable value which indicates the difference between the desired situation and the actual situation is the presence of a valid, systematic way to assess the different requests. A valid, systematic way secures that:

- Rodelta can assess all the requests.
- Rodelta does not makes mistakes when assessing the requests.
- Rodelta knows what the financial risks and opportunities are regarding handling the request. The systematic way should be able to indicate to Rodelta what the chances are to make profit and what the chances are to make loss when handling a certain request.
- Rodelta takes into account all the important Key Performance Indicators (KPIs) when deciding whether or not to accept a request. KPIs are indicators which are measuring the performance of the company.

1.3 Research Questions

To be able to find a solution to the action problem, following questions will be answered:

Regarding context analysis:

1. How does Rodelta currently decide whether or not to handle a request?
2. What kind of requests could come now and in the future?
3. What are the main KPIs for decision-making in the drinking water market?

Regarding literature review

4. What kind of decision-making model should be used to determine if Rodelta can handle a request or not?
5. How do companies decide whether or not the financial risks regarding business decisions they make are too big?

Regarding solution design

6. Which variables are important regarding handling any application (and should therefore be implemented in the model)?
7. What assures that Rodelta will use the model in the most convenient and accurate way?

Regarding solution evaluation

8. What assures that the decision-making model made does not contain any mistakes during implementation?

1.4. Research Objectives

The main intended deliverables of this bachelor assignment are:

A literature review from which:

- Rodelta knows which kind of model it can make best to assess the requests.
- Rodelta knows how to deal with the outcomes of the model.

A cash-flow model from which:

- Rodelta can determine whether or not it should handle the applications. This is the main goal of this thesis. Therefore, it is important that the model is proven to be valid, and that it is clear for Rodelta how to use the model.
- Rodelta can review the results on sample requests. It is important to see whether or not the model is able to assess the requests, and to see if the model is handling the sample request in an accurate way.
- Different cash flow components can be visualized. This is important to get an overview of the risks which are involved with evaluating a request.
- The company's financial growth under requests scenarios can be simulated. As the company's financial growth is an important KPI to decide to handle a request or not, the model should definitely be able to simulate this.

1.5 Summary on the Introduction

Rodelta receives a lot of requests from the drinking water market with the question if it wants to do the maintenance and repair of drinking water pumps. But Rodelta does not know whether or not to handle these requests, since the company does not have a systematic way to come up with the requests. This is the core problem, and coming up with this systematic way would be the main goal of this research.

2 Current Situation

In this chapter, the current situation regarding the requests is explained. This chapter will describe what kind of requests there are (section 2.1.), and how Rodelta deals with these requests at the moment (section 2.2). Furthermore, there will be searched for the KPIs which are important regarding the decision to handle a certain request (section 2.3). Also the implementation of the options (section 2.4) and finally the summary of the current situation will be given (section 2.5).

2.1 Type of Requests

A request is a proposition to do a certain job. In the request, a company asks to Rodelta if it wants to do the maintenance and occasional repair to a certain amount/type of pumps. Additionally, in a request is usually stated where the pumps are located, and how long the contract associated with the request will be. The length of a contract can for example be one year, three years, five years or ten years. The whole process of receiving requests is part of a tendering process, where companies like Rodelta have to place a bid to get an order for the request.

There can be different type of applications. These applications can be divided in two main groups. The first type is a contract based on a 'fixed price', and the second group is a contract based on cost 'reimbursable'. Furthermore, the requests can indicate different types of approaches to handle a request.

Definition of Fixed Price contract and Cost Reimbursable contract
When a contract is based on fixed pricing, the amount of the order for Rodelta is determined with the acceptance of the request. So before executing the request, Rodelta will know which amount of money they will get. Nevertheless, Rodelta does not know the costs beforehand.

When a contract is based on cost reimbursable, Rodelta will receive the revenue periodically. For instance every month, Rodelta sends an invoice to the customer, based on all the work done. The revenue and profit will be dependent on the work done in that specific month. Therefore, Rodelta will not know exactly which amount of money it will eventually receive from handling the request, whereas this would be the case when the customer would have paid in a 'fixed price'-principle.

Definitions of handling options

Rodelta receives applications indicating different type of approaches to handle the application. The requests can propose the following options in which Rodelta must handle the application:

1. Handle the request all by itself. A customer can demand from Rodelta that it should handle the request only by itself, and therefore that Rodelta may not involve third parties into the order.
2. Handle the request by itself with the opportunity to outsource a part of the request to a third party. When Rodelta does not have the man force or materials to conduct service to all the pumps included in the request, Rodelta can outsource the maintenance/repairing of a part of the pumps to another company. Having the opportunity to outsource a part of the tender is not always preferred, because customers are valuing the fact that only one company is

handling the request. This typically secures uniformity in doing the request, since there are no different companies with different visions about how to handle the request.

3. Handle only part of the request (and not involve a third party for the remainder of the request). As stated in the previous paragraph, it can be that Rodelta does not have man force or materials to conduct service to all the pumps standing in the request. When a request provides the option to only maintain a part of the pump types included in the request, it gives Rodelta the ability to select the types best suited for their business. Since Rodelta is not obligated to handle the entire request, there is no need to involve a third party. Therefore, this type of request is not equivalent to the two previous mentioned ways to handle a request.

2.2 Dealing with requests

When Rodelta receives a request from the drinkwater market for handling the service side of business, it does not have a systematic way to assess the requests. At the moment, Rodelta assesses the requests per following:

After receipt of a request by Rodelta, it has to make a decision on whether or not it would be financially attractive to accept the request. By looking quick at the expected main costs and the corresponding expected profit of a request, Rodelta makes a rough estimation on whether or not a certain request would be attractive for the company.

This simple way of deciding whether or not a certain request is attractive to handle may lead to mistakes easily. It is possible that Rodelta does not take into account all the KPIs which are important for decision-making in the drinking water market. This will be talked about in depth in the next subsection.

Furthermore, by not making a complete overview of all the expected costs, and calculating the expected profit quickly, assessing requests leads to multiple problems:

- High chance of not taking into account all the cost variables which are important while handling such a request. For example considering personnel costs, travel costs and material costs, but forget about cost like holding/stock costs.
- There is a high chance that the right constants which are connected to your variables are not taken into account. It can for example be the case that for the comfort, it is stated in the model that an employee has to drive 1 hour on average to get to a pump. Whether this is also the case in reality is doubtful. A certain request has pumps in it which require a 2 hour drive on average. It can be imagined that this difference of one hour in driving can cause a lot of additional costs to Rodelta in general. Therefore, ignoring these kind of constants would lead to an unreliable model.

2.3 Main KPIs for Decision-Making

Systematic literature review

Regarding the core problem, the following can be said: the systematic way only has the 'profit' KPI as an outcome. With the 'Profit' KPI, not only the profit/loss you will make is meant, but also the financial risks which are incurred with accepting a request. So this is for example the chance that you will lose money over handling the request, and how big that loss will be. The indicators 'Value at Risk' (VaR) and 'Conditional Value at Risk' (CVaR) will be used to look at this. These indicators will be described further on in the report. it is important to notice that 'profit' should not be the only KPI that will be taken into account while making the decision about whether or not to handle a request from the drinking water market.

Therefore, it is important to come up with the right KPI's next to the 'profit' KPI. Otherwise, the decisions will be made while looking at only a part of the important KPI's. Therefore, the knowledge question answered with the Systematic Literature Review (SLR) in the project plan is the following: **Which other KPIs, next to the 'Profit' KPI, are important for the decision-making process of a request?**

The articles used in the SLR propose different ways to defining KPIs. Where (Latorre, Roberts, & Riley, 2010) are saying you can find your KPIs by just answering the question 'Does an indicator contribute to the knowledge of the individuals making decisions within the project?', (Del-Rio-Ortega, et al., 2017) and (Permenter, 2015) are proposing to first divide the different KPIs you have in two groups. The first group are lead KPIs, and the second group are lag KPIs. From there, you have to focus only on the lead KPIs. These two ways of identifying KPIs are totally different, but they propose both ways to identify KPIs which is worth trying. In the next section, both ways will be examined.

2.4 Implementation of Techniques

Implementing the first technique

As proposed by (Latorre, Roberts, & Riley, 2010), the KPIs will be found by answering the question 'does an indicator contribute to the knowledge of the individuals making decisions within the project?'. To find the KPIs, the management team of Rodelta is consulted, as this team is making the key decisions within Rodelta. Three employees of the management team are asked about which KPIs they thought would contribute the most to the knowledge of themselves. From all the KPIs they stated, the following KPIs where mentioned by all three of them:

- Profit
- Customer Satisfaction
- Market Awareness
- Cross Selling Opportunities

Implementing the second technique

Now, the KPIs will be divided in two different groups, which are 'lead KPIs' and 'lag KPIs'. As explained by (Del-Rio-Ortega, et al., 2017) and (Permenter, 2015), lead KPIs are KPIs which can be influenced. Lead KPIs have influence on lag KPIs, which are KPIs 'which determine goals of an organization but which cannot be influenced.'

- Looking at the KPIs which are retrieved at the 1st way, it can be said that 'Profit', 'Cross Selling Opportunities', and 'Customer satisfaction' are lead KPI's. Nevertheless, 'Market Awareness' is a lag KPI, since it cannot be influenced directly. Therefore, according to (Del-Rio-Ortega, et al., 2017), the focus should lie on all the KPIs except of 'Market Awareness'

Combining the first and the second technique leads to the result to focus on the KPIs 'Profit', 'Cross Selling Opportunities' and 'Customer satisfaction' while assessing requests.

From the most important to the least important, the KPIs are ordered in the following way by Rodelta:

1 Profit
2 Cross Selling Opportunities
3 Customer Satisfaction
4 Quality of Service

Therefore, Rodelta will assess the requests in the following way:

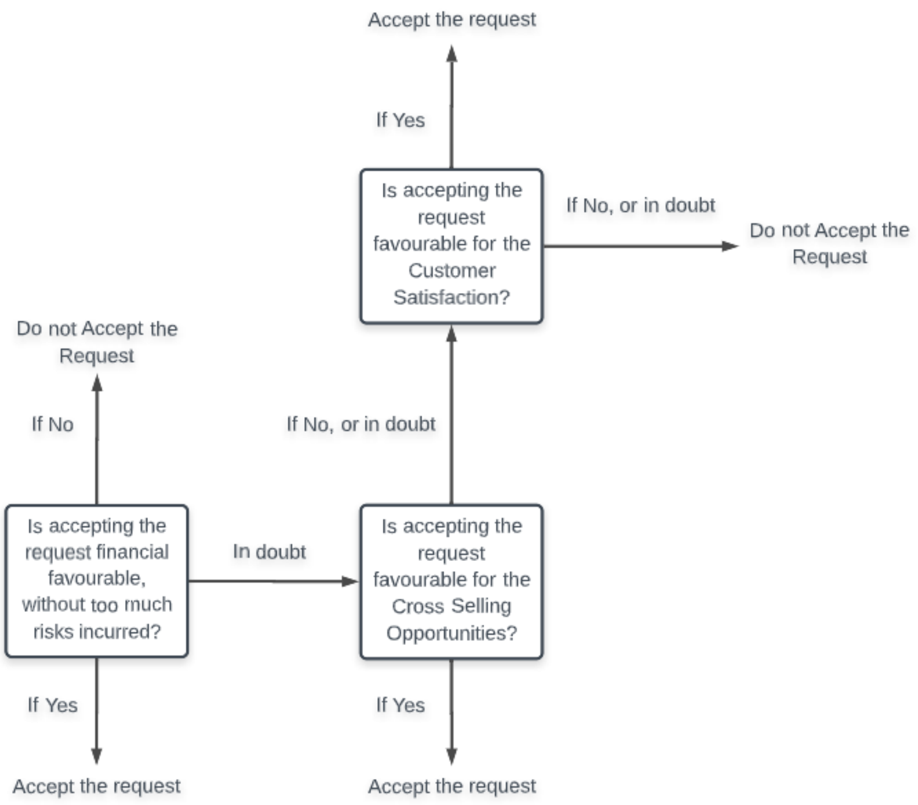

Figure 2: Roadmap past the KPIs

From the roadmap, it can be seen that Rodelta will first look at whether or not a request is financial favourable. By looking at the outcomes of the model, Rodelta itself will determine when a request is financial favourable. When Rodelta doubts if the request is financial favourable, the company will look at the cross selling opportunities related with accepting a request. Also in this case, Rodelta will determine itself whether or not accepting a request is favourable for the cross selling opportunities. The same applies to the situation where Rodelta looks if accepting a request is favourable for the customer satisfaction.

2.5 Summary on the current situation

Rodelta knows quite well which kind of requests it can receive, but it does not have determined a valid, systematic way to assess the requests yet. The company makes a quick calculation, but doing this gives a high chance of errors. Therefore, to improve the current situation, this systematic way to assess the requests should be determined. From this chapter it can be seen that there are different types of requests, so this way should be easily able to test either one of the different types of requests. This is necessary to ensure the model can test any request given.

Furthermore, while assessing whether or not to handle a certain request based on the outcome of the new systematic way, Rodelta should not only focus on the KPI 'Profit' (which is the case with the old way), but also on 'Cross Selling Opportunities' and 'Customer satisfaction'. After consultation with Rodelta, it turned out that of these KPI's, the 'Profit' KPI is still the most important KPI. So on first sight, Rodelta will mainly look at this KPI. Nevertheless, if Rodelta doubts whether it should handle a certain request looking at the 'Profit' KPI, it will look at the other KPI's. If accepting the request will have a positive influence on the 'Cross Selling Opportunities' or 'Customer satisfaction', Rodelta will still accept the request, as can be seen from the roadmap described in figure 2. So for clarification: these KPIs will not be implemented in the model, but they should be taken into account when from the model (looking at profit) it is not clear whether or not to accept the request.

3 Literature Review

In this chapter, the answers to the following questions will be found:

- What kind of model is the most appropriate model to use? This question will be answered in section 3.1 and section 3.2.
- How do companies decide whether or not the risks regarding expansion of their business are too big? This question will be answered in section 3.3.

Furthermore, the chapter will end with a summary on the literature review in section 3.4.

3.1 In Search for the Right Model

Rodelta has to make a decision on whether or not to handle a request. With the model which will be made, Rodelta should be able to assess the requests in a systematic way. Decision making models can be of the following types:

- Rational Decision-Making model: this model is suited to base a complex, difficult decision on, for which high stakes are involved. (Pei, 2013)
- Bounded rationality decision-making model: this model is similar to the rational decision-making model. The only difference is that this model seeks a decision which is 'good enough' (Lorkowski & Kreinovich, 2018)
- Vroom-Yetton Decision-Making Model: this model assumes that there is no optimal type of model to base decisions on when in the starting phase of a decision-making process. It assumes that the type of model used can change if the current situation changes. (Atlasssian, 2022)
- Intuitive decision-making model: this model is used when you already have considerable background knowledge in the area you are operating in. With this model, the decisions are based on gut-feeling. (Organ & O'Flaherty, 2016)
- Recognition-primed decision-making model: this kind of model holds close relations with the previous model. The only difference is that this model looks at the data which is already available, and focuses less on the gut feeling of the user. (Atlasssian, 2022)

Since Rodelta does not have any prior knowledge or data available, the last two models will not be suitable for this case. As there is being searched for the optimal decision, the second option is also not the best to use. As there is being searched for the optimal type of model right away, the third option is also not optimal. Therefore, a rational decision-making model will be made. And this kind of model suits the case of Rodelta, since the company has to make a though decision where high stakes are involved.

Stochastic Capacity model

In the search for a right Rational decision-making model to assess the requests with, the models which were being considered were the models of Giglio (1970). Giglio proposes several models to determine the ideal amount and timing of capacity expansions regarding services. As it is expected that Rodelta also has to expand in capacity regarding man force and resources, there is being looked at these models. The goal of this to get a first sight on rational decision-making models.

Giglio proposes different models for different situations. In this case, there is being looked at the model which is related with 'Capacity Expansion Under Nonstationary, Increasing Demand'. There is being looked at this model, since the demand which is coming from the drinking water market regarding services is increasing, but not stationary: the increase in demand cannot be predicted exactly. It is not known exactly how many requests will come in the future.

The model can be explained as follows: it can be stated that this model is a cash-flow model. A cash flow is 'the movement of money in and out of a company' (Hayes, 2022). The model is a cash-flow model since the goal of the model is to minimize the cost for capacity expansion, and all the values which are standing in the model are cost variables. One term of the model indicates the minimal cost for letting the work-flow run. Another term indicates 'the cost for the remainder of the cycle once capacity A has been built'. The next term is 'the discounted cost of building the capacity', and the final term gives 'the discounted cost of future capacity cycles'. So referring it back to this research specifically, the following can be stated:

- the first term is the minimal cost for doing service in the drinking water market.
- the second term indicates the costs that still have to be made to meet the requests which are being handled right now.
- the third term is the cost for adding the resources (e.g. employees, materials) needed to handle the new request which you are considering to take.
- The last term is the cost you expect to make in the future in order to be able to handle future requests.

After seeing the model of Giglio, the plan is to make a cash-flow model. This is because Giglio showed that making a cash-flow model can be a valid way to assess capacity expansions. Nevertheless, looking at the different components of the model of Giglio, probably not use the same components will be used in the model. Rodelta gave the assignment to make a systematic way to assess one single request, and see whether or not Rodelta should handle the request. When using the model of Giglio, there will be considered multiple requests which Rodelta has received right now, and will receive in the future. This difference in number of requests which is being looked at, causes that this model is not directly applicable to this case. Nevertheless, certain components from Giglio's model are important to use in the model. For example the component 'cost for adding the resources (e.g. employees, materials) needed to meet the new request which you are considering to take' is an important component to add to the cash-flow model.

Furthermore, after looking at Giglio's model, the realizing came that a way has to be found to calculate the parameters of the model of this thesis. It should for instance be known what the parameters are which fit the variable 'personnel costs'. The parameters in the model should be estimated quite precisely, otherwise a valid model cannot be made. This kind of information will be retrieved from interviews with employees from Rodelta. If this does not work, the needed values will be determined via a search on the internet.

The next step is to further clarify the kind of cash-flow model which can be used to assess the different requests. A model which can assess all different kinds of requests has to be made. The model of Giglio showed that a model which can be applied to a specific capacity expansion problem is not necessarily suited to be applied to all capacity expansion problems. Therefore, in this research, it should be determined how to make a model which can assess all requests.

3.2. Identifying the Cash-Flow model for Rodelta

All cash flow models are basically based on transactions. Looking at this research, the transactions will be the revenue which Rodelta receives from the request, but also all the costs Rodelta makes to handle the request.

There are different kinds of cash-flow models. The different kinds of cash-flow models will be described below.

1. The first type of cash flow model is where you divide the cash flows in a 'two-asset environment'. This two-asset environment makes a clear deviation between available money and short term investments. (Gregory, 1976)

2. The second type of cash-flow model is Baumol's model. This model said that 'there are only cash outflows, and the stock of assets was replaced periodically by the sale of assets of value M'. (Sandmeyer, 1964)

3. The third type is Patinkin's model. This model builds further upon Baumol's model, but Patinkin did change some elements. Instead of only having cash outflows, Patinkin said that a cash-flow model should both have payments and receipts in it. Also, he stated that it should not be possible to determine the total cash-flow of the entire period based on one week, since both payments and receipts could change per week. (May, 1970)

4. The last type is the Miller-Orr model. This model has a lot of principles which are the same as Patinkin's model, but there is one main difference: the Miller-Orr model does not have a finite time horizon, whereas Patinkin's model does have a finite time horizon. (Gregory, 1976).

The situation how it is described in Patinkin's model, should also be the case with the cash-flow model which is used for Rodelta. Patinkin's model suits to the current situation, since the contracts connected with the requests will namely have a finite duration of, in most cases, one, three, five or maybe ten years.

Also in the current situation, both payments and receipts are possibly not exactly the same every year. It can be the case that pump A does not break down in year 1, but it does break down in year 2. Therefore, the costs which Rodelta is going to make in year 2 will be higher than in year 1, since pump A has broken down. This is only the case if the rest of the variables in the contract will have the same outcome, and the costs to repair pump A is the only parameter which changes in the model.

Additionally, Patinkin's model stated that most of the costs will be made before any income could have been received. This will also be the same in the case of Rodelta. Before any payment is received by the company, especially in the reimbursable case, quite some costs will already be made. Administration costs will already be made to prepare for handling the request. Stock costs will be made to keep the needed materials on stock. And travel costs will be made, to get to the pumps which should be handled.

Thus, looking at the models described above, it can be said that Patinkin's model suits the best to the model which will be made in this research. Patinkin's model namely assumes a finite time horizon, it takes into account payments and receipts (which will also be the two most important kind of cash-flows in my model), it assumes most of the costs will be made whereas no payment has been received, and it presumes that the flow of payments and receipts is not systematically. All these characteristics are also applicable to the model which is intended to be made, and therefore Patinkin's model will be used as a starting point of the model. But as Patinkin uses interest rates, equilibrium positions and aggregate demands (Agarwal, n.d.), not exactly the same model will be used.

3.3 Assessing Risks in businesses

Accepting a certain request can require Rodelta to do significant investments regarding personnel costs, material costs or holding costs. For a relatively small company like Rodelta, these investments are connected to quite some risks. It is for example doubtful what happens if Rodelta does not succeed in handling the request, and the investments turn out not to be profitable, but only cost money instead.

It is important for Rodelta to know when applying to a certain request is connected with too much risk. Maybe a certain request can be profitable in theory, but still Rodelta should not accept the request because of the risk. For example, if Rodelta has to hire 30 extra employees to handle a certain request, Rodelta possibly should not handle the request. Assessing the risk of a request can be done with several risk management theories.

1. Tortoise Theory

The 'Tortoise Theory' (Pamnami, 2016) explains the consideration between fast and aggressive growth against slow and gradual growth.

For this, 'Tortoise Theory' uses the story of a race between a rabbit and a tortoise. The rabbit runs fast, but at a certain point in time, the rabbit is tired of running. He falls asleep, but the tortoise keeps running with the same, steady tempo with which he had run all the time. While the rabbit is sleeping, the tortoise continues running, overtakes the rabbit, and wins the race. This story can be well applied to business.

This story namely indicates a consideration where a lot of businesses are struggling with. Of course, a lot of businesses want growth. But a lot of businesses want growth too fast, which eventually results in bankruptcy of the business. The company cannot handle the growth it makes, and is tiring out its own resources. They 'fall asleep', as well as the rabbit, and lose the race to other companies. The tortoise, who runs with a slower pace than the rabbit, represents the companies which are choosing for more gradual growth. At the beginning, the tortoise is behind the rabbit, but it uses his energy in a more regulated and standardized way, and then wins the race eventually. The story therefore warns to not make growth too fast, and indicates that a slower but also more gradual growth is often the better option.

2. Make use of Enterprise Risk Management (ERM)

ERM is a structured way to cope with possible risks businesses are facing. ERM indicates how a company looks at the risks they are facing: how they feel about these risks, and in which ways the company normally deals with these risks.

The main advantage of ERM is the exponentially increase of awareness regarding the risks you are facing. This should, in its turn, increase the operational efficiency of the company as well as the confidence of the company to take certain (possibly risky) steps. Because ERM causes that you know better which risks you are facing, and how to cope with them more effectively.

Nevertheless, ERM also has it downsides. ERM sometimes includes human judgment, which is of course not waterproof: humans can make mistakes in every circumstance, and this is also the case when assessing risks you are taking with the use of ERM. Another error that can be made while implementing ERM is that you do not assess the business and economic climate of the company in a valid way, which can cause that you misjudge certain opportunities you get as a company. This can mean that you take risks while you should not, or that you not take risks whereas in reality, it would have been lucrative. Therefore, in any case, you should have the KPI's of your business in the back of your head while assessing the risks you are facing.
(Allianz, 2021)

3. 'Seven Steps'-approach

Step 1: Prioritize your risks
Prioritizing risks should always be the first step of assessing risks. Therefore, it is important that it is known which risks there are, how likely the negative sides of the risks will occur in the future, and what the consequences are when such a risk occurs. It is therefore good to make clear which risk you find more important. This can for example be the choice between:
1 20% chance of losing your most important customer
2 40% chance of losing €1.000.000

Step 2: Make sure you are insured
Where possible, and especially for the risks which have a high priority, it is important to buy insurance. When for example handling with physical risks regarding your employees, it is important to make sure to get a life insurance in case something bad happens to them. Getting insurance is equal to lending out the risk to the insurance company for a small amount of money. And especially with risks of a high priority, this is a good thing to consider.

Step 3: Limit Liability
When being the company owner, make sure to change the company structure to 'cooperation' or 'Limited Liability Company'. In this way, the debts are for the company, and not for the company owner.

Step 4: Ensure Quality of your services/products
Either when delivering services or delivering products, quality have to be ensured. In case of delivering services, make sure to have a system to analyse the quality of the service which is being delivered. What the company owner possibly can do, is to let the customers fill in a questionnaire after they have seen the delivered service. In this way the company owner can see if the customers are satisfied, and therefore if the service is of a quality which is high enough. Ideally, the owner also evaluates if the above mentioned 'process checking the quality of your services' is solid. All this is to ensure customers satisfaction, and therefore to ensure a good reputation for your company.

Step 5: Limit high-risk customers
The company owner has to make sure that the percentage of the customers which have difficulties to pay is low. Especially in the beginning of the company, it cannot be the case that a lot of customers pay late or does not pay at all. And also, when people do not have a lot of money, make sure they pay before delivering the service.

Step 6: train your employees
The company owner has to make sure that he lets his employees know that quality always go before quantity. In other words, his employees should not take unnecessary risks to increase the quantity of products sold, whereas meanwhile, there is a risk that the quality of his products goes backwards.

Step 7: Realize there is a Risk Management Team
By making sure there is a Risk Management Team, the company owner will always have a group of people who are monitoring the risks of your company, and who are making sure your company does not take risks when it should not. If it is possible to have a Risk Management Team which consists of employees, the company owner should make sure to have this. But if there are not enough suitable employees to do this, creating a Risk Management team with people from outside the company is also a good investment to make. Nevertheless, it can be imagined that for a small company like Rodelta, it would not be feasible to hire an entire team from outside the company for only monitoring the risks which Rodelta is facing. (Moskowitz, 2021)

Now the three techniques are being described, it is good to describe how to use the techniques. From the 'Tortoise Theory', the core idea should be taken into account while coping with risks. The core idea is that when a risk is looking like it is too big, it is preferable not to take the risk. This is to prevent unpleasant consequences in the future. When doubting about whether a risk is too big or not, Rodelta can make a ERM system, or follow the 'Seven Steps'-approach described above. With both the ways, Rodelta should be able to assess whether or not a risk is too big or not.

From the model which will be made, Rodelta can quantitively assess if a financial risk is too big to take, or if Rodelta should doubt to handle the request. How this exactly should be done, is described further on in this report.

3.4 Summary on the Literature Review

This chapter started with analysing the different kinds of decision-making models. From this analysis, it turned out that making a rational decision-based model would be the best fit for the current situation. Thereafter, Giglio's model has been analysed. Due to Giglio's model, it has been determined that a cash-flow model will be made. And after the research done in section 3.2, it turned out Patinkin's model would be the most convenient type of cash-flow model to use in this case. Therefore, when making the model, there will be sticked to the main principle of Patinkin's model: the model should consist all major cost- and revenue components applicable to the specific case.

Furthermore, it has been determined in this chapter how Rodelta should assess the risks which are connected with accepting a request. When a decision is likely to be too big, Rodelta should not take the risk (Tortoise Theory). Furthermore, when Rodelta doubts whether a certain risk is too big or not, Rodelta can make an ERM system, or follow the seven steps which are described at the end of section 3.5.

4 Solution Design

This chapter will be subdivided in the following sections: it starts with designing the cash-flow model in section 4.1. Then in section 4.2, there will be talked about how the model is implemented in Excel. Then, a summary on this chapter will be given in section 4.3.

4.1 Design of the Cash-Flow Model

In Search for the Right Variables in the Model

To get to know all the right variables which should stand in the model, two interviews within Rodelta have been held to get an overview of the entire process from receiving a request to finishing a request. From these interviews, all the cost variables which should stand in the model are determined. The process of receiving and handling requests will be described below, and meanwhile, the variables which are coherent with that the specific part of the process will be shown.

Project Handling Costs

The request will come in at Rodelta. They look if it can handle the enquiry. And in case it can handle the request, Rodelta has to decide how and which part (if applicable in the tender) of the request it will handle, and how much it is going to cost.

When the customer of Rodelta indicates that Rodelta gets the assignment which is described in the request, Rodelta can work further on preparing to do the request. First of all, Rodelta has to plan to execute the request. It has to determine how much workforce it is going to need to handle the request, how much materials it needs and which pumps they are going to handle at what time. Also, when needed, there have to be negotiations with possible third parties which Rodelta is going to involve in handling the request. These third parties are possibly going to maintain a part of the pumps which are standing in the request. Employees of Rodelta have to execute these kind of tasks, and the costs regarding the time spent on these tasks can be placed under Project Handling Costs.

During the execution of the assignment, Rodelta has to go to the pump sites, but there are also other activities when handling the request which should be taken care of. Employees need to know which pump station to go on which day exactly and what they have to do at the specific station. Also, the needed materials should be available continuously, problems in the process of handling the request should be solved, and financially there should be no flaws in the process. Payments for example have to be paid and possible invoices have to be sent. To do all these activities, Rodelta will probably need multiple employees. All these employees have to be paid, and the costs incurred regarding this can be placed under ‘Projection Handling costs’. The project handling costs are the costs for paying all additional employees involved with administration activities, so not the employees which are going to the pump sites.

The employees who do the administration activities can be divided into several disciplines within the company:

- Finance department: making sure all the invoices will be sent and will be paid. Furthermore, this department will provide an overview of all the costs which are being made / all the revenues being earned with regard to the request

- Planner: making sure that the handling of the request is going fluently. The planner should make sure that there is a planning for the employees going to the stations, solve the problems which occurs in the process of handling the request and let the purchase department know what should be ordered.

Personnel Costs

Rodelta has to make sure it has enough capacity and enough resources to execute the assignment. In order to have enough suitable employees to handle the request, the company maybe has to hire additional employees to handle the request. The search for and getting new employees costs money, which can be placed under personnel costs. Also, when the employees do not have the required expertise, the employees need training to get the required knowledge to handle the request. This can for example come down to get to know how to maintain or repair certain type of pumps. The employees might also needs a training to get a VCA, which is some kind of a 'safety certificate'. Providing employees with required training can also be seen as personnel costs. Additional to the cost for hiring new employees this can be seen as personnel costs. So the costs for paying the salaries of the personnel handling the request are not included in the personnel costs.

Investment Costs

Rodelta needs to get the materials to handle the request. When the request for example asks for four employees which are driving around full time throughout the country, and you only have two vans available to drive around all day, two additional vans are needed. Handling a request sometimes asks the use of a specific kind of software. This software is needed to maintain certain kinds of pumps, and keep track with administrating which pumps you maintained, repaired, and at what time. The costs which come looking with buying new vans or new software can be seen as Investment Costs.

Travel Costs

To maintain pumps, the employees of Rodelta have to get to the pumps. And probably from the office in Almelo, the employees of Rodelta have to drive to all different pump stations throughout the Netherlands. Therefore, there will be costs to the travel the distance (e.g. costs for petrol, maintenance and insurance of vans), but also to pay the employee driving the car. Furthermore, it can happen that a pump needs a repair at the factory in Almelo, so then the pumps has to be brought back and forth from the pump plant to the factory in Almelo. There will also be travel costs incurred regarding this activity, and these travel costs will also be standing in the model. These costs can be indicated as travel costs.

Service Costs

When the employee is on site, it has to perform the maintenance and also the occasional repair of pumps. The main sources of costs regarding these activities are the hourly rate of the employee and costs for the materials used during the service. These costs are combined in the 'Service Costs'. The cost to conduct service has two main components: the cost to maintain all the pumps, and the cost to execute the needed repairs to the pumps. The model should make a clear distinction between these two components, since maintenance is quite predictable, whereas repair has also a level of uncertainty in it. This is because it is not known with certainty if a certain pump will break down during the year.

Stock Costs

Rodelta has Stock costs regarding the materials it uses during the service of pumps, like lubrication and periodically replacement parts of pumps. Optimally, Rodelta makes sure it has all the materials it needs in stock in the factory in Almelo. To do this, it has to reserve space in the factory. Reserving space and having stock in the factory comes with costs for Rodelta, so therefore, the stock costs should be taken into account in the model.

Additional Costs

The last main cost component will be the additional costs. These are costs which do not really fit to the other costs components, but should be implemented in the model. Examples of additional costs are costs for clothes and costs for maintenance of tools.

Fixed Revenue

The revenue can be divided in two principles. First principle is that Rodelta gets the contract based on a fixed price. When Rodelta gets its revenue in a 'fixed price-way', Rodelta will know exactly what amount of money it will get from the customer to perform the assignment which is standing in the request. It can differ if Rodelta gets the money in one time, two times or ten times, but this does not change the amount of money.

Constant to ensure the profit margin

Rodelta can also get the contract based on a cost reimbursable principle. With this principle, Rodelta will send invoices to the customer after every month, based on the amount of work which Rodelta has done during that month. When Rodelta gets the contract based on a reimbursable price, the model needs a constant to ensure the profit margin. The expected costs will then be multiplied by this constant, in order to ensure the profit margin.

The overview of all the variables which will be included in the model:

- Fixed revenue (when the request is fixed price)
- Constant to ensure the profit margin (when the model is reimbursable)
- Se = Service Costs
- T = Travel Costs
- Pe = Personnel Costs
- St= Stock Costs

- I = Investment Costs
- Ph = Project Handling Costs
- A = Additional Costs

Derivation of the Cost Variables

The costs made regarding handling a request has been split in different categories like stock costs, travel costs and personnel costs. But next to that, you can also arrange the cost variables in other ways. This will be done below.

Direct VS indirect costs:

Direct costs are costs which are immediately connected to your product/service. When you build a house, you need cement, stones and a crane. The costs related to purchasing these components are all examples of direct costs. So direct costs regarding requests are for example oil to maintain the pumps, or tools to repair the pumps.

Indirect costs are costs which are not directly connected to providing the service. If you want to build a house, the costs to get a license to build a house can for example be considered as indirect costs. (House of Control, sd). So indirect costs regarding requests can be administration costs, ICT costs and security costs.

Fixed VS variable costs:

You can also divide the costs in fixed and variable costs. Fixed costs are standing apart from the amount of services you provide to your customer, but are costs for the entire company. So when you are building a house, fixed costs are the costs for the personnel you always have, or the machines which you already are hiring anyways. So fixed costs regarding requests are for example the salaries of employees working on the request.

Variable costs are costs which are dependent to the amount of services you provide to your customer. So when you are building a house, variable costs are the costs for the personnel you have to hire extra to build the house, or for additional material you have to buy to make the house. So variable costs regarding requests are for example the salaries for the employees you have to hire extra to handle the request. (Centraal Bureau voor de Statistiek, 2021)

There are a lot of ways to calculate the cost price, which for example make distinction between fixed and variable costs, and direct and indirect costs. In these cost price models, certain types of costs more important than other types of cost. Sometimes, indirect costs are more important than direct costs. In other cases, certain types of costs are even just left out. Nevertheless, there will not be made a clear deviation between indirect VS direct costs, or variable VS fixed costs, since all type of costs are of significant importance for the cash-flow model. Therefore, all type costs will be included equally in the eventual cash-flow model.

Defining The Model

At this point, all the needed information is known to make the model. This will be done in this subsection. First, all the variables which should stand in the model will be repeated, and then the formula of the model will be given.

Repeating the Variables for in the model

The main variables regarding this model are the following:
Revenue components:

- F = Fixed revenue (when the request is fixed price)
- C = Constant to ensure the profit margin (when the model is reimbursable)

Cost components:

- Se = Service Costs
- T = Travel Costs
- Pe = Personnel Costs
- St= Stock Costs
- I = Investment Costs
- Ph = Project Handling Costs
- A = Additional Costs

Implementing these variables into the model of Patinkin will result in the following models:

The model (fixed price):

$$\boldsymbol{Profit\,per\,Year} = \boldsymbol{F_i} - (\boldsymbol{Se_i} + \boldsymbol{T_i} + \boldsymbol{Pe_i} + \boldsymbol{St_i} + \boldsymbol{I_i} + \boldsymbol{Ph_i} + \boldsymbol{A_i})$$

The model (reimbursable)

$$\boldsymbol{Profit\,per\,Year} = \boldsymbol{C} * (\boldsymbol{Se_i} + \boldsymbol{T_i} + \boldsymbol{Pe_i} + \boldsymbol{St_i} + \boldsymbol{I_i} + \boldsymbol{Ph_i} + \boldsymbol{A_i})$$

These models nevertheless are calculating the profit over one year. As the contract associated with the request can have a duration of multiple years, the model should also be able to calculate the profit over multiple years. As the values for the costs variables can differ over the years due to uncertainty (regarding which pumps will break down and which not), the profit can also differ per year. This should be taken into account in the model.

Also, there should be implemented a discount factor in the model. As the value of money can change over the years, the discount factor is used to calculate the present value of the amount of money you will earn in a couple of years. This discount factor should be implemented in the model to secure the validity of the model. Therefore, the following two factors should be added to the model:

- D = Discount Factor
- $\sum_{i=1}^{Duration\ Of\ The\ Contract} \ldots$= Summation of the Multiple profits which were gained over separate years

Then, the eventual model will look as follows:

The model (Fixed Price)

$$\boldsymbol{Profit\ Over\ the\ entire\ Request} = \sum_{i=1}^{Duration\ Of\ the\ Contract} D^{i-1} * (\boldsymbol{F_i} - (\boldsymbol{Se_i} + \boldsymbol{T_i} + \boldsymbol{Pe_i} + \boldsymbol{St_i} + \boldsymbol{I_i} + \boldsymbol{Ph_i} + \boldsymbol{A_i}))$$

The model (Reimbursable)

$$\boldsymbol{Profit} = \sum_{i=1}^{Duration\ Of\ the\ Contract} D^{i-1} * (\boldsymbol{C_i} * (\boldsymbol{Se_i} + \boldsymbol{T_i} + \boldsymbol{Pe_i} + \boldsymbol{St_i} + \boldsymbol{I_i} + \boldsymbol{Ph_i} + \boldsymbol{A_i}))$$

Now, it will further defined how to calculate the values regarding the cost variables which are standing in the model.

How to calculate the values regarding the variables?

- **Fixed revenue = predetermined revenue over one year**

- **Service Costs = Fixed personnel costs + fixed material costs + variable personnel costs + variable material costs**
- (Fixed personnel costs = total hours needed to maintain pumps * €/h)
- (Fixed material costs = #pumps * €/materials to maintain one pump)
- (Variable personnel costs = yearly chance that the pump breaks down * hours needed to repair pumps * €/h)
- (Variable material costs = yearly chance that the pump breaks down * #pumps * €/materials to repair one pump)

- **Travel Costs = Fixed Travel Costs + Variable Travel Costs**
- (Fixed travel costs = (Average Distance to a pump * #pumps * €/ to drive one km) + (#hours to drive to all the pumps * € to drive one hour))
- (Variable travel costs = (yearly chance that the pump breaks down * Average Distance to a pump * #pumps * €/ to drive one km) + (chance * #hours to drive to all the pumps * € to drive one hour))

- **Personnel Costs = (price employee * number employees) + (price training * number of training)**

- **Investment (Material) Costs = (price van * number of vans) + (price software * number of software)**

(Costs for additional materials are included in the Service Costs)

- **Stock Costs = (price to keep component of stock * number of components)**

- **Project Handling Costs = (hours employee works * cost/hour)**

- **Additional Costs = Costs for Clothes + Costs for vans maintenance + Costs for tools maintenance**

Now that all the variables for in the model are determined, the search for the right parameters can be started.

Completing the model with constants

The parameters which are standing below are determined after long sessions with the head of sales of the company and after consultation of two other employees within Rodelta. All the parameters have been multiplied with a key factor, due to privacy reasons of the company. This has resulted in the following list of parameters:

Parameters regarding Service Costs Variables

First, it is good to know that there are several hundred different types of drinking water pumps. So therefore, it is not possible to add all the types of pumps to the model. Therefore, there has been made a selection of key types of pumps. Other types of pumps can always be implemented at a later moment.

- Pump type A: Distribution pump
- Pump type B: Flush pump
- Pump type C: Circulation pump
- Pump type D: Descaling pump
- Pump type E: Dosing pump
- Pump type F: Drain pump

	Pump A	Pump B	Pump C	Pump D	Pump E	Pump F
Number of hours needed to maintain the pump	2 x 1.5	2 x 1.0	2 x 0.75	2 x 1.25	2 x 0.5	2 x 1
Number of hours needed to repair the pump	4	3	2	3	1	1
Chance this pump will break down over a year	4%	8%	8%	10%	12%	10%
Expected Material costs to maintain this type of pump	€ 110.-	€ 110.-	€ 110.-	€ 110.-	€ 110.-	€ 110.-
Expected material costs to repair this type of pump	€ 49k	€ 26k	€ 18k	€ 33k	€ 4k	€ 4k

Parameters regarding Travel Costs Variables

- Cost to drive 1 km (in €): €1,10
- Cost to let one employee drive for one hour (in €): €99
- Average speed of a vehicle of Rodelta: 70 km/h

Parameters regarding Personnel Costs Variables

- Average costs for attracting a new employee in general (in €): 18k

Type of Training	A (pomp)	B (VCA)	C	D	E
Costs for Training	24u x €99: €2376.-	8u x + € 99: € 792 + €550.- Tot: € 1342.-			

Parameters regarding Stock Costs Variables

Type of Stock Component	A	B	C	D	E	F
Costs to keep one component of this type on stock	€ 660.-	€ 396.-	€ 264.-	€ 330.-	€ 264.-	€ 176.-

- Considered Stock items: bearings, o-rings, gaskets, grease.

Parameters regarding Investment Costs Variables

Type of ICT	A (software)	B (hardware)	C (monitor)	D	E
Cost for this type of Software	€ 5500.- + € 264 per pump.	€ 1320.- per employee	€ 2640.-		

- Software: considering investment cost for software + cost of licence
- Hardware: considering tablets, mobile.
- Monitor: vibration device, sound device, temperature device.

- Price for an additional van (in €): Considering custom made van (suitable for repair activities), including tool: € 66.000,-

Parameters regarding Project Handling Costs Variables

Type of Employee	A (engineer)	B (Finance)	C (planner)	D	E	F
Cost to let this employee work for one hour	€ 99.-	€ 117.-	€ 110.-			

Additional Parameters which have to be filled in:

- Total Hours Available per employee (who conducts service) per year (or maybe per week): 1260 hours (170 (effective) days)
- Amount of Vans needed per FTE (full-time employees, who are maintaining/repairing the pumps in this case): 0.8
- Clothes for FTE's: €550/year
- Maintenance/depreciation per van: €6600/year
- Maintenance/depreciation of the tools per van: €616/year

4.2 Implementation of the Model in Excel

In this subsection, the model will be implemented into a programming application. The process of doing this is described below. It starts with choosing the programming application to implement the model in.

Choice for Programming Application

The model is built in Excel/VBA because:

- Looking at the outline of the model, it can be seen that it should be feasible to implement the model into Excel/VBA
- The employees of Rodelta are familiar with Excel. Therefore, the employees will know how to adapt the parameters in Excel. In this way, they can test the different requests.

Calculations made in excel

In excel, most calculations are being made by a code which is written in VBA. In the code, the Total Service Cost is for example being calculated. In order to calculate the total service costs, it is needed to know what the values for the fixed personnel costs, fixed material costs, variable personnel costs and variable material costs are. In the code, it can for example be seen that the fixed personnel costs are calculated as follows:

- First, the model need to know how much hours Rodelta needs in total to maintain all the pumps which are standing in the request. Therefore, a 'For-Loop' is been made, which goes past all the pumps types, and looks how much pumps there are of each type. Then, it checks how long it takes on average to maintain one pump of that specific type, and multiplies it with the number of pumps of that type. Adding this to the number of hours which are already made to maintain the previous types of pumps, will give you the total hours you need to maintain all the pumps.

Then, once you have the fixed personnel costs, you can write it away in the table which is standing in the 'Outcome-Table'-tab. A picture of this table is shown below:

Variables of the model(values given per year)			
Fixed Revenue (in l)	1666667		
Total Service Costs (in l)	854185	Fixed Personnel Costs (in l)	18500
		Fixed Material Costs (in l)	100000
		Variable Personnel Costs (in l)	8685
		Variable Material Costs (in l)	777000
Total Travel Costs (in l)	237447	Fixed Travel Costs (in l)	226571
		Variable Travel Costs (in l)	10875
Total Personnel Costs (in l)	4323,667	Costs for Attracking Additional Employees (in l)	4323,8
		Costs for Training (in l)	0
Total Stock Costs (in l)	116000		
Total Investment Costs (in l)	53295,67	Costs for Vans (in l)	12971
		Costs for Software (in l)	40324
Project Handling Costs (in l)	103		
Total Additional Costs	4659		
Cash-Flow Over Each Year (Excluded the Discount Factor, in l)	396653,3		

Figure 3: 'Outcome-Table'

The upmost right number in this table depicts the fixed personnel costs, which is calculated in the way which is described above.

And this is happening with all the variables which are standing in the model. In the sheets of Excel, Rodelta fills in the necessary parameters. Then, with the help of the VBA code, the values for the variables are being calculated, and written down back in Excel.

How does the model cope with risk?

In the model, the values of a lot of variables are dependent on how many pumps break down throughout a year. Costs like the variable personnel costs, variable material costs and the variable travel costs are completely dependent on the number of needed repairs throughout a year. How many pumps will break down throughout the year, you do not know. Now, it will be explained how the model copes with these risks.

The probability distribution used is a Bernoulli distribution. The values which are coming out of Bernoulli's formula are in this case either 0 or 1. At the top of the 'Request-Independent'-tab, there is a column which indicates the chance of breakdown of each type of pump per year. When from the table below it turns out that the chance of breakdown of a certain pump is p=0,2, the E[X] is also 0,2. Then following Bernoulli's distribution, per turn, you have p=0,8 on 0, and p=0,2 on 1. When you let the model run 5 times, the sequence of numbers can for example be 0, 1, 0, 0, 0. (Geest, 2006)

Chance that this type of pump will break down in one year (expressed between 0 and 1)
0,04
0,08
0,08
0,1
0,12
0,1

Figure 4: Chances of Break Down

When the value which comes out of the formula is 1, the pump needs to be repaired. In this case, the full costs for e.g. repairing and travelling to the pump will be taken into account. When the value is 0, the pump does not need to be repaired, and none of this costs will be taken into account. How often the pump breaks down, is based on the probabilities which are standing in the figure above.

The model is simulated in Monte Carlo and by letting the model run a thousand times, there will arise complete different cash flows because of the implementation of the Bernoulli distribution. This eventually will result in a distribution of cash-flows, which can be seen on the 'cash flow distribution'-tabs in excel.

From the outcome of the different cash flows, the VaR and CVaR can be determined. The VaR is the 'Value-At-Risk', which indicates the value where for example 10% of the outcomes of the cash-flows are lying underneath. The connected CVaR indicates the average value of the outcomes which are lying underneath the VaR. With the VaR and CVaR, Rodelta is able to quantitatively assess whether or not a certain request is financially too risky. Rodelta can determine a value for VaR (let say value A) and CVaR (let say value B) for which Rodelta knows for sure the financial risks are too big. Then following Tortoise theory, it should not accept the request. Rodelta can also determine values for VaR (let say value C) and CVaR (let say value D) from which it knows for sure the financial risks are that small it can accept the request with certainty. If the VaR or CVaR are then lying between the values of respectively A and C or B and D, it is doubtful if the financial risks are too big, and the company should make an ERM system or follow the 'Seven-Steps'-approach described in chapter 3.

No risks incurred while calculating the expected profit

The expected profit will not be calculated with the help of Bernoulli's probability distribution, but with the fixed values for the chance of breakdown of a certain pump. These are indicated in figure 4.

4.3 Summary on the Solution Design

In this chapter, the model which will be used by Rodelta to assess the request has been built. The right variables for in the model have been determined. This has led to the following outline of the models:

The model (Fixed Price)

$$\boldsymbol{Profit\ Over\ the\ entire\ Request} = \sum_{i=1}^{Duration\ Of\ the\ Contract} D^{i-1} * (\boldsymbol{F_i} - (\boldsymbol{Se_i} + \boldsymbol{T_i} + \boldsymbol{Pe_i} + \boldsymbol{St_i} + \boldsymbol{I_i} + \boldsymbol{Ph_i} + \boldsymbol{A_i}))$$

The model (Reimbursable)

$$\boldsymbol{Profit} = \sum_{i=1}^{Duration\ Of\ the\ Contract} D^{i-1} * (\boldsymbol{C_i} * (\boldsymbol{Se_i} + \boldsymbol{T_i} + \boldsymbol{Pe_i} + \boldsymbol{St_i} + \boldsymbol{I_i} + \boldsymbol{Ph_i} + \boldsymbol{A_i}))$$

In excel, this model has been implemented, together with the right constants corresponding to the variables. Additionally, the choice has been made to include all kind of cost variables in the model, since they are all significant for calculating the profit/loss from handling the request.

Also, building up on chapter three, were was stated how Rodelta should deal with risk: it is now possible that this risk will be quantified. By determining for which values of VaR and CVaR the financial risks are too big, or for which values it is doubtful that the financial risks are too big, Rodelta can determine if it should accept a request, not accept a request, build an ERM system or follow the 'Seven Steps'-approach which is described in chapter 3.

5 Solution evaluation

In this chapter, the model will be tested to look if the model is valid. To test this, first, the model will run and there will be searched for some general pitfalls (section 5.1). Then some simple requests will be implemented in the model (section 5.2), and after that some more specific experiments will be done with the model to test the model more in-depth (section 5.3). If from these experiments it turns out that the model is not working properly, the model will be adapted. This will be done until the model works optimally.

5.1 Model Run

With simply letting the model run several times, it can be seen if the model acts logically on first sight. The following settings are used for the runs:

- Number of pumps: 100 pumps of each type (A to F)
- Average distance to travel: 100 km
- Number of years: 3
- Fixed revenue: €8.400.000

Additionally, the model has run for both a ‘fixed price’-contract and a ‘reimbursable’-contract. What can be seen from the model is the following:

Project-Overview

The total costs and revenues of handling the request can be seen on this tab. These numbers are not changing, since no random variables are incurred with calculating these numbers.

Request-Dependent Sheet

On the Request-Tab, it can be seen that only the values of certain variables are changing. This is for example the case with the variable ‘number of hardware needed’, which is placed under investment costs. This number is namely based on the number of FTE’s needed to handle the request. The number of FTE’s needed is based on the number of needed service hours. In its turn, the number of needed service hours is partly based on the number of pumps that break down through a year. And since random variables are included in the calculation of this last number, it is logical that the ‘number of hardware needed’ changes.

Request-Independent Sheet

Since the values on this sheet are not changing per request, the values on this sheet should also not change per run. This is indeed the case when the model runs.

Resources Sheet

The number of FTE’s needed to handle the request and the number of vans needed to handle the request changes per run. This can be explained, since these numbers are based on the total service hours needed to handle the request. The total service hours is changing per run, since the number of pumps you need to repair is changing per run. It can therefore be concluded that on this sheet, the model also behaves logically.

Output Sheet

It can be explained how this sheet behaves while letting the model run. None of the values are changing, since none of the values of these variables are calculated with the help of random variables. And this should also not be the case when you calculate the expected profit.

Cash-Flow-Distribution Sheets

The behaviour of the model on these sheets can also be explained. Since the cash-flow changes per run, different values for the outcome of the cash-flow are received. These values are depicted on the bottom of the sheets. On the top of the sheets, the VaR and CVaR are calculated. Connecting the values of these two variables with the distributions displayed on this sheet is indicating that based on these distributions, the values of the VaR and the CVaR are logical.

Outcome-Table Sheet

On the output-tab, it can be seen that per run, the values for the Variable Personnel Costs, Variable Material Costs, Variable Travel Costs, Costs for attracting Additional Employees, Costs for Vans and Costs for Additional Materials are changing. Therefore, the outcomes of the cash-flow are continuously changing also. This is logical, since the values of these variables are partly based on how many pumps you need to repair. Since the number of pumps you need to repair is partly based on a chance-factor that the pump breaks down, some runs a certain pump breaks down, and other runs a certain pump does not break down. Thus with some runs, the number of pumps that break down will be higher than with other runs. Therefore, the outcome of the cash-flow can differ per run. The expected profit nevertheless stays the same for all the runs, as this value is calculated with fixed values only.

Also, it can be seen on the output-tab that values related to variables like ‘Fixed Personnel Costs’, ‘Fixed Material Costs’ and ‘Costs For Training’ do not change per run. Whether a pump breaks down or not does not have any influence on these values, so therefore it can be explained that these parameters do not change.

Summary

What can be concluded from this subsection, is that, on every sheet, the model is behaving as it should. In the next section, there will be implemented simple and complex requests in the model.

5.2 Experiments of the Model

Several experiments have been done to check if the model is indeed working fine. Next to behaving logically, it will be determined if the model also gives logical outcomes for e.g. the expected profit. This will be figured out in this section.

Testing Simple Requests

Experiment 1

In experiment 1A, it will be tested how the model behaves while assessing a request with only one pump of type A in it. It is estimated that Rodelta would get a fixed revenue of €5000 for handling this request. The distance to the pump (back and forth) is estimated on 100km. The length of the contract is one year. The average time to get to the pump and back is estimated on 1,3 hours. Additionally, there are for example also some stock costs and a bit of software costs.

Filling in these numbers in the model eventually gives a logical outcome: €2709 profit when the pump does not break down, and €46971 in loss in case the pump breaks down. What additionally can been seen from this experiment, is that the cost variable 'Variable Material Costs' is having the highest influence on the expected profit. From the €49680 difference in profit between a year when a pump breaks down and a year when a pump does not break down, €49.000 of this difference has been caused by the Variable Material Costs. Below there is a picture of the Outcome Table, which depicts the values of the variables related to the above standing experiment.

Expected Profit (over the entire contract, in €)	Outcome Cash-Flow		Duration of the Contract(in years)	Discount Factor
92.090	€ 149.664	Run Model!	3	0,9

There should not be changed any number manually in the table below!!!			
Variables of the model(values given per year)			
Fixed Revenue (in €)	€ 200.000		
Total Service Costs (in €)	€ 53.955	Fixed Personnel Costs (in €)	€ 19.998
		Fixed Material Costs (in €)	€ 11.660
		Variable Personnel Costs (in €)	€ 297
		Variable Material Costs (in €)	€ 22.000
Total Travel Costs (in €)	€ 20.366	Fixed Travel Costs (in €)	€ 19.989
		Variable Travel Costs (in €)	€ 377
Total Personnel Costs (in €)	€ 976	Costs for Attracking Additional Employees (in €)	€ 976
		Costs for Training (in €)	€ -
Total Stock Costs (in €)	€ 17.512		
Total Investment Costs (in €)	€ 7.599	Costs for Vans (in €)	€ 2.863
		Costs for Software (in €)	€ 4.736
Project Handling Costs (in €)	€ 227		
Total Additional Costs	€ 1.028		
Cash flow_Each Year (Excluded the Discount Factor, in €)	€ 98.337		

Figure 5: Outcome-Table during Experiment 1A

Experiment 1B tests how the model behaves when assessing a request where only one pump of type B is incurred. This pump has to be maintained for one year long. Furthermore, with regards to experiment 1A, the following numbers have been changed:

- Fixed Revenue: €4000
- Distance to the pump: 45 km

This gives that the outcome of the cash flow either can be €2860 in case the pump does not break down, or €23574 in loss when the pumps does break down. Because the chance that the pump breaks down is only 8% per year, the average outcome of the cash-flow is still €877, which can be seen as quite a normal profit for maintaining one pump for one year. Nevertheless, accepting this request would be risky, since looking at the VaR and CVaR, it can be said that there is still a probability of about 7% you make a loss of €23574.

Experiment 2

In experiment 2, Rodelta is going to maintain one pump of type B for one year. But now, compared to experiment 1B, the probability that the one pump of type B will break down will be increased. The probability will be increased from 8% to 16%.

The distribution of cash-flows, with probability of breakdown = 0,08, is depicted as follows:

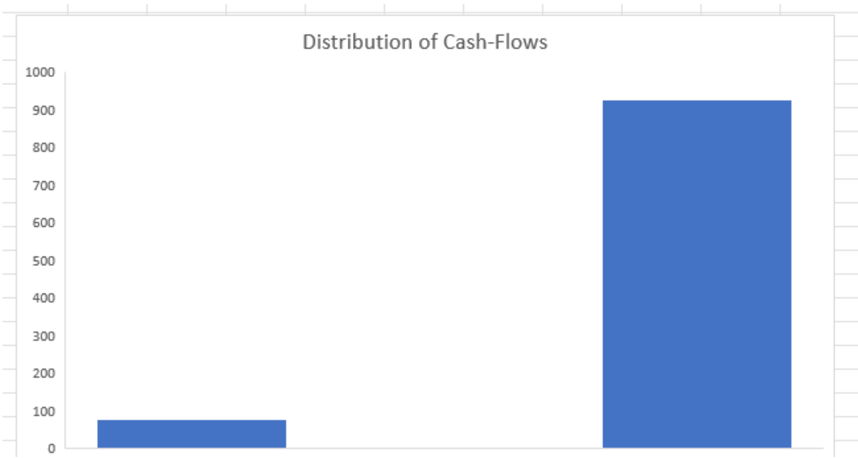

Figure 6: Distribution of Cash-Flows Exp. 1B

In this graph, the left bar depicts the value of -€23574, on the right bar depicts the value of €2860.

After the probability that pump B breaks has been raised to 0,16, the distribution of cash-flows looks as follows:

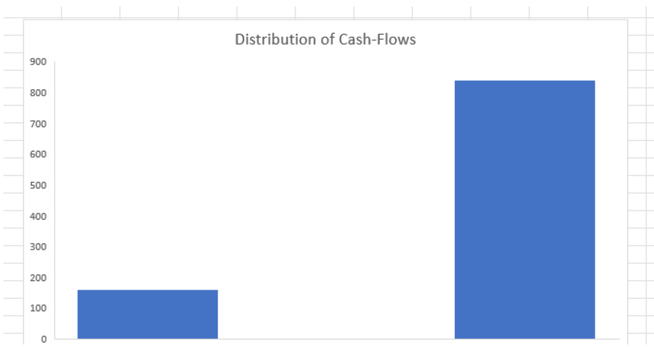

Figure 7: Distribution of Cash-Flows Exp. 2

Again, the left bar depicts the value of -€23574, on the right bar depicts the value of €2860.

What can be seen from the graphs, is that increasing the probability that pump B will break down lowers the average outcome of the cash-flows. To be exactly, the average outcome of cash-flows has decreased from €877 to -€1343. This can be explained, since when you increase the probability that a pump will break down, the pump will break down more often. Therefore, you more often have to make the costs to repair the pumps, which lowers the outcome of the cash-flows.

Experiment 3

For the third experiment, the stock costs will be made twice as high compared to experiment 1B. So again, Rodelta is going to maintain one pump of type B for one year. Only now, the stock costs of stock component B will be raised from €396 to €792. What you expect, is that the average outcome of cash flows will decrease, since the costs have been made higher.

Following this change, the average outcome of cash-flows has decreased. Instead of the distribution of cash flows depicted in figure 6, the distribution of cash flows is now as follows:

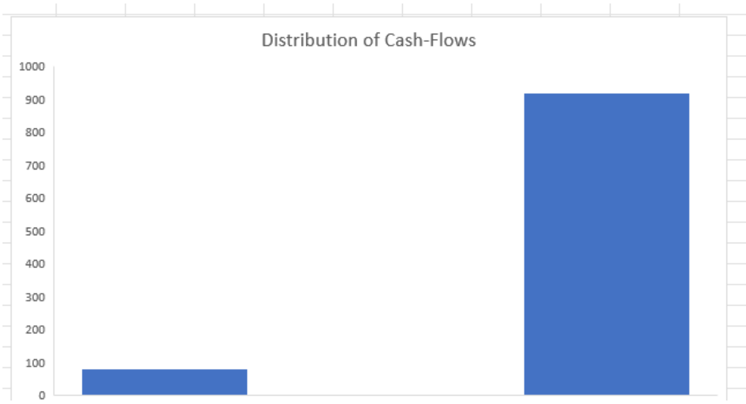

Figure 8: Distribution of Cash Flows Exp. 3

In this graph, the left bar depicts the value of -€23970, on the right bar depicts the value of €2464.

Comparing figure 8 with figure 6 shows that the probabilities to make profit or to make losses are still the same. But when you make profit, your profit is less high (€2464 instead of €2860) and when you make losses, your losses are bigger (€23970 instead of €23574).

What can be concluded from the three experiments described above, is that the model is behaving logical while putting basic requests in it. Now that some simple requests are tested, some more in depth requests will be tested, and see how the model reacts to these experiments.

Testing complex requests

Experiment 4A

During the following experiment, a sample request with the following parameters will be implemented:

- Number of pumps in the request: 600 (6 types of pumps, quantity of 100 pumps)
- Duration of the Contract: 1 year
- Fixed Revenue: €2.800.000
- Average distance to a pump (back and forth): 100km
- Pomp trainings needed: 2, VCA trainings needed: 2
- Regarding software; monitors needed: 2
- Number of hours financer and planner have to work on the request: 1000 hours each

The average outcome of the cash-flows from this request is €500.700. Based on their past experience, Rodelta verified that this profit can indeed be a realistic outcome for a €2.800.000 project (in case of a 'fixed price'-contract, the profit in case of a 'reimbursable price'-contract will be calculated in experiment 5). So from this result, it can be said that if Rodelta wants to make a profit of €1.000.000, it should ask €3.300.000 as a fixed revenue to the customer (€3.300.000-€2.800.000=€500.000., which should be added to €500.700 to make €1.000.000 in profit).

Experiment 4B

Experiment 4B is based on Experiment 4A. So in the request, they ask if Rodelta can serve 100 pumps of each type (A to F) for one year. The difference is that now the overall probability that each pump breaks down is increased with 5%. This has lead to the fact that the expected profit has decreased to -€34000. This significant decrease is mostly due to the increase in variable material costs. These costs has risen with €1.500.000 with respect to experiment 4A. These costs has risen this much since a lot more pumps had to be repaired in this experiment, due to higher chances of breakdown.

Now that the probabilities that a pump breaks down have been increased, it is also interesting to look if the risk regarding accepting the request has risen. To assess this, the standard deviation of the outcomes of the cash flows will be considered. From the model, it turns out that the standard deviation has increased from €170.000 in Experiment 4A to €220.000 in this experiment. So the financial risks has risen, since the outcome of the cash flow can be predicted worse.

That the financial risks has risen, can also be seen from the VaR and CVaR regarding both the situations. Before shifting up the probabilities, the VaR at 10% was €317250, with a CVaR of €222715. After increasing the probabilities of the pumps breaking down with 5%, the VaR at 10% was -€363260, with a CVaR of €474930.

Experiment 4C

Experiment 4C is based on Experiment 4A. So in the request, the customer asks if Rodelta can serve 100 pumps of each type (A to F). The difference is that the duration of the contract is now three years instead of one year. This increase in the duration of the contract, combined with keeping the same fixed revenue for handling the entire request, decreases the expected profit from €500.000 to -€3.100.000. This is because the annual revenue is now almost a million, and not €2.800.000 per year as it was in Experiment 4A. Increasing the number of years thus has big impact on the expected profit, in case the annual revenue does not increase.

This will not be the same when having a reimbursable contract. Since in this case, you get paid per month, based on the amount of work you have done in that month. Increasing the duration of the contract in the model can therefore have two consequences. One, you will make more profit in case you made profit in the first year. Or two, you make more loss in case you made loss in the first year.

This can also be seen from the following experiment. With the same parameters as in experiment 4A, only the type of contract will be changed to reimbursable. For one year, and with profit margin 1,1, you will then have an expected revenue of €2.200.000. When you then increase the duration of the contract to three years, you will have an expected revenue of €6.020.000. So this example shows that when you have a reimbursable contract and you make profit in the first year, you will only make more profit when the duration of the contract will be extended.

Experiment 4D

Experiment 4D is based on Experiment 4B. So in the request, the customer asks if Rodelta can serve 100 pumps of each type of pump (A to F) for one year. Also, the overall probability that each pump breaks down is 5% higher compared to experiment 4A and 4C. But now, the difference is the discount factor has been changed from 0,9 to 0,8. At experiment 4B, the expected profit was -€3.100.000, and the distribution of the average value for the cash-flows per year was depicted in the following way:

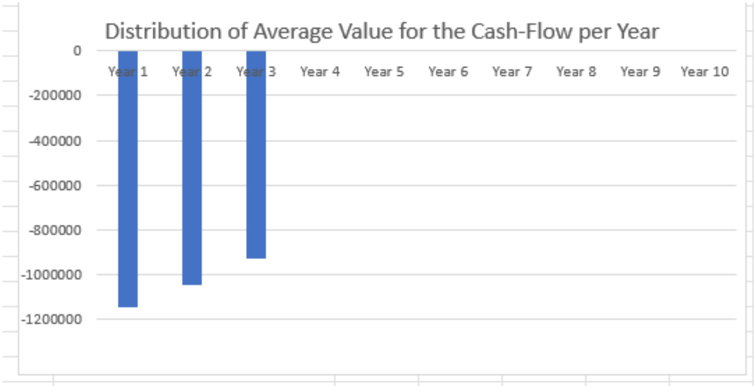

Figure 9: Average Value for Cash Flows per Year Exp. 4B

Now, when changing the discount factor to 0,8, the expected profit changes to -€2.800.000. Also, the distribution of the average value for the cash-flows per year now looks as follows:

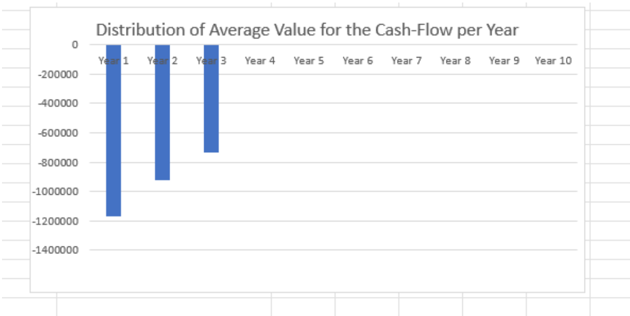

Figure 10: Average Value for Cash Flows per Year Exp. 4D

When you make losses in money every year, which is the case with this experiment, lowering the discount factor makes the value of the losses less. This is because lowering the discount factor makes the value of money less. Nevertheless, when you make profit every year, the value of this profit would become less when lowering the discount factor. So when you make profit every year, lowering the discount factor is not favourable. But when you make losses every year, lowering the discount factor is advantageous.

Experiment 5

Fixed Revenue VS Reimbursable

Coming back to experiment 4A: in the request, the customer asked if Rodelta could serve 100 pumps of each type of pump (A to F) for one year long. The average outcome of the cash-flows from this request was €500.700. This request was implemented in the model as a 'fixed price' request, with a fixed revenue of €2.800.000. The distribution of the outcome of the cash-flows can be seen on the next page.

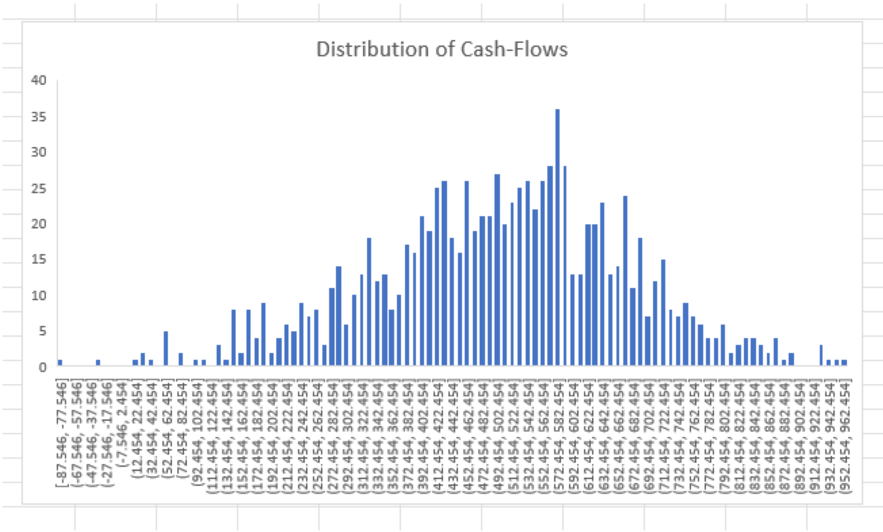

Figure 11: Distribution of Cash Flows Exp. 4A

From the fixed revenue and average outcome of the cash-flows mentioned in the alinea above, it can be seen that the expected costs of handling this request are more or less €2.300.000. This would mean that, in case of a reimbursable contract with a 1,25 profit margin, the revenue from the request would be around €2.875.000, and the expected profit would be around €575.000. This is indeed the case when we implement the request in the model.

The expected profit in case of a reimbursable contract is €579.300 with an expected revenue of €2.896.500, and with a distribution of the total expected revenue as it is depicted in the graph below:

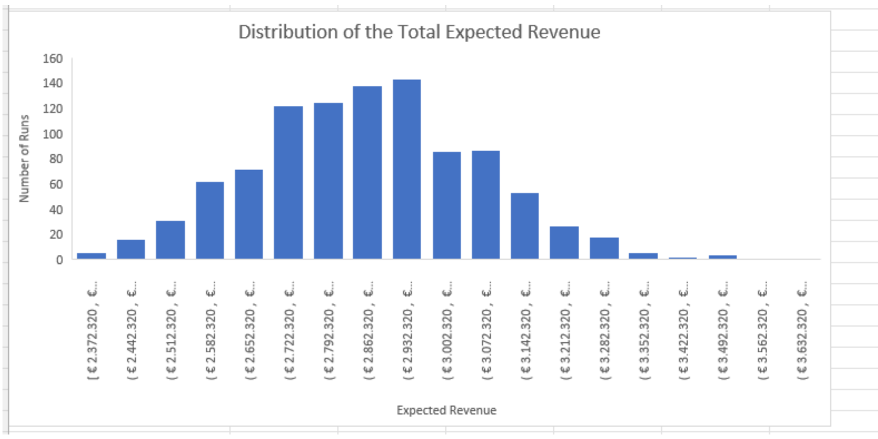

Figure 22: Distribution of Cash Flows Exp. 5

Now the comparison between the two situations will be made. With a cost reimbursable contract, it is expected that Rodelta will make more profit. Furthermore, what can be seen from both the distributions, is that when implementing a fixed price contract in the model, it can be the case that there will be made loss over handling the request. This will be the situation when in reality a lot of pumps are breaking down.

When implementing a cost reimbursable contract, you cannot make losses, since the revenue you get is based on the amount of work what you have done that month/year. The model agrees with this. Looking at the distribution, the lowest value of the distribution is positive. Since this number is 1,25 (profit margin) * total costs, the lowest expected profit out of the distribution is always positive. So with the cost reimbursable contract, there is no risk of losing money. Therefore, the financial risks are higher when accepting a fixed price contract. From the information given in this subsection, it can be said that handling a cost reimbursable contract is more favourable for Rodelta.

Experiment 6

Do the entire request by yourself/involve a third party/do a part of the request by yourself

All the experiments which have been done until now were experiments which were based on the thought that Rodelta will do the request all by itself. Since it can also be the case that Rodelta only has to handle a part of the request by itself, or that it gets the opportunity to involve a third party in doing the request, these cases will also be tested.

Experiment 6A

Only handle a part of a request by yourself: from only handling one pump of type A to handling 100 pumps of each type; the model can test every possible amount of pumps possible. So when the request for example indicates that Rodelta can, next to handle the entire request, also choose to only handle pump types A, B and C, it is also possible to test this situation. In experiment 4A, Rodelta handled 100 pumps of every type of pump for one year and got a revenue of €2.800.000. With this experiment, Rodelta will handle 100 pumps of type A,B and C, and will get a revenue of €1.400.000. So both the values for the amount of pumps and the fixed revenue are reduced by 50%.

From this experiment, it can be seen that in this case, it is more beneficial to handle the entire request. This is because the outcome of the cash-flows has dropped from €500.700 when doing the entire request to only €70.000 when doing a part of the request. So it can make a difference in revenue if you choose to only handle a part of the request instead of handling the entire request. This difference depends on which types of pumps you leave out of the request and the amount of money you will still get when leaving out that specific types of pumps.

Experiment 6B

Involve a Third Party: When you involve a third party into handling the request, you let a third party handle a part of the pumps from the request against a payment from your side. This scenario can also be tested with the model. The number of pumps which you have to serve can be subtracted from the total of number of pumps which are standing in the request. Additionally, the amount of money which the third party is asking can be subtracted from the revenue you expect. Then you can compare this with the situation where you handle the entire request, and see which situation is more beneficial.

The following experiment will be performed based on experiment 4A. In experiment 4A, the customer asked if Rodelta could serve 100 pumps of each type of pump (A to F) for one year. Now, the fixed revenue is changed to €1.400.000, since the third party asks €1.400.000. Additionally, the number of pumps of type A, B and C are set to zero, since these pumps will be maintained by the third company. It turns out the average outcome of the cash-flows drops from €500.700 to €172.040, which therefore means that financially, it would be favourable to handle the entire request.

So it makes a difference in the outcome of the cash flows if you let a third party do a part of the request. This difference depends on which pumps the third company is going to maintain, and which amount of money the third company is asking for maintaining these pumps.

The Pricing Process

Rodelta will have to propose an amount of money to the customer which the customer will have to pay. In case of a fixed price contract, this amount is fixed before handling the request in reality. With a cost reimbursable contract, this amount can change while handling the request, since the real amount of work can be less/more than expected beforehand.

When a request with a 'reimbursable'-contract has been implemented in the model, Rodelta can indicate to the customer that it probably will have to pay the expected profit which comes out the model.

In the case of a 'fixed price' contract, Rodelta should minimally ask the amount of money for which the expected profit is positive. Otherwise, Rodelta will probably lose money over handling the contract.

Additionally, if Rodelta want to make €1.000.000 profit with a fixed price contract, and from the outcome of the model, it turns out Rodelta makes €500.000 profit with a fixed revenue of €2.800.000, it should ask €3.300.000 as a fixed revenue to the customer. (€3.300.000 - €2.800.000 = €500.000., which should be added to €500.000 to make €1.000.000 in profit)

When Rodelta wants to base its pricing partly on the financial risks incurred with the request, Rodelta can implement the intended fixed revenue in the model, and then consider the VaR and CVaR. Based on these values, Rodelta can adjust the fixed revenue until the point that Rodelta for example only has less than a 5% chance that it will make losses. This is case when the VaR at 5% is positive.

It is important for Rodelta to base their pricing on the outcomes of the model, because then, the company will not ask too much money to the customer and scare them off. Or ask too little money, and surprise the customer with a high payment eventually.

Summary of insights

After doing the experiments, the following can be said:

- First of all, the model is running fine. With both the simple and complex requests, the model gives logical outcomes. Also, the changing of the numbers and the non-changing of numbers are logical.
- Second of all, it can be said that the 'Variable Material Costs' is the variable which affects the expected profit the most. This is because the parameters of these costs are the highest by far.
- Rodelta should choose a 'reimbursable'-contract over a 'fixed price'-contract, since the profit is lower and the financial risks are higher when handling a fixed price contract.
- The duration of the contract has a lot of influence on the expected profit. In case of a 'fixed price' contract, the annual revenue should definitely increase when the duration increases. Otherwise you are likely to make losses on handling the request. In the case of a 'cost reimbursable'-contract and profit in the first year, the profit will increase if the duration of the contract increases further.
- Changes in the discount factor does influence the expected profit by a bit, but not by that much.
- Letting a third company do a part of the request, or only doing a part of the request by yourself, has influence on the revenue received from handling the request.

5.3 Summary on the Solution Implementation

What can be seen from this chapter, is that the model is indeed a valid way to assess the requests. Letting the model run showed that the model behaves as it should. The experiments showed the same, and showed that the outcomes of the model are also realistic.

6 Conclusion

Conclusion and Recommendations

The goal of this Bachelor Thesis was to provide Rodelta with a systematic way to assess service requests from the drinking water market. This systematic way should not contain any mistakes in the calculation while assessing the requests. Additionally, it should provide Rodelta with insights into the financial risks and opportunities regarding handling a specific request. In order to get the necessary background knowledge for the systematic way, the research included a literature review and multiple interviews.

The research supported the initial thought for the need of a new systematic way. Reason is that the old way of calculation had a high chance of not including all the important cost variables and right constants. With the new systematic way, this is not be the case anymore.

Furthermore, while using the old way of calculating, Rodelta did not take into account all the important KPIs for decision-making. The research indicated that Rodelta should not only look at the Profit incurred with handling a request, but also at the KPIs 'Cross Selling Opportunities' or 'Customer satisfaction'. The company can use the provided roadmap after the calculation to take their final decision.

For further improvement of the current situation, a Cash-flow model has been made. This model is derived from the principles of Patinkin and based on revenues-costs. There is no deviation between the type of costs, since all costs are of significant importance for the cash-flow model. Due to this reason, all type of costs and revenues are included in the model. This includes variables like Service Costs, Travel Costs, Investment Costs, Stock Costs and the Fixed Revenue.

The model has been implemented in Excel/VBA. The experiments done with the model have indicated that the model behaves logically, and that it is possible to put all kind of requests into the model. Furthermore, the numbers in the model which should be changing are changing and the numbers in the model which should not be changing are not changing. Also, the values of the cost variables which come out of the model are realistic to Rodelta.

To evaluate the financial risks incurred with accepting a request, Rodelta can look at the distributions of the cash-flows. Additionally, it can look at the Value of Risk (VaR) or Conditional Value at Risk (CVaR) related to the distribution of cash-flows. Based on these values, Rodelta can then determine whether the risks are too high, since these should not be to big following Tortoise Theory. In case of doubt, Rodelta should make an ERM system or follow the 'Seven-Steps'-approach.

Discussion / Insights on Future Research

After consultation of Rodelta, the conclusion came that the current model is a valid way to assess the requests from the drinking water market. Nevertheless, the model can be finetuned in the future. Rodelta will ensure to realize this with the points mentioned below:

Rodelta will be keen on adding variables when necessary. When Rodelta notices that, while executing the requests, certain cost variables are still missing, they will add those variables to the model. This will make the model even more accurate.

Rodelta also will be keen on updating the constants of the model. While executing the request, Rodelta should monitor the constants and adapt these when required.

7 References

Agarwal, M. (n.d.). *Patinkin's Monetary Model - Explained !* Retrieved from Economics Discussion: https://www.economicsdiscussion.net/money/quantity-theory-of-money/patinkins-monetary-model-explained/8101

Allianz. (2021, August 18). *How to create a business risk management plan for your company*. Retrieved from Allianz Trade: https://www.allianz-trade.com/en_global/news-insights/business-tips-and-trade-advice/business-risk-management.html#:~:text=Business%20risk%20management%20is%20a,an%20emergency%20or%20an%20opportunity

Atlasssian. (2022). *5 decision-making models to try if you're stuck*. Retrieved from Atlassian The Workstream: https://www.atlassian.com/work-management/team-management-and-leadership/decision-making/models

Centraal Bureau voor de Statistiek. (2021). *Kostprijs berekenen en productprijs bepalen*. Retrieved from Ondernemersplein: https://ondernemersplein.kvk.nl/productprijs-bepalen-info-en-tips/

Cooper, D. R., & Schindler, P. S. (2014). *Business Research Methods.* New York: McGraw-Hill Irwin.

Del-Rio-Ortega, A., Garcia, F., Resinas, M., Weber, E., Ruiz, F., & Ruiz-Cortes, A. (2017). Enriching Decision Making with Data-Based Thresholds of Process-Related KPIs. *Advanced Information Systems Engineering*, 193-209.

Geest, P. V. (2006). The binomial distribution with dependent Bernoulli trials. *Journal of Statistical Computation and Simulation*, 141-154.

Gregory, G. (1976). Cash flow models: A review. *Omega*, 643-656.

Hayes, A. (2022, June 8). *Cash Flow*. Retrieved from Investopedia: https://www.investopedia.com/terms/c/cashflow.asp

Heerkens, H., & van Winden, A. (2021). *Solving Managerial Problems Systematically.* Noordhoff Uitgevers.

House of Control. (n.d.). *Kostprijsberekening & Kostprijsformule*. Retrieved from House of Control: https://www.house-of-control.nl/kostprijsberekening-en-kostprijsformule.html

Latorre, V., Roberts, M., & Riley, M. (2010). *Development of a Systems Dynamics Frmework for KPIs to Assist Project Managers' Decision Making Processes.* Santiago.

Lorkowski, J. A., & Kreinovich, V. (2018). *Bounded Rationality in Decision Making Under Uncertainty : Towards Optimal Granularity.* Cham: Springer.

May, J. (1970). Period analysis and continuous analysis in Patinkin's macroeconomic model. *Journal of Economic Theory*, 1-9.

Moskowitz, D. (2021, October 11). *Top Ways to Manage Business Risks*. Retrieved from Investopedia: https://www.investopedia.com/articles/personal-finance/072315/top-ways-manage-business-risks.asp

Organ, D., & O'Flaherty, B. (2016). Intuitive decision-making and deep level diversity in entrepreneurial ICT teams. *Decision Systems*, 421-435.

Pamnami, A. (2016, April 23). *"Tortoise Theory" for Success in Business Expansion*. Retrieved from Linkedin: https://www.linkedin.com/pulse/tortoise-theory-success-business-expansion-amit-pamnani

Pei, Z. (2013). Rational decision making models with incomplete weight information for production line assessment. *Information Sciences*, 696-716.

Permenter, D. (2015). *Key Performance Indicators: Developing, Implementing, and Using Winning KPIs.* New Jersey: John Wiley & Sons Inc.

Pricewise. (2022). *kWh-prijs*. Retrieved from Pricewise: https://www.pricewise.nl/energieprijzen/kwh-prijs/#:~:text=Wil%20je%20weten%20wat%20een,50%20en%20%E2%82%AC%200%2C70.

Sandmeyer, R. L. (1964). Baumol's Sales-Maximization Model: Comment. *The American Economic Review*, 1073-1080.

Watkosteenauto.nl. (n.d.). *Wat kost een auto per km?* Retrieved from watkosteenauto.nl: https://watkosteenauto.nl/wat-kost-een-auto-per-km/#:~:text=ANWB%20heeft%20een%20berekening%20vrijgegeven,middenklas%20auto%20%E2%82%AC0%2C49.

8 Appendix

In this appendix, a scheme with all the functionalities of each sheet of the model is shown, together with the input and the output of each sheet (section 8.1). This is an addition to the explanation on how to use each tab of Excel, which is given on the bottom of every tab in the model.

8.1 Overview of Tabs

Tab	Functionality	Input	Output
Project-Overview Tab	Display the main information of the request	Main information of the request	Main information of the request, together with the total costs, revenue, and profit regarding the request
Request-Dependent Tab	Fill in all the request-dependent variables	Values determined from the request and automatically calculated numbers	Contribute to the calculation of the values on the output-tabs
Request-Independent Tab	Fill in all the request-Independent Variables	Numbers from past experience and automatically calculated numbers	Contribute to the calculation of the values on the output-tabs
Resources Tab	Calculate the amount of FTE's and Vans needed additionally to handle the request	Number of FTE's and number of Vans available at the moment. Also, automatically calculated numbers	Number of Vans and FTE's needed additionally to handle the request. This contributes to the calculation of the values on the output-tabs
Expected Outcomes Tab	Calculate the expected profit for handling the request	Automatically calculated numbers	The expected profit for handling a request
Cash-Flow-Distribution Tabs	Indicate the outcome of the cash-flow per run, the average value for the Cash-Flow per Year, and its corresponding graphs	Automatically calculated numbers	The outcome of the cash-flow per run, the average value for the Cash-Flow per Year, and its corresponding graphs
Outcome-Table Tab	Calculate Outcome cashflow	All cost variables and revenues regarding the contract	Outcome Cashflow
Definition list Tab	Indicate all the meanings of the main variables which are standing in the model	The main variables of the model, together with their meanings	An overview of all the main variables which are standing in the model