From Quote to Cash

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Abstract
This master thesis project is conducted at Den Hartogh, an intermodal logistic service provider. The focus of the project is on the quote performance. An analysis on the quote performance of the business unit Liquid Logistics is performed.

Six quote performance parameters are developed to measure the quality of the price setting in the quote. The parameters measure the profitability of an order and how good the costs are predicted in the quote.

Also a new quote structure is developed which is better analyzable. In this structure the value of an order in the network is priced. This is done by making a distinction between a market correction and a repositioning correction. This distinction makes it possible to calculate both corrections with the use of discrete-time Markov chains.
Management Summary

In this thesis a description is given of a project conducted at Den Hartogh. Den Hartogh is a logistic service provider for the petrochemical industry, which has to deal with the creation of quotes upfront of the order. A quote has validity for over a year and therefore it is essential that the quote accurately predicts the costs. Den Hartogh expected that the quotes could be improved but they were not able to justify that gut feeling.

To investigate if this gut feeling is justified the pricing performance of the business unit liquid logistic is investigated. Den Hartogh has a very large amount of quote related data available, but they do not have the tools to analyze it. They currently use a couple of parameters to determine the pricing performance, but these parameters contain too much error or do not give all the required information.

To improve the pricing analysis the equipment costs per order are added to the dataset using activity based costing. Also new parameters are introduced to measure the pricing performance of the quote. The first parameter is the job financial profit margin and it measures the profitability of the order. The second parameter, the network performance, is designed to show the value of a quote in relation to the network.

Besides that a quote must be profitable, a good quote should also be based on a solid prediction of the expected costs. Therefore the third parameter, the quote performance, shows how much the quoted costs deviate from the actual costs. A deviation is not a problem if all the costs can be passed on to the customer. This is measured by the pass on performance parameter. The last quote performance parameter is the margin performance. The margin performance measures if the quoted margin deviates from the actual margin.

These parameters are used to evaluate the financial quote performance of the business unit liquid logistic in the first nine months of 2011. The conclusion of this analysis is that the current quote structure does not provide guidelines to price the value of the quote in the network. Therefore a new quote structure is designed to include the value of the quote in the network. This is done by replacing the current market imbalance correction by a repositioning correction and a market correction. Both parameters can be calculated using the discrete-time Markov Chains. The market correction and the repositioning correction in combination with an optional repositioning surcharge can price the value of a quote request to the existing network.

The new quote structure is split in direct and indirect costs and profit. The direct costs are the costs that are related to the order in the financial settlement and consist of the operational calculation of the order and the repositioning correction. The indirect costs are the costs that cannot be found in the financial settlement of the order like the overhead costs, the repositioning surcharge and the market corrections. The last part of the quote is the profit, which is the only element the commercial manager can adjust. A strategy element is added in the profit part to incorporate possible strategic decisions by the management in the quote.
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1 Introduction
In this thesis a project conducted at Den Hartogh Group (Den Hartogh) is described. In the petrochemical transport sector it is a common practice to create quotes upfront, these quotes can have validity for over a year. Therefore it is essential that a quote accurately predicts the costs that will occur during the execution, to maintain its profitability. But in a transport market that has been hit by rising fuel prices, uncertainty from the Greek debt crises and continuing unrest in the Middle East, it is hard enough to be profitable in the first place.

Den Hartogh’s commercial department tries to create quotes that accurately describe the costs of the order execution. Quotes are often created upfront, this makes it challenging for the commercial manager. But the actual profit does not only depend on the quality of the quote, also on how well the operational departments processes the orders and the financial department settles the order. At the time the actual order is being executed the planning tries to plan the order as efficient as possible. Then it is the account manager’s responsibility to keep the customer informed during the whole process and if any problems occur the account manager will try to solve the problem. After the order is delivered the financial department of Den Hartogh gets involved, they have to send an invoice to the customer for the delivered service. Hence, there are a lot of different aspects that have an impact on the actual profit and the expected profit.

To see if the quote describes the reality accurate and is profitable, the main research question focuses on the pricing performance. To answer this research question the data and performance parameters are improved to be able to perform a data analysis. Allocation based costing is used to improve the data, to allocate for example equipment costs to a single order or a group of orders. The performance parameters are based on accounting practices and financial ratios to analyze the profit.

After the performance of the quote is analyzed and the poor performing elements are identified, a new quote structure is developed to improve the quote performance.

1.1 Research Questions
As mentioned in the introduction of this chapter many transport companies have to create quotes upfront. Therefore it is interesting to know which parameters can give information on how good the quoted rates are. Den Hartogh already uses several parameters to get an indication of the pricing performance, but the information they give is insufficient. Therefore first new parameters to measure the pricing performance must be found before the performance can be analyzed. Den Hartogh is especially interested in the pricing performance of its largest business unit, liquid logistic, because they create most of the quotes. This resulted in the following main research question:

What parameters must be used to analyze the pricing performance of the quote and using these parameters what is the pricing performance of the business unit liquid logistics?

1.2 Motivation
The motivation to investigate the pricing performance is twofold. First it contributes to the current literature on intermodal freight transport. Bontekoning (2004) argues that intermodal freight transportation research is an emerging research field and that it is still in a pre-paradigmatic phase. This means that it needs different models than uni-modal transportation and that there are still
models that are not developed. Macharis (2004) adds to that the literature and models concerning an intermodal operator are not yet created. Zhou and Lee (2009) also indicate that little is known about how to set the prices optimally in an intermodal transportation market, with empty equipment repositioning. By investigating the pricing performance of Den Hartogh, this Master Thesis will contribute to the pricing literature and because Den Hartogh is an intermodal operator it also adds to the merging research field of intermodal transport.

Next to the contribution to the existing literature the results of this master thesis project can give Den Hartogh more insights in its quote performance. This makes it possible to better identify key markets for profitable pricing initiatives, reduce equipment imbalances and thus improve profitability (Gorman, 2001).

1.3 The Case
Based on preliminary research done by Den Hartogh it is expected that the price setting of the quotes can be improved. The quality of the price setting depends on the accuracy of the predicted costs and revenues in the quote. If Den Hartogh is able to predict both the costs and the revenues accurately they are able to predict the profit and thus know at the time of quoting if an order request is profitable.

To measure if the price setting in the quote is accurate, the quoted costs and revenues must be compared with the actual costs and revenues. Den Hartogh already uses several parameters to get an indication of the pricing performance but the information they give is insufficient. Therefore first new parameters to measure the pricing performance must be found before the performance can be analyzed and possibly improved.

1.4 Scope
The pricing performance does not only depend on the performance of the quote, but also on the performance of the operations and the financial administration. This is shown in the preliminary cause-effect diagram in figure B1 of Appendix B4. Because the pricing performance is a broad concept, it is important to define clear boundaries on the research project. In this thesis only the pricing performance in the quote is taken into account. The operational and financial administrative performances that may have an impact on the pricing performance are not taken into account. Two improvement projects have already been started for the operational performance and the financial administrative performance is not in the span of control of the supervisors of this project.

Because the price-setting itself is also a very broad concept, the strategic motives behind the price-setting are left outside the scope. Thus it is assumed that the chosen quote strategy is the right strategy for Den Hartogh.

Den Hartogh is a company that consists of five different business units. Only the business unit liquid logistics is taken into account in this thesis. Liquid Logistics is by far the largest business unit of Den Hartogh and is therefore responsible for the creation of most of the quotes.

1.5 Literature Review
Macharis (2004) defines intermodal freight transport, based on the definition created by the European conference of ministers of transport in 1993, as:
“Intermodal freight transport is the term used to describe the movement of goods in one and the same loading unit or vehicle which uses successive, various modes of transport (road, rail, water) without any handling of the goods themselves during transfers between modes.” (Macharis & Bontekoning, 2004).

In the frameworks of the existing literature on intermodal freight transport by Macharis (2004) and Bontekoning (2004), the subject of the master thesis can be characterized as a pricing model of intermodal freight for an intermodal operator. As explained in the motivation of the master thesis project the literature on intermodal freight transportation is emerging. The consequence of an emerging research field is that not all types of models already exist. Little literature is written about both the intermodal operator as well pricing intermodal freight transport. But some literature exists on the components of pricing intermodal freight transportation. (Berckmans, 2012)

There are two different streams of research related to pricing intermodal freight transport. The first stream of work, often referred to as the empty equipment repositioning problem, focuses on optimal reposition strategies given the unbalanced demand flow in a transportation network. The second stream of research is about the pricing and competition in a transportation market. (Zhou & Lee, 2009)

Considerable work has already been done on the empty container repositioning problem. The first literature directly related to the problem is Cranic (1993), he created one of the first models which considered an inland empty container transportation problem and offered a general modeling framework for this class of problem. Yan (1995) developed a framework to include opportunity cost of empty repositioning in intermodal operations. The latest work on empty repositioning is done by Song and Tang. Song (2007) used Markov models to create an optimal stationary policy for both expected discounted cost and long-run average cost of empty repositioning. Tang (2009) surprisingly finds that profit may increase with price sensitivity and unit repositioning cost in a competitive market.

A pricing and demand related model is first described by Gorman (2001). The model first calculates the profit for all the markets and then uses Monte Carlo Simulation to estimate the demand in the different markets to come to a price recommendation. The closest to a pricing model for an intermodal operator is developed by Zhou and Lee (2009). They consider a two-location transportation market, including the repositioning of empty equipment. Based on a mathematical model, they develop a basic theory concerning the pricing behavior and competition outcome in such a market.

1.6 Structure of the Report
The research design of this project is based on the reflective cycle (Van Aken, 2007) and the regulative cycle (Van Strien, 1997), the design of the project is given in Figure 1.1. The structure of the report is as follows. First the problem context is described in chapter 2 to place the problem in a broader perspective. Next, special attention is paid to the profit breakdown in chapter 3 due to its importance for the research project. In chapter 4 the financial dataset is described and its summary statistics are given. Chapter 5 describes the validation of the problem stated in this chapter. To overcome the problem, the costs and revenues data are adjusted and new parameters are developed.
to measure the pricing performance of the quote. The improvements to the costs and revenues allocation and the new parameters are given in chapter 6. The results of the pricing performance analysis are discussed in chapter 7. Based on the pricing performance of Liquid Logistic a solution direction to improve the pricing performance is chosen and the chosen improvement direction is elaborated on in chapter 8. This thesis will conclude with an overall conclusion in chapter 9.

Figure 1.1: Research design
2 The Problem Context
To set the problem described in chapter 1 in a broader perspective, this chapter outlines the problem context. To do so the Den Hartogh Group, the business unit Liquid Logistics and the market situation are described.

2.1 Den Hartogh Group
Den Hartogh Logistics is privately owned by two partners Jack and Pieter den Hartogh. Their relative Jacobus Den Hartogh founded Den Hartogh in the 1920s as a grocery store. When in the 1950s the chemical industry was growing fast, Den Hartogh took this opportunity to carry the large demand of goods further into Europe. The result is a still ongoing international expansion. Belgium became the first branch abroad in 1970. Spain, Germany, Poland, France, Hungary, Switzerland, Italy and Turkey followed. The expansion of the international network has not stopped, last year Den Hartogh went intercontinental. The opening of new office-locations in 2011 and 2012 is planned in Houston, Dubai, Singapore and Shanghai.

Den Hartogh’s activities are aimed at providing creative solutions for their clients. The close contact with their clients allows Den Hartogh to achieve additional value within the logistics process. “This additional value is achieved by a combination of the following: optimization of resources, reduction of cost, optimum attunement of the logistics chain and increase in safety, health and environment.” (Den Hartogh Group, 2012)

Organization
Den Hartogh is a privately owned company with the daily control and management over the organization in the hands of the board of directors. The board is supported by several staff departments: SHEQ (Safety, Health, Environment and Quality), Finance & Resources, Marketing & communications, HRM and IT. The operations of Den Hartogh are divided into 5 business units, which can be seen in the organizational chart in Figure 2.1. The largest business unit is liquid logistics, because the main focus of this research project is on this department it will be described in more detail in the next paragraph.

Next to liquids, Den Hartogh is also specialized in gas logistics; it transports air, chemical and liquefied natural gases. The operation of these tanks takes place throughout Western, Central and Eastern Europe and involves distribution to multiple sites as well as full load deliveries. Den Hartogh Global has recently been founded specialized in intercontinental transport of bulk liquids with tank containers.

To make it possible to load new products effectively for the next transport Den Hartogh has spread their cleaning facilities over various locations in Europe. The last business unit that is not discussed is technical services this does what is says, it supports the fleet with service.
Liquid Logistics

Den Hartogh Liquid Logistics is the largest business unit and specialized in road and intermodal transport of bulk liquids for the chemical industry. The business unit Liquid Logistics is separated into two subunits: road and intermodal. Road deals only with single modal trucking shipments, while intermodal deals with all multiple modal shipments, like: ferry, rail and also road transport. Because it operates in this niche market its personnel and containers are well adapted and certified to deal with chemicals. In line with Den Hartogh’s mission statement Liquid Logistics describes its operations as follows: “Loading and discharging substances classified as hazardous involves creative solutions, this is our strongest point, delivering creative solutions individualized for each customer in different situations.” (Den Hartogh Group, 2012)

2.2 Customer Order

An order is the main element of analysis of the business unit. From the making of the quote up until the billing process, all actions are related to the initial order. Therefore this section describes the different phases a customer order goes through. The roles of the different departments in this process are described in Appendix C.

An order request of a customer can be new or based on an existing one. If an order request is new two extra actions have to be performed, a quote and thereafter a standard pre-order have to be created in the system. In Figure 2.2 these two different starting points for a customer request are shown, the five steps will be discussed in more detail below.

**Step 1: Quote**

If an order request is new, first a quote will be made to give an indication of the rate to the customer. In a quote the price will be specified for a particular lane, product and the period for which the quote is valid. The quoted price will be based on a quote specific calculation, overhead costs and a profit margin. Sometimes at the time of quotation not all information is available, therefore all the cost components that are include and excluded in the quoted price must been stated clearly in the quote.
It is important to understand that a lot of customers request multiple quotes at different companies and choose the economically most advantageous bid. This makes quotation also a strategic process.

**Step 2: Standard Pre-Order**

If the customer has accepted the quoted rate and places its first order a Standard Pre-Order (SPO) will be created. In an SPO a blueprint is created for all the orders that will follow on that particular lane. In an SPO at least the route and the route modalities are specified. First, it gives a description of the operational aspects of the execution of the order. Secondly, a template is created where later on invoice lines can be linked to. In this template so called zero lines can be added by the account manager as a reminder of possible costs that can occur.

**Step 3: Pre-Order**

If the customer specifies the product and the date of the shipment a pre-order, based on an SPO, is created. This means that the order is given a Den Hartogh order identification number. From this moment on expected costs and revenues can directly be linked to the order. If the order is near its due date the account manager has to feed the pre-order to the multiple day equipment planning. From that moment on the planning system will take the order into account when assigning equipment or drivers to orders. The multiple day equipment planning is an advance planning tool that tries to optimize the equipment allocation. In the multiple day equipment planning, depending on the order, a container or a road barrel will be assigned to the order. If a tank is scheduled, the order will be release to the truck driver planning.

**Step 4: Order**

If a pre-order has specified modalities it is called an order. When modalities are specified this means that all type of route modalities are known and can be planned in by the planning department. The truck driver planning will assign a truck to the tank and checks if the truck has a chassis and if the truck needs maintenance. When everything is planned the operation will execute the order as planned, if unexpected events happen the communication will go through the account manager.

**Step 5: Invoice**

The financial settlement of an order is done when the tank container or road barrel has picked up its next load. All the costs allocated to that particular order are known and can be invoiced by the account manager. When the invoice is ready it is send to the financial department for a final check and then to the customer.

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Figure 2.2: From request to billing
2.3 The Market Situation

Den Hartogh operates in a niche market as a service provider for the petrochemical industry. Most competitors are active in more than the petrochemical transport market only. In the Netherlands the most important competitors are De Rijke and Van den Bosch. In Europe Den Hartogh is also a top 5 player in the petrochemical transport market. European competitors are Bertschi, Hayer, Rinnen and Suttons. But one should realize that a large part of the international competition comes from smaller regionally operating transport companies.

Just as the market has begun to recover in 2010, the European economy has been hit by rising fuel prices and uncertainty from the Greek debt crises and the lower GDP growth expectations. Continuing unrest in Libya and other North African and Middle East countries has led to the highest crude oil prices since 2008. The rising demand for more sustainable transport is driving the growth of multimodal transport. Rail and sea, the two most energy-efficient modes, have a clear longer term advantage in this respect (Global Intelligence Alliance, 2011).

In 2010, world GDP grew by 3.6% (-2.3% in 2009) and exports are estimated to have grown 14.5%. The recession had a strong negative impact on transport but the sector is recovering. World container traffic is estimated to have grown 13% in 2010 while air freight grew by nearly 21%. Rail freight was hit hard by crisis and volumes fell by around 20% in 2009 on average. Rail freight is estimated to have grown by 8% in the EU and in Russia, with 11% growth. Road freight grew by a more moderate rate of 1.4% in the EU area and 10.3% in Russia, according to the estimates (International Transport Forum, 2011).

Freight volumes are still below peak levels for road and rail cargo. Despite positive developments, recovery in global freight transport is still uncertain and weak. Especially the recovery of the freight volumes in the EU area has been slower. Rail and road ton per km were still 16.0% and 13.5% below their pre-crisis levels in the last quarter of 2010. 

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3 Profit Breakdown

Essential when looking at the pricing performance is to have a good understanding of the profit structure, therefore this chapter discusses the profit breakdown in detail. Two different types of profit are used in the report: the quoted job financial profit and the job financial profit. The term ‘job financial’ refers to the database of Den Hartogh. Thus the quoted job financial profit (QJFP) is the profit used by Den Hartogh in its quotes and it is broken down into different elements than the job financial profit (JFP). The JFP is the actual profit after the execution of the order, given in the financial database. The different breakdown of both types of profit is discussed because if both types of profit are compared, to investigate the pricing performance, a good understanding of both types of profit is essential. In paragraph 3.1 the QJFP is discussed in detail and in paragraph 3.2 the same is done for the JFP.

3.1 The Quoted Job Financial Profit

If an order request is new, first a quote is made to give an indication of the rate to the customer. In a quote the price is specified for a particular lane, product and a period for which the quote is valid. The quoted price is based on a quote specific calculation, overhead cost and a profit margin. Sometimes at the time of quotation not all information is available. Therefore all the cost components that are included and excluded in the quoted rate must be clearly stated in the quote. The rate of a quote can be split up in three parts: the quote calculation, overhead and QJFP. In Figure 3.1 the breakdown of the quoted rate is shown. The remainder of this section is used to outline the three parts of the rate in more detail.

3.1.1 Calculation Operations

In the quote calculation a prediction is made of all the direct costs that will occur during the execution of the order and a market balance correction is added, which is explained in the paragraph below.

The quote calculation starts with determining the route of the order. When identifying the route of an existing quote the same trajectory can be used or a new route can be created. In case an existing quote is used the commercial manager has to check whether all the costs in the calculation are still up to date and if the trajectory is the preferred one. The route is determined by a build in route planner in the quote software, Transfusion. The route can be adjusted by the commercial manager as another route is preferable due to ferry or rail schedules/prices. When the route is known the expected trucking costs are calculated based on the kilometer rate. Depending on the country the toll cost are included, in some countries they can be looked up on internet sites of the toll company, in others it is estimated with a toll rate per kilometer. For an intermodal route these costs are included in the fares of the ferry or the train. Sometimes the load needs to be heated or cooled, than the expected costs are stated for heating. The costs for the documentation like custom’s papers are included in the documents cost. After a shipment is finished the container needs to be cleaned, the cost of the cleaning are fixed and given in cleaning costs. To pass on the costs of the used tank container or road
barrel, a fixed amount of equipment cost per day is quoted in equipment hire (Hire). If a tank container is used for a longer period than one month by the same customer, this is invoiced through a different invoice than that of the order, namely a sales order. This means that these equipment costs are not included in the quoted rate. For some large customers, like Huntsman and DOW, the Hire is standard included in a sales order, but this is an exception. If there are costs that do not fit in one of the categories described above they are quoted in the category other.

The cost described above are costs that occur during the execution of the order, there is another element in the calculation that tries to capture the imbalance of the European freight network. This element is the market imbalance correction (MIC) and is a correction for the difference between the market price and the required profit set by the management. It also includes some costs for expected empty repositioning. In chapter 8 this is explained in more detail, for now it is important to know that the quote has an element MIC. This parameter is quoted differently in the road and the intermodal department. The road department uses the MIC as a market correction and includes next to the MIC a surcharge for the repositioning kilometers to the nearest hub in Den Hartogh’s network. The intermodal department on the other hand does not use the MIC very often, most of the times they add an empty retour shipment. The only time intermodal quotes a MIC, is if they do not calculate an empty retour shipment. This is the case for example in Great Britain or in Finland. Due to Den Hartogh’s sector most of Den Hartogh’s customers are in the harbor areas in Western Europe. Shipments from these areas get a surcharge on their rate, a positive MIC as a correction for the high demand for liquid transport in the harbor areas and a limited amount of transporters. In the inland of Europe the situation is the other way around, the demand for liquid transport is lower and therefore to be competitive the quoted rate should be lower. By quoting a negative MIC the rate is lowered to be competitive in the market. The idea behind the MIC is a network balance, in other words that the discount given on the retour shipment should be equal to the surcharge of the shipment in the harbor areas. Den Hartogh uses the MIC as a fixed amount and changes it only once a year. The fixed market imbalance corrections sometimes include a discount used as growth strategy. The idea behind this discount is that by giving a discount the total amount of shipments will be larger, this will reduce the density of the network in that area and should therefore reduce the amount of empty kilometers driven to get to the next shipments. This method is mainly used by the road department and both departments would describe the intermodal department as more conservative. Due to the unclear definition of the MIC, it happens that the commercial managers quote the MIC not as MIC but in other categories in the quote.

3.1.2 Overhead & Profit
Next to the quote calculation the quote consists of an overhead and profit element. The overhead costs are a percentage of the quote calculation, to cover the expenses made by the supporting departments and other not directly to the order related costs. The management has determined that the overhead costs are set on [ ]% of the quote calculation for intermodal and for road this percentage is [ ]% due to the relative higher utilization of the overhead resources. For example an intermodal container that is placed on a ferry or train does not need any attention of Den Hartogh’s own personnel. But a truck can ask Den Hartogh’s personnel for assistance at all time. By linking the overhead cost of an order to the quote calculation, a larger part of the overhead costs are allocated to longer more expensive orders and smaller part to shorter inexpensive orders. Although both short and long shipments use for a large part the same amount of overhead, because both orders need a
quote and invoiced for example. To overcome this problem intermodal uses for orders to Russia a fixed amount of overhead

Quoted Job Financial Margin
All three quote elements described above account together for the quoted rate to the customer. The quoted job financial margin (QJFP%) is therefore the QJFP of order $i$ divided by the quoted rate of order $i$, this can be seen in Equation 3.1.

$$QJFP_{0i} = \frac{QJFP_i}{Quoted \ Rate_i}$$

### 3.2 The Job Financial Profit

The job financial profit is the profit calculated by subtracting the job financial costs from the job financial revenues. In Figure 3.2 a breakdown is given of the job financial profit and also of its sub-components job financial costs and job financial revenues. The remainder of this section is used to describe the breakdown of the job financial revenues and the job financial costs.

#### 3.2.1 Job Financial Revenues

The first part of the revenues and often the largest part of the total revenue is the freight revenue. The freight revenue is the revenue due to the original quote and should be equal to the quoted rate.

The quote tries to cover the expected cost as good as possible, but sometimes unforeseen costs occur. Account managers try to pass on this cost to the customer or other parties involved with the order. If they succeed in this, this will result in extra revenue. The extra revenue is split in the following categories: fuel loading, delivery, cleaning, heating, equipment and other. These categories are basically the same as those described in the quote. The quoted category trucking is split in the extra revenue categories fuel, loading and delivery.

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**Figure 3.2: Breakdown Job Financials**
due to the way the data is collected. An extra fuel surcharge is usually included in the quote as an additional agreement. The fast rising fuel prices have a significant impact on the profit. Therefore Den Hartogh has included a clause in the quote to pass on the extra fuel costs in a fuel surcharge. Extra equipment revenue is used for the days a shipment is late on the planned delivery date. The days between the delivery date and the next loading date are otherwise at Den Hartogh’s own expense and therefore in case of a late delivery these costs should be passed on.

As explained, when a tank container is used for longer than one month by the same customer this is invoiced through a sales order. The sales order equipment revenue is currently not included in the JFP because this is not directly related to the order invoice and therefore more difficult to allocate to an order.

3.2.2 Job Financial Costs
The job financial cost is the second component of the JFP and contains the order related cost. The costs are split up in different categories which are basically the same as the categories in the calculation part of the quote. The MIC is not a cost category because this is used to incorporate the unequal distribution of the profit in the network and is thus not a cost element.

For equipment costs a differentiation is made between own equipment and hired equipment. Hired equipment costs are booked directly on the order, while this is not the case for own equipment. Hired equipment is booked directly on the order because these costs occur during the order and can therefore easily be allocated to the order. The own equipment costs are a lot more difficult to determine because these costs occur during the whole lifetime of the equipment. For this reason this is not included in the job financial costs and therefore also not in the job financial profit. To be clear, the element hire in the job financial costs only contains the costs of hired equipment and not the costs of own equipment.

The overhead costs are also not directly related to an order and not invoiced through the order. Therefore the job financial database does not contain the overhead costs. Hence the overhead costs are currently not included in the job financial costs and thus also not in the job financial profit.

Job Financial Profit Margin
The JFP can be calculated by subtracting the job financial costs from the job financial revenues. To calculate the job financial profit margin (JFP%), the JFP of order $i$ is divided by the job financial revenues of order $i$, as is shown in Equation 3.2.

The equipment revenue that is invoiced through a sales order only occurs for a small amount of orders. Therefore the JFP% is in most cases too high, because equipment costs and overhead cost are not included in the job financial costs as explained above.

$$\text{JFP}\%_i = \frac{\text{JFP}_i}{\text{Job Financial Revenues}_i}$$  (3.2)
4 Data

The dataset used in the analysis part of this research project is described in this chapter. Den Hartogh collects a large amount of data in an internal data warehouse. The database consists of a large amount of operational, financial and administrational data. Sap Business Objects is used as platform to create reports and to subtract data from the data warehouse through queries. Queries are formulas made to specify which data elements must be subtracted from the data warehouse. Den Hartogh uses several weekly updated datasets to analyze the current performance, Job Financial Pivot and the Quote Financials are the two datasets used in the analysis. In the analysis the Job Financial Pivot and the Quote Financials are put together per order in one dataset, this dataset is referred to as the job financial dataset or financial dataset. In Appendix E the operational dataset is described but this set is not used in the analysis of the master thesis.

The job financial dataset is used to compare the quoted profit with the actual profit. The analysis performed in chapter 5 is based on this job financial dataset. Later on in the rapport extra data elements are added to the dataset. This will not have any effect on the original elements described in this chapter. In the remainder of this chapter the job financial dataset is discussed in more detail.

4.1 Financial Dataset

Every order in the dataset can be uniquely identified by its identification number. Per order the following general information is available: loading year and month, customer, product, invoice department (Rozenburg/Oss), account manager, commercial and the number of modalities it used. Most intermodal orders are created in Oss and most road orders in Rozenburg. Therefore a dummy is added to indicate if an order uses a road barrel or a container, to be able to separate the intermodal from the road operations.

Geographic

The database contains geographical information in three different aggregation levels: country, region and grouped region. These geographical levels are available for the loading location and for the delivery location. Also this geographical information is available for the previous delivery location and the next loading location, but only on country and grouped region aggregation level.

Operational

The total amount of kilometers covered by road transport during an order is recorded. A distinction is made between the kilometers covered with freight and the kilometers covered without freight, to reposition or to pick up the load. Also the total days of the order or in other words the total amount of time the road barrel or tank container is used by the customer is captured.

Quote

The offer to the customer done by a commercial manger is the rate. The rate is also differentiated in three parts: the calculation of the quote, the overhead and the profit. The quoted revenue is also differentiated in the expected cost categories of an order: trucking, toll, route, cleaning, heating, document, hire, other and MIC.
Next to financial aspects of a quote the database contains some expected operational information like the predicted amount of kilometers with freight, the predicted empty kilometers without freight and the expected amount of days the equipment is being used is included in the dataset.

**Actual cost and revenue**

All actual cost and revenue elements in the database are converted, if needed, to Euros. The main financial elements are the total revenue and the total actual cost of an order and resulting from these the JFP, as discussed in the previous chapter.

The database contains all sub-elements of the job financial revenue, these are the freight revenue and the revenue resulting from extra passed on costs: fuel, loading, delivery, cleaning, heating, equipment and other. Also all the sub-costs elements described in the previous chapter are included: trucking, toll, route, cleaning, heating, document, hire and other. It important to realize that hire cost are the hire cost for Den Hartogh, this does not include the cost of the usage of own equipment.

### 4.2 Data Selection

In the analysis not all data available in the dataset is used, the data selection and motivation is given in this paragraph. The orders that are loaded in January 2011 up until September 2011 are taken into account. The analysis focuses on road and intermodal orders of the operational department Liquid Logistics. Therefore only data from operational department Liquid Logistics and invoice departments Oss and Rozenburg are taken into account. The newly set up global department, used in the beginning the operational departments Oss and Rozenburg instead of global, because invoice department global did not yet existed. To correct the dataset for this, all shipment origins and destinations outside Europe are removed from the dataset.

The clearinghouse tries to sell or buy orders to/from third parties to optimize Den Hartogh’s own network. All orders that are handled by the clearinghouse are left out the dataset, because only a small amount of orders is handled by the clearinghouse department and is not the core business of Den Hartogh. The performance of these orders is largely dependent of the quality of the clearinghouse and not on Den Hartogh’s own performance.

Dedicated orders are also removed from the dataset because their equipment revenue cannot be allocated to a specific order. The reason is that dedicated orders use containers that are rented on a month or year basis and are invoiced on a single invoice (Sales Order),... but the impact on the analysis is minor because the pricing of dedicated orders is straight forward as discussed in chapter 8.

Finally, the orders in the dataset are checked on completeness and correctness. Therefore orders without cost or a quote rate are removed. This is less than 1 % of all orders in the database. Orders that do not meet the completeness requirements for further analysis are removed. That is why all orders without an order ID, previous delivery region or next loading region are also removed. The data requirements as described above are summarized in Table 4.1.
Table 4.1: Financial dataset restrictions

<table>
<thead>
<tr>
<th>Data Element</th>
<th>Restriction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Invoice Department</td>
<td>Liquid Logistics</td>
</tr>
<tr>
<td>Operations Department</td>
<td>Oss and Rozenburg</td>
</tr>
<tr>
<td>Loading Year</td>
<td>2011</td>
</tr>
<tr>
<td>Loading Month</td>
<td>1 t/m 9</td>
</tr>
<tr>
<td>Quote ID</td>
<td>Available</td>
</tr>
<tr>
<td>Previous Loading Region</td>
<td>Available</td>
</tr>
<tr>
<td>Next Delivery Region</td>
<td>Available</td>
</tr>
<tr>
<td>Rate</td>
<td>&gt;0</td>
</tr>
<tr>
<td>Cost</td>
<td>&gt;0</td>
</tr>
<tr>
<td>Clearinghouse</td>
<td>No</td>
</tr>
<tr>
<td>Dedicated</td>
<td>No</td>
</tr>
<tr>
<td>Equipment Days</td>
<td>&gt;0</td>
</tr>
</tbody>
</table>

### 4.3 Summary Statistics

The summary statistics are given in Table D1 of Appendix D. In this paragraph the data of Table D1 is discussed and some extra information is given.

Figure 4.1: Quote breakdown
Quoted Job financials
The quoted job financials are given in table D1 of Appendix D. The quote elements have a relative high standard deviation due to the broad scalar of orders Den Hartogh processes.

Job Financial costs and revenues
5 Validation of the Problem

In chapter 1, in the description of the case, the following problem is formulated: Den Hartogh is not able to analyze its pricing performance accurately, because the parameters it is using do not give complete and/or accurate information. Before any adjustments are made to the current situation it has to be validated if the problem is valid, this is done in this chapter. First, in paragraph 5.1 the currently used performance analysis parameters are described. Then the results, these parameters can generate, are shown in paragraph 5.2. This chapter concludes with a discussion on the results and a conclusion on the validity of the problem.

5.1 Existing Performance Parameters

Den Hartogh uses three different parameters to determine the pricing performance of a quote. The first parameter is the JFP% and is used to give information about the profitability of an order. The JFPDifference is the second parameter and is used to determine if there is a difference between the JFP and the QJFP. The last parameter, the Difference parameter per quote element, gives information about how good the predicted costs in the quote describe the actual cost. The JFP% that is used to show the profitability is described the previous chapter. In the remainder of this section the other two parameters are described in more detail.

JFP Difference

The JFPDifference parameter is developed by Den Hartogh and is used to see if the expected profit in the quote differs from the actual profit. Unfortunately it is not possible to simply compare the JFP with the QJFP due to the costs and revenues allocation issues described in chapter 3. In the JFP the cost of own equipment are not taken into account, while the QJFP does include equipment costs. Next to that not all equipment revenue is included in the JFP. And finally the overhead costs are not included in the JFP.

Because Den Hartogh is not able to include own equipment cost and overhead cost in the JFP, the indicated profit is much higher than it actually is, this would result in a false comparison with the QJFP. Den Hartogh tried to correct for this using an equipment costs correction and an overhead correction, as can be seen in Equation 5.1. A detailed description of both corrections and the derivation of the formula are given in Appendix F. It is important to understand that the JFPDifference of order \( i \) is calculated by subtraction the QJFP of order \( i \) from the JFP of order \( i \) and that two corrections are included to overcome the allocation problem of the costs and revenues of the order.

\[
JFP\text{Difference}_i = JFP_i - EqCostNegative_i - (QJFP_i - OverheadCorrection_i) \tag{5.1}
\]

Difference Quote Elements

The Difference parameter per quote elements gives information about how good the predicted costs in the quote describe the actual cost during the execution of the order. An overview of all quote elements can be seen in Figure 3.1 in chapter 3. To calculate the Difference per quote element the job financial costs of element \( c \) have to be subtracted from the quoted job financial costs of element \( c \). If extra job financial revenue of element \( c \) occurs this should be added to the previous subtotal. Equation 5.2 shows the formula to calculate the difference of quote element \( c \) in order \( i \). Equation
5.2 can be used to calculate the difference of the following quote elements: toll, cleaning, route, heating, documents and other.

\[
\text{Difference}_{c,l} = \text{Quoted Cost}_{c,l} - \text{Cost}_{c,l} + \text{Extra Revenue}_{c,l}
\] (5.2)

To determine the difference of quote element trucking Equation 5.3 should be used, due to the three different extra revenues corresponding with the trucking quote element.

\[
\text{Difference}_{\text{trucking},l} = \text{Quoted Cost}_{\text{trucking},l} - \text{Cost}_{\text{trucking},l} + \text{Extra Revenue}_{\text{fuel},l} + \text{Extra Revenue}_{\text{loadings},l} + \text{Extra Revenue}_{\text{unloadings},l}
\] (5.3)

5.2 Results
The results generated by the formulas currently used by Den Hartogh, are shown in this section.
Table 5.1: Current Pricing Performance Analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std Deviation</th>
<th>Min</th>
<th>Max</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profitability</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JFP%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difference in Profit (per order in Euros)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JFPDifference</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OverheadCorrection</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>EqCostNegative</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JFPDifference (with error, see Appendix F)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difference Quote Elements (per order in Euros)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Trucking</td>
<td></td>
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<tr>
<td>Toll</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Route</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cleaning</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Heating</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Documents</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

5.3 Discussion

The results of the analysis performed in the previous paragraph would indicate that on average the JFP% but less than the quoted profit and that the difference per quote element fluctuates per order. But the performed analysis is far from optimal and therefore there is a valid problem statement, in this discussion it is explained why.

JFP%

The JFP% is used to give information about the profitability of an order. But as already explained in chapter 3, the JFP% is in most cases too high, because Den Hartogh is not able to include equipment cost and overhead cost in the job financial costs. Equipment costs and revenues can differ per order due to the equipment used and the amount of costs that can be passed on to the customer. Therefore the change in JFP%, when equipment costs and revenues are included, can differ per order.

Although it is useful to know what the profitability of an order is, it is also useful to know the network value of an order. In other words, what effect has this order on the profitability of the other orders in the network? For example, this order can have a high profit but if the profit of the orders before and after this order will decrease to fit this order in the network, it would be valuable to know.

JFPDifference

The corrections made in the JFPDifference formula do not correct for a positive difference. The equipment cost correction is only made when the amount of actual equipment days is more than the quoted equipment days. If the equipment actually is used less time than quoted the JFP of the order
is not positively rewarded for consuming less equipment time. This will result in a slightly too negative difference between the quoted and actual profit. The same is true for the overhead correction, an overhead correction is only used when too little overhead will be allocated and not when too much overhead is allocated to an order.

The corrections made are both based on approximations which will result in some kind of error. More than 10 different kinds of equipment types per equipment category are being used. For example a container can be a single or multi compartment container with or without cooling, the same holds for road barrels. By using a fixed cost per day, difference in operational costs per equipment type are neglected. The difference between different types of containers or road barrels can be more than 10 euro a day and therefore influences the impact of extra days.

Also the actual amount of overhead used by an order will differ. Some recurring orders need less time of account managers, commercial managers and planners. Digital orders cost less time to process than an order by telephone. Quoted revenue is used as indicator of the amount of overhead needed for an order. This will lead to an error because most of the time spend on an order is the making of it, all further attention will cost less time. Thus using a percentage of the revenue will lead to a too low amount of overhead allocated to the short shipment and a too high amount to long shipment.

Finally, when the quoted profit is compared with actual profit this does not say anything about the return on capital. For example if the quoted profit is 100 euro resulting from 200 euro revenues and 100 euro costs, this parameter would indicate that there is no difference with if the actual revenue is 2000 and the actual costs are 1900. While your return on allocated capital is much lower.

**Difference Quote Elements**

Due to the missing equipment cost/revenue the quoted hire cannot be compared. Also the quoted MIC and the actual overhead have no actual cost to compare it with.

Unexpected events will always happen and cannot be prevented. Some of these unexpected events will lead to extra costs, but if Den Hartogh cannot be blamed than these extra costs can most of the time be passed on to the customer. Therefore the calculation of the extra costs on standalone basis does not tell the complete story, the amount of extra costs that can be passed on should also be known.

**5.4 Conclusion**

After the discussion of the existing pricing performance parameter it can be concluded that the problem stated in chapter 1 is valid. The parameters JFP% and JFPDifference do not give accurate information and all three parameters do not give all the information needed to perform a good pricing performance analysis.
6 Improvements in the Pricing Performance Analysis

In this chapter a solution is given for the problems that make a good pricing performance analysis (PPA) impossible. The first problem concerns the allocation of own equipment costs to orders. A solution for this problem is given in paragraph 6.1. Paragraph 6.2 presents a solution for the second problem, the allocation of the equipment revenue invoiced through sales orders. Paragraph 6.3 discusses a fix for the overhead, because the quoted overhead is also used as a parameter to adjust the profit and because the job financial overhead is not included. This chapter concludes with the introduction of new performance parameters in paragraph 6.4. These new parameters make it possible to draw more accurate conclusions about the pricing performance of one quote or a group of quotes.

6.1 Equipment Cost Allocation

The costs of own equipment are not included in the job financial costs because it is not a direct order cost. One piece of equipment is used for a lot of orders during its life. The total cost of the equipment must be spread over all the orders that use the equipment. The literature gives a solution for this problem; activity based costing. Activity based costing is a costing method based on the activity of the products (Garrison et al., 2003). Activity cost pools can be used to accumulate all costs that relate to the same cost type. Activity measures will allocate these accumulated costs to a single piece of equipment by its activity.

For every executed order the total days of equipment usage is known and given in the financial dataset. Therefore the equipment cost per day, per equipment type is needed to include equipment cost in the financial dataset. By multiplying the number of equipment days of order $i$ by the cost per day of equipment type $e$ used by order $i$, the total equipment costs for order $i$ can be calculated, the formula is given in Equation 6.1.

$$ Equipment\ Cost_i = Equipment\ Days_i * Equipment\ Cost_{i,e} $$ (6.1)

Some equipment costs are known only for the whole life time of an equipment piece, other per equipment category and other only for all equipment together. Therefore activity based costing is used to allocate these accumulated cost (cost pools) to a single day of equipment usage. The actual allocation of Den Hartogh’s equipment costs based on activity is shown in Appendix H1. The resulting equipment cost per day for the intermodal department is shown in Table H1 of Appendix H2 and for the road department in Table H2 of appendix H3.

6.2 Equipment Revenue Allocation

Next to the equipment costs also the equipment revenue, which is invoiced through a sales order, is not allocated to an order. In this paragraph a fix is given, but first a good understanding of a sales order is needed.

A sales order is not an order that needs to be executed by the operational department. It is a kind of dummy order created to invoice costs that are difficult to allocate to one freight order. The sales order is invoiced separately from the order because those are monthly returning costs and are therefore billed on a monthly basis. The most common posts on a sales order are the extra fuel surcharge and equipment revenue, but all quote elements can be invoiced through a sales order.
Equipment that is invoiced through a sales order is often used for dedicated orders and orders that are in rental. Equipment that is used for more than a month by one customer is put in rental. If a container is put in rental the cost cannot be allocated to a single order, therefore a sales order is made to invoice the costs. Dedicated orders often rent the equipment used for that order for the whole life time of that particular dedicated lane.

There are a several kind of sales orders. First, a differentiation is made between a general and an equipment sales order. In an equipment sales order all equipment related costs are invoiced that are not directly related to an order. An example of an equipment sales order is an invoice of the total amount of rental days. For some customers the equipment is invoiced through a general sales order, this is not preferable because it is difficult to separate the equipment costs from other costs. This makes it impossible to allocate the amount of cost to an order. Therefore the dedicated fleet is removed from the dataset. The equipment sales orders are included in the financial dataset as equipment revenue by matching the order ID of the sales order and the order ID of the freight order.

6.3 Overhead Solution

Two problems concerning the overhead costs are identified. First, the quoted overhead is used to adjust the profit and has little to do with the actual overhead costs. Second, the actual overhead costs are not included in the job financial costs. The overhead can be allocated using activity based costing. This will be difficult and time consuming to do. For example first a new activity measure has to be found, because the currently used activity measure is not perfect. Den Hartogh relates overhead cost to the revenue, this causes that too much overhead is allocated to long expensive shipments and too little to short inexpensive shipments. Also, it is difficult to determine the amount of time account managers and commercial mangers actually use to handle the order. A suggested approach by the financial controller and the commercial managers is to make half of the overhead cost fixed and the other half related to the quoted revenue. This is of course not the optimal solution but it is expected to be easy to implement and to be more accurate. Although this might improve the overhead in the future, it comes too late for the current analysis.

To overcome the problem in the current data, it must be realized that the overhead and profit are directly related. By increasing the overhead and keeping the rate stable the profit will drop. Therefore, to exclude unnecessary error in the analysis the overhead will be combined with the profit. If job financial profit and overhead is considered it is called Job Financial Margin (JFM) and in case of the quote Quoted Job Financial Margin (QJFM). If the overhead costs are included in the profit margin than the analysis can be performed without error. One should only realize that, when analyzing the results, the overhead must still being paid for. The improved structure of job financial costs, job financial revenues and quoted rate can be seen in Figure 6.1 and Figure 6.2.
6.4 Pricing Performance Parameters

In chapter 5, it is shown that the current performance parameters do not have the required accuracy and give the information needed for a good analysis. Therefore in this section new parameters are introduced to make a good PPA. A large part of the quotes are awarded through a bidding process. The customer draws up a detailed specification for a shipment of multiple orders of a product from one location to another and puts it out to a tender. All other things being equal the supplier with the lowest quote will be selected. Because the competition can be fierce, the first aspect of a good quote is that it remains profitable despite the competitive pricing. Therefore an obvious pricing performance parameter (PPP) is job financial margin%, which is based on the old JFP%.

**Job Financial Margin% (JFM%)**

The Job financial margin% (JFM%) is the job financial profit including, equipment cost and equipment revenue. But as discussed in the previous section, to overcome issues with the wrongly quoted and not accurately known actual overhead cost, the overhead costs are not included in the actual costs in this analysis. Thus, Equation 6.2 gives the profitability, excluding the overhead costs, of order \( i \) as percentage of the job financial revenues.

\[
JFM\%_i = \frac{\text{Job Financial Revenue}_i - (\text{Job Financial Cost}_i - \text{Overhead}_i)}{\text{Job Financial Revenue}_i}
\]  

(6.2)
Network Performance (NP)
The profitability is not equal in every region in Europe, in the harbor region there is a lot of petrochemical industry and due to the high demand the profitability is high. On the other hand the loading location more inland, where less petrochemical industry is settled, the profitability is lower. Due to Den Hartogh’s experience these differences are known and a market imbalance correction is quoted to give a discount in some regions and to get some extra profit in others. Hence, if the profitability of an order is examined, the MICs of the previous and next order should also be taken into account. If only the JFM% is considered an order can be described as poor while, in combination with the previous and next order, it performs very well. The next or previous order is based on the same equipment used in the next or previous order. Due to the financial settlement of an order, the costs are booked on an order from loading location to the next loading location. Thus if in the previous order a MIC is given of 100 euro and the repositioning cost are 150 euro the network performance (NP) of the order is not good (only considering the previous order). The MIC will give more positive result of the current order, while the cost of repositioning are booked on the previous. Therefore the previous MIC will only be included in the NP if the previous delivery location \(d_{i-2}\) is equal to the current loading location \(l_i\). If the previous delivery location is the same as the current loading location the repositioning costs are assumed to be neglect able. This problem does not arise for the MIC of the next order because all the repositioning costs are booked on the current order. The NP gives the profitability of an order as a percentage of the actual revenue including the MIC of the next order and of the previous order, if the previous delivery location is the same as the current loading location. The NP is given in Equation 6.3 and shows how good order \(i\) performs within the network of Den Hartogh.

\[
NP_i = \frac{JFM_i + MIC_{i+1} + MIC_{i-1} + I(d_{i-1} = l_i)}{Job\ Financial\ Revenue_i} \tag{6.3}
\]

Quote Performance (QP)
A good prediction of the direct order cost is essential to quote competitive prices (Fobber & Fahy, 2006). The costs of all known parts of the quote request should be priced using a full cost pricing method. In other words the actual operational order costs should be predicted as accurate as possible. The QP is the difference between the quoted operational costs and the actual costs as a percentage of the quoted rate. This gives an indication of how well commercial managers were able to predict the actual costs in the quote. The quoted operational cost is the result of the quoted operational calculation in the financial dataset minus the MIC of the order \(i\). This can be seen in Equation 6.4. Only the cost directly related to the order are included, because the indirect cost like the MIC and overhead are outside the span of control of the commercial manager.

\[
QP_i = \frac{Quote\ Calculation_i - MIC_i - Actual\ Cost_i}{Quote\ Rate_i} \tag{6.4}
\]

A more in depth analysis is also possible for the different quote elements. This can be done with the already existing Difference per quote element parameter given in Equations 5.2 and 5.3.

Pass on Performance (PP/PP*)
Because quotes are made using a competitor-oriented pricing method, this might involve not including all cost in the quote to get a lower rate. If that is the strategy the commercial manager
must be sure that if these costs arise, they can be passed on to the customer. This can be done by good marking out the quote with for example clauses. But extra costs can also arise due to unexpected events outside the span of control of Den Hartogh or due to faults made by Den Hartogh.

To show which percentage of the extra costs can be passed on to the customer, the pass on performance parameter can be used.

As explained above the pass on performance is the percentage of the extra costs that is passed on to the customer of order \( i \). It shows if the quote was market out good and if Den Hartogh is responsible for the unforeseen costs. The pass on performance is split in two different complementary parameters. The first parameter is the pass on performance if extra cost occur, given in Equation 6.5, it shows how much of the extra cost are passed on.

\[
PP_i = \frac{Total\ Extra\ Revenue_i}{Total\ Extra\ Cost_i} \quad |Total\ Extra\ Cost > 0
\]  

(6.5)

The second pass on parameter is the pass on performance if no extra costs occur. It happens regularly that no extra costs for Den Hartogh occur, but that account managers are still able to pass on costs. The PP* shows the percentage of the total costs that is acquired extra without having to pay for the extra costs, the formula is given in Equation 6.6.

\[
PP^*_i = \frac{Total\ Extra\ Revenue_i + Total\ Cost_i}{Total\ Cost_i} \quad |Total\ Extra\ Cost = 0
\]  

(6.6)

**Margin Performance (MP)**

The last performance parameter compares the JFM% with the QJFM%. The added value of this parameter is that it compares the quoted return on allocated capital with the actual return on allocated capital. For example if a quote is made with a profit of 10 euro and a rate of 100, the QJFP% is 10%. If due to extra cost and revenue the profit is still 10 euro but total revenue is 1000, the JFP% is 1%. Although the actual profit remains the same the return on allocated capital is much lower than quoted. The margin performance (MP) gives the difference between the JFM% and the QJFM% of order \( i \). Because the overhead is not include in the JFM it should also be excluded for QJFP in the analysis (QJFM%). The MP shows if the expected return allocated capital is realized and is given in Equation 6.7.

\[
MP_i = JFM\%_i - QJFM\%_i
\]  

(6.7)

**Order Group Analysis**

If a group of orders is analyzed instead of a single order the same formulas can be used. If the parameter used for the analysis of a group contains a division, the average of the result of the division should not be taken. All different elements of the division should be summed separately before the division is calculated. The JFM% of group A, consisting of the quotes \( i=1,2,3 \), is given as example in formula 6.8. The JFM% is also called the gross profit margin and is used as a common financial ratio by accountants and other financial experts (Garisson et al., 2003).

\[
JFM_A = \frac{\sum_{i=1}^{3} Actual\ Revenue_i - \sum_{i=1}^{3} (Actual\ Cost_i + overhead_i)}{\sum_{i=1}^{3} Actual\ Revenue_i}
\]  

(6.8)
7 Pricing Performance Analysis
The new pricing performance parameters developed in the previous chapter are used in this chapter to analyze the pricing performance of the business unit Liquid Logistics. The results of this analysis are given in paragraph 7.1. These results are discussed in paragraph 7.2 and the conclusions are stated in paragraph 7.3.

7.1 Results
In this section the pricing performance of Den Hartogh’s road and intermodal department is analyzed. The analysis is based on the financial dataset described in chapter 4 and the pricing performance parameters introduced in the previous chapter. The analysis can be performed from an enormous amount of perspectives, different in detail, subject and time period. To answer the research question a broad perspective is chosen. The quote performance analysis is based on the month of ordering, product group, equipment type, customer, commercial manager, account manager and on grouped region for each department. The most interesting results are discussed in the remainder of this section.

<table>
<thead>
<tr>
<th>Month/Department</th>
<th>N Orders</th>
<th>Average JFM%</th>
<th>Average MP</th>
<th>Average NP</th>
<th>Average QP</th>
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In Table 7.1 the PPA results are shown for the Liquid Logistics as a whole and per department.
This section continuous with a more detailed discussion, reported per department, product group, equipment type, customer, commercial manager and account manager and by grouped region.

Figure 7.1: Average JFM% over time

Departments

The results are given in table 7.1.
Equipment type

The differences in equipment cost can be made more visible due to the improved allocation of the equipment costs. The actual costs per equipment type are determined by activity based costing and therefore give a good indication of the cost per equipment day. The results per equipment type are given in Table 7.3. The consequence of the new equipment cost allocation is that the quotes of the most expensive equipment types are quoted at a constant loss. The new allocation of equipment cost does not only affect the PPA of equipment but also the other analyses. For example the more difficult to transport product groups use the more expensive equipment type, the result of these product groups are thus also poor. This can be seen in Table I1 of Appendix I.

Table 7.3: Equipment Type PPA

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>N Orders</th>
<th>Average JFM%</th>
<th>Average MP</th>
<th>Average NP</th>
<th>Average QP</th>
<th>Average PP</th>
<th>Average PP*</th>
<th>Number of PP*</th>
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Table 7.4: Customer PPA

<table>
<thead>
<tr>
<th>Customer</th>
<th>N Orders</th>
<th>Average JFM%</th>
<th>Average MP</th>
<th>Average NP</th>
<th>Average QP</th>
<th>Average PP</th>
<th>Average PP*</th>
<th>Number of PP*</th>
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</table>

Commercial and Account Manager

A good commercial manager makes profitable, realistic quotes that are good marked out. This means that they should have a very high PP because the quotes are good marked out and a QP around zero due to a good cost prediction and are still profitable. In Table 7.5 differences can be seen between the commercial managers. Of course numbers do not tell the whole story and the product, customer, regions and situation also determine how the numbers should be interpreted.

The same can be done for account managers, account managers have less influence on the price setting, but more on the pass on performance. In Table 12 of Appendix I differences on pass on performance can be seen. Some account managers are able to pass on more than 100% of the extra cost while others can pass on only half of the extra. But one should be reluctant in drawing to hasty conclusions, because some of the account and commercial managers manage only the account of one customer and this can be an easy or difficult one.

Table 7.5: Commercial Manager PPA

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<tr>
<th>Commercial Manager</th>
<th>N Orders</th>
<th>Average JFM%</th>
<th>Average MP</th>
<th>Average NP</th>
<th>Average QP</th>
<th>Average PP</th>
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Grouped Regions

The imbalances within the European freight network are clearly visible in the Tables I3 and I4 of Appendix I. The differences in number of orders delivered and loaded in a region also underline the existence and impact of the imbalances. There are numerous interesting conclusions to draw out of Table I3 and I4, the most important ones are given.

First, this is done for the intermodal department. If only a small amount of orders are delivered in a region than the quotes are too positive most of the time, in most cases this will result in a loss.

7.2 Discussion

For now only a tiny bit of all the data is analyzed, although enough to draw conclusions on the quote performance. A more detailed analysis based on customer, product group or equipment type might give other interesting results.

This is the first time equipment costs are included in an analysis, which will result in new insights in the profitability. Because the actual equipment costs were not known, an approximation was made, this was not always very accurate and results now in a low QP and JFM% for the more expensive equipment types and product types, but might have also an effect on other PPAs.

As discussed in previous chapters, the MIC is quoted differently by the road and intermodal department. The road department quotes the extra trucking cost due to the imbalance in the trucking category and the other imbalance cost as MIC. While the intermodal department books all costs as MIC, both calculate sometimes an empty return instead of a MIC. In the financial dataset it is almost impossible to allocate all these different MIC related costs to the MIC. Therefore the actual intended MIC by the customer can deviate from the MIC used in the analysis. This deviation can be either positive or negative. This will have an impact on the QP and the NP. To overcome this problem the MICs of the previous and next order are recomputed. This is done based on the information of the MIC calculation method used in the departments, the delivery location and the loading location. The calculation method of the MIC is based on the experience of the commercial directors and is thus subjected to the opinion of the commercial managers, which might introduce error into the calculation. This error resulted in an unusable NP.

The grouped region analysis is based on the grouped regions defined by the strategic management by Den Hartogh. The classification of the grouped regions may impact the results. If other regions were defined the results might have been different.
In the calculation of the NP the repositioning costs are assumed to be negligible if the previous delivery location is the same as the current loading location. Because the analysis is based on grouped region which can be as large as Spain and Portugal together this assumption seems too positive. The actual network performance will be lower, due to the higher repositioning costs.

The road department gives in some regions a discount to attract more freight, increase the density of the network and decrease the cost of repositioning. In the analysis this kind of discount will result in a lower JFM and a worse quote performance, although this is intentionally done. There is not a guideline for the amount of discount given. Therefore it is difficult to filter the intentional discount out of the dataset.

7.3 Conclusion
In this chapter the pricing performance parameters are used to analyze the pricing performance of the first 9 months of 2011. But the actual costs are on average larger than quoted and only of these extra costs can be passed on to the customer. Therefore the quotes in general can improve on their cost prediction. An important factor of these extra costs is the trucking cost, due to a bad prediction of the empty kilometers. This may indicate that commercial managers are too optimistic about how well orders fit in the network. This in combination with a different quoted MIC by both departments gives a strong indication that the prediction of how well an order fits in the network is below the mark. The newly determined equipment prices result in differences in the profitability between the equipment types. The equipment prices should be adjusted in future quotes to improve them. Also some customers, products and regions in the intermodal and road network are identified as unprofitable and need a closer look to determine their value to Den Hartogh’s Network.
8 Improved Quote Structure

Based on the conclusions drawn in chapter 7, several solution directions are developed to improve the pricing performance. An overview of the developed solution directions is given in Appendix J. The solution to create a new improved quote structure is elaborated on and outlined in this chapter. One of the arguments to improve the quote structure is the MIC, which is inconsistent and inaccurately quoted. To improve the MIC it is split into a market and a repositioning correction, the decision is described and clarified with an example in section 8.1. In section 8.2 the new quote structure is outlined. This structure is better analyzable and less adjustable to minimize the chance on unnecessary poor estimations by the commercial manager. The calculation model for the in section 8.1 introduced repositioning and market correction is derived in section 8.3. In sections 8.4 and 8.5 this calculation model is verified and the validated. Then, in section 8.6 the adjustments of the in chapter 6 given PPP to the new quote structure are described and this chapter concludes with a discussion in section 8.7.

8.1 Network value of an order

Before the new quote structure can be introduced it is important to first understand the expected network value of the quote. The concept of network value is explained in this paragraph.

If a customer request arrives it will be in the form of: *What is your rate for a shipment of product X from loading location L to delivery location D?*

With the help of a good route and modality planner, in combination with a good description of the request, the commercial manager can predict the direct cost of such an order request reasonably accurate. The difficult part of the valuation process is to value how well this order request fits into the network. At the time of quoting the commercial manager does not know what the delivery location of the previous order and the loading location of the next order will be. To get a better understanding of which factors have an impact on how well an order fits in the network an example is given.

![Figure 8.1: Example MIC](image-url)
Example

In figure 8.1 two scenarios are shown of what can happen with the equipment before and after the shipment from the Netherlands (NL) to the United Kingdom (UK). How well a shipment fits in the network depends on how well the loading and the unloading location of that shipment fit in the network. Hence, the loading and unloading location can be valued separately.

The value of fitting the loading location Netherland in the network depends on if the previous shipment is delivered in the Netherlands or if it is repositioned to the Netherlands. In scenario A the situation is shown in which the previous shipment is delivered in the Netherlands. Due to the imbalance in profitability in Europe’s freight sector not in every region the required profit can be acquired. The required profit depends on the targets the board of directors set, this can be for example 5% of the calculated costs. In scenario A the difference with the required profit is -10 euro. Thus on average a delivery in the Netherlands ‘costs’ Den Hartogh 10 euro. This difference is called the market correction (MC), because this is the extra profit that must be acquired in the current order to compensate for this unprofitable loading location. On the other hand if the previous order is not delivered in the Netherlands it has to be repositioned. In Scenario B this is shown and the repositioning correction (RC) to fit the order in the network is -50 euro. Thus on average a repositioning to the Netherlands costs 50 euro. Also if the previous order is delivered in NL there are repositioning costs, but they are relatively small compared to the RC outside NL and ignored for now. To answer the question how well fits the loading location NL in the network, the MC has to be multiplied by the chance that the previous order is delivered in NL and added to the RC multiplied by the chance that the previous order is not delivered in NL.

The same valuation can be done for the delivery location UK. In scenario A the MC for loading location UK is -100 euro, thus on average loading in the UK ‘costs’ Den Hartogh 100 euro. On the other hand if the previous order is not loaded in the UK it has to be repositioned. In Scenario B this is shown and the repositioning correction to fit the order in the network is -150 euro, thus on average a repositioning from the UK costs 150 euro. To answer the question, how well fits the delivery location UK in the network, the MC has to be multiplied by the chance that the next order is loaded in the UK and added to the RC multiplied by the chance that the next order is not loaded in UK. If we add the values of how well the delivery and location fits in the network the total cost of fitting the shipment in the network are calculated. In this example all the corrections are negative but in reality these can also be positive. The calculations of the corrections are described later in this chapter.

Currently Den Hartogh uses the MIC to value how well an order fits in the network. The MIC is based on the expertise of the commercial manager, but as is shown in the previous example the MIC can be calculated if it is split in a MC and a RC. The financial settlement of an order in Den Hartogh’s financial dataset is based on orders defined as: from one loading location to the next. To estimate the MC and RC the financial dataset is needed, thus the impact of this financial settlement must be known.

The market correction is a reallocation of profit needed due to the imbalance in the profitability in Europe’s freight sector. By including the previous and next market correction in the quote calculation, profit is not counted double or is not removed. Therefore the financial settlement does not affect the MC. The repositioning correction on the other hand is included in every quote to
foresee in the cost to get to the next loading location. If the account manager calculates the expected cost of repositioning to the Netherlands and the expected costs of repositioning from the UK, some of these costs are paid for twice. The previous order also calculated the expected cost of repositioning and is therefore included in the financial settlement of the previous order. So, that raises the question if the expected repositioning revenue of the previous order is sufficient to cover the repositioning costs of the current order. The answer is yes, if it is assumed that all orders fit equally well in the network. In other words the distance to the next load should be equal for every delivery location. In practice this is only the case in a very dense freight network in which the expected distance to the next load is equally small in each delivery location.

To cope with this assumption a core area must be identified in Den Hartogh’s freight network, the regions included in this area are the expected next loading locations. For these regions it is assumed that the distance to the next loading location should be equal for every delivery location. The RC from the previous delivery location is deleted because the RC to the next loading location in the previous order is sufficient. If a quote is requested with a loading location outside this area a repositioning surcharge should be included in the quote to pass on the extra repositioning cost to the customer.

8.2 Quote Structure

The current quote structure of Den Hartogh leaves too much room for subjective decisions by the account managers. Account managers not only adjust the profit of an order but also the overhead and the MIC. Currently it is possible to lower the overhead percentage to increase the profit, at first glance the quote appears to be very profitable, but in reality the overhead costs are hidden in the profit. This makes it very difficult to analyze the quote data, let alone that the commercial manager precisely can oversee what he is doing. Therefore a new quote structure is described in this section in which the commercial manager only can adjust the profitability. By making profit the only adjustable parameter in the quote it is always clear if the quote is expected to be profitable or not. This fixed quote structure will also make the quote performance better analyzable. This new quote structure is given in Figure 8.2. Three different quote categories are distinguished, the direct order costs, the indirect order costs and the profit. The three categories will be explained in more detail in the remainder of this paragraph.

8.2.1 Direct Elements

The elements of the direct order costs category are: the calculation of the requested order and the repositioning correction. This category is called the direct order costs because the costs quoted in this category can be, if the order is executed, directly related to the order in the financial settlement. Because the profit is the only element that is adjustable in the quote, these costs need to be predicted as accurate as possible. To do so, the direct costs are priced using a method called full cost pricing (Fobber & Fahy, 2006). This method should ensure that the quoted price is equal to the expected costs. A more detailed description of the direct elements is given below:

Operational Calculation

The calculation remains basically the same as in the current quote structure. The costs of trucking, toll, route, cleaning, heating, documents, equipment and the other cost are as accurately as possible predicted in the calculation. The only difference with the current calculation is that the MIC is removed from the calculation.
Repositioning Correction
The repositioning correction is, as described in the previous section 8.1, the expected cost of repositioning to the next loading location. The calculation method of the repositioning correction is given in the next section 8.3. The commercial manager does not have to calculate the repositioning correction, this is done beforehand. If the calculation of the repositioning correction is integrated in the quote software, it is automatically included in the quote if the commercial manager defines the delivery location of the requested order. If the repositioning correction is not integrated in the quote software the commercial managers have to look up the values in pre-calculated tables.

8.2.2 Indirect Elements
The elements of the indirect order costs category are: the overhead, the markets corrections and the repositioning surcharge. This category is called the indirect order costs because the costs quoted in this category are not included in the financial settlement of this order. The overhead costs are stated in the profit and loss account and the cost of the extra repositioning are included in the financial settlement of the previous order. The market corrections serve only as a valuation of the order in the network and are not included in any statement. The costs in this category are priced, like the direct costs, using full cost pricing (Fobber & Fahy, 2006). This method should ensure that the quoted price is equal to the expected costs. A more detailed description of the indirect elements is given below:

Overhead
The overhead cost should not be adjustable. Ideally the overhead costs are calculated using activity based costing (Garisson et al., 2003). If this is not possible, an as good as possible approximation of the actual overhead costs of the requested order is preferred. For example a 50% fixed overhead and a 50% variable overhead cost based on the turnover of the order. Other possibilities would be based on modality or, like the global department, based on the amount of order days.

Previous Order Market Correction/Next Order Market Correction
The previous and next order market correction are a reallocation of the profit, this is done to include the value of the order to the network into the quote. The market corrections are introduced in the previous section 8.1 and their calculation method is described in section 8.3. The commercial manager does not have to calculate these correction factors, this is done be forehand. If the calculation of the market corrections is integrated in the quote software, they are automatically included in the quote when the commercial manager defines the loading and unloading location of the requested order. If the market corrections are not integrated in the quote software the commercial managers have to look up the values in pre-calculated tables.

Repositioning Surcharge
The surcharge is an optional quote element which is needed due to the job definition Den Hartogh uses. The financial settlement starts when an order is loaded and ends when the next order is loaded. The costs of an unexpected loading location of the current order are settled in the previous order. To compensate for that a repositioning surcharge is used. As is described in the previous section 8.1, it is only used for loading locations outside the core area of Den Hartogh’s network. Because the loading location is not part of the core area, it is assumed that near that loading location no equipment is available and that it has to be repositioned from the core area. Therefore the surcharge is the extra repositioning cost to get from the core area to loading location outside the
core area of Den Hartogh’s network. The commercial manager can calculate these costs by calculating the expected kilometers from the loading location to the boarder of the core area with a route planner, and multiplying it by the trucking rate per kilometer plus the equipment costs per kilometer.

8.2.3 Profit
The profit is the last quote category and the only category that is adjustable, although it should always be optimized. In the transport sector the quoted rates are based on competitor orientated pricing (Fobber & Fahy, 2006). Therefore the commercial manager should try to get an as high as possible rate at first, when that is done this rate can be adjusted by the determined strategy factor by the commercial director/board of directors. For example if the maximum rate a commercial manager expects to be possible is 1500 euro and the strategy is to penetrate the market and give a five percent discount on the maximum rate, 75 euro, then the quoted rate is 1425 euro. The reason to split strategy and profit is because profit is mainly a check if the required profit is acquired before the strategy decisions are incorporated in the rate.

Profit
The profit is the only element in the quote that can be adjusted by the commercial manager. It is the task of the commercial manager to optimize the profit. Due to the competitor orientated pricing (Fobber & Fahy, 2006) contracts are awarded through a competitive bidding process. Because all other elements of the quote are known, the commercial manager should try to discover the maximum possible market rate and compare that to the required profit determined by the management. A possible pricing strategy decisions should not be included in the comparison. Without a good reason the order request should only be accepted if the expected profit is equal to or larger than the required profit.

Strategy
The management of Den Hartogh wants to double its revenue in the next five year and therefore it has adopted a growing policy. The pricing of the order should be in line with the firm’s competitive strategy (Fobber & Fahy, 2006). The strategy is determined by the management for a region or a product group and cannot be adjusted by the account manager. Fobber and Fahy (2006) distinguish between four pricing objectives that determine the pricing strategy:

- **Build objective**: For a price-sensitive market, like the areas with more imported than exported freight, a price lower than that of the competition is set to penetrate the market. If the competition increases its price Den Hartogh would be slow to match it. For price-sensitive markets the best pricing strategy will depends on the thought appropriate strategy for the product.
- **Hold Objective**: If the management wants to hold the current sales or market price, the pricing strategy would be to match or maintain the price relative to the competition.
- **Harvest Objective**: If the management wants to harvest this implies that the profit margins are increased even though sales or market share are falling. For an area that is being harvested there will be a reluctance to match price cuts, on the other hand price increases would swiftly be matched.
- **Reposition Objective:** If market conditions change, it can happen that the chosen strategy in an area has to be changed, repositioned. This may involve a price change, the magnitude and direction are based on the changed conditions and new strategy.

![Diagram showing the improved quote structure]

**Figure 8.2: Improved Quote Structure**

### 8.3 Calculation method RC and MC

Currently the commercial managers use the MIC to price the imbalance in freight flows in Den Hartog’s network. When there is an imbalance, imbalance cost arise because the market rates in some regions are lower and there is less or no retour load available. While in other regions, due to the high amount of freight offered, prices and the chance on freight are above average. Den Hartog’s MIC is currently based on the commercials managers’ market expertise and does not make a clear distinction between the chance on a return load and the difference in required rate and market rate in a region. Although the road department at least tries, in contrast with the intermodal department, to separate the expected empty trucking and the expected difference in market price, it
is still based on the subjective vision of the account manager. In this section a mathematical model will be derived to price the imbalance costs. Instead of one correction, currently the MIC, the correction is split in a market correction (MC) and a repositioning correction (RC). The MC is a correction made for the expected difference between the required rate and the market rate in a region and the RC comprises the cost of expected empty repositioning to a region.

This separation is done because of computational reasons, the RC is based on expected repositioning kilometers and the MC is based on expected difference from the required JFP, which are two separate calculations. Also the RC contains direct operation related costs and can directly be seen in the financial settlement of the order. On the other hand the MC is only an expected deviation from the required rate and cannot directly be seen in the job financials. The last reason to separate the MC and the RC is that they are related but their existence can have different causes. Den Hartogh’s market rate in a region depends on Den Hartogh’s position in a region, but also on the supply and demand (Fobber & Fahy, 2006). The RC depends also on the supply and demand in a region, because if there is no demand than the equipment has to be repositioned. The supply and demand in a region not only depends on the market, but also on Den Hartogh position in the region. If there is for example more supply than demand and Den Hartogh is able to ship all existing demand, the RC of Den Hartogh will be low but the MC can still be negative. So, to get a better insight in what is going on in a region both types of correction are split.

The MC and the RC depend on how the regions are defined for which they are calculated. The larger the region the more data is available to calculate both parameters, but the less accurate they become. If the regions are chosen too small there is not enough data available for all regions to accurately estimate the parameters. On the other hand if the chosen regions are too large existing imbalances within the region can be hidden, which will make the parameters unreliable. In order to make a better analysis of their network possible, Den Hartogh has identified so called “grouped regions”. The grouped regions are classified by hub location and can cover a small part of a country to multiple countries, depending on the most important hub locations of Den Hartogh’s network. The calculation of the RC and MC is done by these grouped regions. In appendix A, Table A3 an overview of these grouped regions is given.

Liquid Logistics consists of a road and an intermodal department. The road department uses road barrels and operates mainly in the Benelux and the neighbor countries. The intermodal department uses containers and operates in West, Central and South Europe, Great Britain, Scandinavia and parts of Eastern Europe. Because the equipment is not interchangeable between the departments and the operating areas are so different the RC and MC should be calculated separately for the road and intermodal department. The calculation method that is outlined in the upcoming paragraphs is the same for both departments. In paragraph 8.3.1 a start is made by describing the chance of load in a next region in the form of a discrete-time Markov chain. This Markov model will be used in paragraph 8.3.2 to calculate the RC and in paragraph 8.3.3 to calculate the MC.

### 8.3.1 Discrete-Time Markov Chain

The key to determine the market and repositioning correction is to know the probabilities of the next loading location. This is important because Den Hartogh defines the job financial of an order from loading location till the next loading location. For example, to calculate the expected repositioning
kilometers of an order, it is essential to know where the next loading location is expected to be. A quote is made before the order is actually planned and the equipment is allocated. Because the order is not yet planned at the time the quote is made, it is assumed that the next loading location is not known and depends only on the current delivery location. This memoryless property is called the Markov property (Kulkarni, 1999).

\[ X_t \] is the state of Den Hartogh’s network at time \( t \). The state of ‘the equipment distribution’ over the network determines the transition chances of a single piece of equipment in the network. Therefore a stochastic process \( \{X_t, t>0\} \) on state space \( S \) is said to be a discrete time Markov chain (DTMC), if for all delivery regions \( d \) and all next loading regions \( l \) in \( S \),

\[
P(X_{t+1} = l|X_t = d, X_{t-1}, ..., X_0) = P(X_{t+1} = l|X_t = d) \quad (8.1)
\]

Equation 8.1 implies that given the present state of the system \( X_t \) the future state of \( X_{t+1} \) is independent of the past \( (X_0, X_1, \ldots X_t) \). For now it is also assumed that the chance that the next load is in region \( l \), when the current load is delivered in region \( d \) is the same over time \( (X_0, X_1, \ldots X_t) \). This assumption is given in Equation 8.2. In paragraph 8.4.1 this assumption is tested with the financial dataset, but for now it is assumed it holds. DTMC \( \{X_t, t>0\} \) is time homogeneous if for all \( t = 0, 1, \ldots, \)

\[
P(X_{t+1} = l|X_t = d, \ldots) = P(X_1 = l|X_0 = d) \quad (8.2)
\]

Given the two assumptions described above, the one-step transition probability of the DTMC at time \( t \) can be calculated with Equation 8.3. In words this formula determines the chance that if the current load is delivered in region \( d \) the next loading region is \( l \).

\[
n_{d,l} = P(X_{t+1} = l|X_t = d) \quad l, d = 1, 2, \ldots, N \quad (8.3)
\]

If the one-step probabilities are arranged in an \( N \times N \) matrix as is shown in Equation 8.4, it is called the transition matrix \( P_n \). The transition matrix rows correspond to the delivery regions and the columns to the next loading regions. Thus the probability of going from delivery region 3 to next loading region 4 is given in row 3 and column 4. The transition matrix \( P_n \) will be used to calculate the RC and the MC next order.

\[
P_n = \begin{bmatrix}
n_{1,1} & n_{1,2} & \cdots & n_{1,N} \\
n_{2,1} & n_{2,2} & \cdots & n_{2,N} \\
\vdots & \vdots & \ddots & \vdots \\
n_{N,1} & n_{N,2} & \cdots & n_{N,N}
\end{bmatrix} \quad (8.4)
\]

8.3.2 Calculation Repositioning Correction

In the quote the expected costs of the order are calculated in the calculation part of the quote. The expected costs in the calculation only include the cost from loading till delivery of the order, because those are the two locations known at the time of making the quote. The job financial order starts at the same loading location but ends at the next loading location instead of the delivery location. The costs of repositioning to the next loading location are not included in the calculation because the next loading location is not yet known. Den Hartogh tries to include these costs in the MIC but has no calculation method available to calculate the expected repositioning cost, thus it is subjected to the
opinion of the commercial manager. If there is freight in the delivery region of the current order the repositioning costs will be relatively small, but if the next freight is in another region far from the current region the repositioning cost can be a very significant part of the total costs of the order.

In this paragraph only the general model for calculating the repositioning correction is derived, therefore the core area that is mentioned in previous paragraphs is not yet applied. The adjustments to the general model if a core area is used are outlined in paragraph 8.4.3.

In this model it is assumed that the repositioning is done by truck only. If the repositioning can also be done by other modalities, the same method can still be used, only the expected repositioning costs of these other modalities must be included. To calculate the expected costs of reposition, or short Repositioning Correction (RC), in delivery region \(d\), first the expected amount of repositioning kilometers for each delivery region needs to be calculated. This is done by taking the average amount of empty kilometer in the financial dataset to next loading location \(l\) given the delivery location \(d\). Equation 8.5 gives the expected amount of repositioning kilometers \(k_{d,l}\) to the next loading location \(l\) given the delivery location \(d\).

\[
k_{d,l} = E(\text{Repositioning kilometers}) \mid X_{t+1}=l \text{ and } X_t=d \quad l, d = 1, 2, \ldots, N \tag{8.5}
\]

For now it is assumed that \(k_{d,l}\) also has the Markov memory less property and is time homogeneous. In paragraph 8.4.1 this assumption is tested. The expected amount of repositioning kilometers for all loading locations, given all delivery locations are organized in matrix \(K\) (Equation 8.6).

\[
E[\text{Repositioning km}] = K = \begin{bmatrix}
k_{1,1} & k_{1,2} & \cdots & k_{1,N} \\
k_{2,1} & k_{2,2} & \cdots & k_{2,N} \\
\vdots & \vdots & \ddots & \vdots \\
k_{N,1} & k_{N,2} & \cdots & k_{N,N}
\end{bmatrix} \tag{8.6}
\]

If a shipment is delivered in location \(d\) there is a chance that the next loading location is \(l=1, l=2, \ldots, l=N\). To take this chance into account, the transition matrix \(P_n\) has to be multiplied by expected repositioning kilometers, matrix \(K\). The result of the multiplication is matrix \(R\) and is given in Equation 8.7.

\[
R = P_n \ast K = \begin{bmatrix}
r_{1,1} & n_{1,2} & \cdots & n_{1,N} \\
n_{2,1} & n_{2,2} & \cdots & n_{2,N} \\
\vdots & \vdots & \ddots & \vdots \\
n_{N,1} & n_{N,2} & \cdots & n_{N,N}
\end{bmatrix} \ast \begin{bmatrix}
k_{1,1} & k_{1,2} & \cdots & k_{1,N} \\
k_{2,1} & k_{2,2} & \cdots & k_{2,N} \\
\vdots & \vdots & \ddots & \vdots \\
k_{N,1} & k_{N,2} & \cdots & k_{N,N}
\end{bmatrix} = \begin{bmatrix}
r_{1,1} & r_{1,2} & \cdots & r_{1,N} \\
r_{2,1} & r_{2,2} & \cdots & r_{2,N} \\
\vdots & \vdots & \ddots & \vdots \\
r_{N,1} & r_{N,2} & \cdots & r_{N,N}
\end{bmatrix} \tag{8.7}
\]

In the calculation of the expected amount of repositioning kilometers, a distinction is made between the expected amounts of repositioning kilometers, if the next load is within the region \(R_{\text{inside}}\) or if it is outside the region \(R_{\text{outside}}\). If the next load is within the region the average repositioning kilometers are less than if the next is outside the region. The \(R_{\text{inside}}\) for delivery location \(d\) is given on the diagonal of matrix \(R\) and in Equation 8.8.

\[
E[R_{\text{inside}_d}] = r_{d,l} \mid l = d \tag{8.8}
\]
$R_{\text{outside}}$ for delivery location $d$ cannot easily be taken from matrix $R$. It needs to be calculated by adding the row of delivery location $d$ in matrix $R$ and subtracting $R_{\text{inside}}$. In a row of matrix $R$ the expected repositioning kilometers to the next loading locations are multiplied by the chance that that location will be the next loading location. Therefore by adding the results of all these multiplications the expected repositioning kilometers are calculated for a delivery location. Because the next loading location is outside the region, the expected $R_{\text{inside}}$ should be subtracted. The formula for $R_{\text{outside}}$ is given in Equation 8.9.

$$E[R_{\text{outside}}] = -E[R_{\text{inside}}] + \sum_{l=1}^{N} r_{d,l}$$

(Equation 8.9)

Now only the chance on load in delivery region $d$ must be known to calculate the RC. Because of the Markov property, it is assumed that the location of the next load depends only on the current location of delivery. So, the chance is simply given by $n_{d,d}$ in the transition matrix $P_n$.

The cost factors of repositioning are trucking and the usage of equipment. Hence, the cost of repositioning per kilometer is given by the sum of the trucking rate per kilometer $C_{tr}$ and equipment rate per kilometer $C_{eq}$.

The RC of delivery region $d$ adds the expected repositioning costs inside the region multiplied by the chance at freight in the delivery region, to the expected repositioning costs outside the region multiplied by the chance on a next load outside the region (Equation 8.10).

$$E[RC_d] = (1 - n_{d,d}) \times E[R_{\text{outside}}] \times (C_{eq} + C_{tr}) + n_{d,d} \times E[R_{\text{inside}}] \times (C_{eq} + C_{tr})$$

(Equation 8.10)

### 8.3.3 Calculation Market Correction

The petrochemical industry operates mainly near the harbors in Western Europe and the Ruhr area, therefore the demand for transportation is high in these regions. Hence, the orders from the harbors into the mainland of Europe are very profitable. On the other hand, there is less demand for petrochemical transportation in the mainland of Europe and sometimes Den Hartogh loses money on shipments from the mainland or returns empty. The expected empty return is now covered by the RC in the quote. Due to the imbalance of the profitability of an order, the previous and the next order must also be taken into account if the profitability of the order is determined.

Therefore in this section the expected discount or extra profit of the previous order to the current loading location $l$ is derived and given by the market correction previous ($MC_{\text{previous}}$). The same is done for the next order in the current delivery region $d$ and is given by the market correction next ($MC_{\text{next}}$).

To be able to determine if a discount is given or extra profit is made a target or required profit should be defined. The required profit of order $i$ is equal to the total revenue of order $i$ multiplied by the sum of the required profit percentage and the strategy of order $i$. The strategy is determined by the management and can be set as a positive percentage, but also as a negative percentage. The required profit for Liquid Logistics should be determined by the strategic managers. The required profit calculation for order $i$ is given in Equation 8.11.
Required profit\(_i\) = Total Revenue\(_i\) \(\times\) (Profit\(_\%\) + Strategy\(_i\)\(_\%\)) \hfill (8.11)

Now that the required profit of order \(i\) is defined the difference with actual JFP of order \(i\) can be calculated, this is shown in Equation 8.12 and is called the market correction of order \(i\).

\[
Market Correction\(_i\) = JFP\(_i\) - Required Profit\(_i\)
\] \hfill (8.12)

From this point on the MC\(_{\text{previous}}\) and the MC\(_{\text{next}}\) must be derived separately. First the derivation of the MC\(_{\text{next}}\) is given and then the adjustments to get the MC\(_{\text{previous}}\) are shown.

To calculate the expected market correction in loading region \(l\), first the expected market correction for each delivery region must be calculated. This is done by taking the average market correction \(i\) in the financial dataset to the delivery region \(d\) given the loading region \(l\). Equation 8.13 gives the expected market correction \((m_{l,d})\) to the delivery region \(d\) given the loading region \(l\).

\[
m_{l,d} = E[\text{Market correction}] \mid X_{t+1} = d \text{ and } X_t = l \quad l, d = 1, 2, \ldots, N \hfill (8.13)
\]

For now it is assumed that \(m_{l,d}\) also has the Markov memory less property and is time homogeneous. In paragraph 8.4.1 this assumption is tested. The expected market correction for all delivery regions given all loading regions are organized in matrix \(M\(_l\)\) (Equation 8.14).

\[
E[\text{Market Difference}] = M\(_l\) = \begin{bmatrix}
  m_{1,1} & m_{1,2} & \cdots & m_{1,N} \\
  m_{2,1} & m_{2,2} & \cdots & m_{2,N} \\
    \vdots  & \vdots  & \ddots & \vdots \\
  m_{N,1} & m_{N,2} & \cdots & m_{N,N}
\end{bmatrix}
\] \hfill (8.14)

If an order is loaded in region \(l\) there is a chance that the delivery region is \(d=1, d=2, \ldots, d=N\). If the one-step probabilities are arranged in an \(N \times N\) matrix as is shown in Equation 8.15, it is called the transition matrix \(P\(_l\)\). Matrix \(P\(_l\)\) is different from matrix \(P\(_n\)\), because now the condition is, that an order is loaded in region \(l\) instead of the condition that the order is delivered in region \(d\).

\[
P\(_l\) = \begin{bmatrix}
  l_{1,1} & l_{1,2} & \cdots & l_{1,N} \\
  l_{2,1} & l_{2,2} & \cdots & l_{2,N} \\
    \vdots  & \vdots  & \ddots & \vdots \\
  l_{N,1} & l_{N,2} & \cdots & l_{N,N}
\end{bmatrix}
\] \hfill (8.15)

To take the chance in the \(P\(_l\)\) transition matrix into account, the transition matrix \(P\(_l\)\) has to be multiplied by the expected market correction matrix \(M\(_l\)\). The result of the multiplication is matrix \(H\(_l\)\) and is given in Equation 8.16.

\[
H\(_l\) = P\(_l\) \times M\(_l\) = \begin{bmatrix}
  l_{1,1} & l_{1,2} & \cdots & l_{1,N} \\
  l_{2,1} & l_{2,2} & \cdots & l_{2,N} \\
    \vdots  & \vdots  & \ddots & \vdots \\
  l_{N,1} & l_{N,2} & \cdots & l_{N,N}
\end{bmatrix} \times \begin{bmatrix}
  m_{1,1} & m_{1,2} & \cdots & m_{1,N} \\
  m_{2,1} & m_{2,2} & \cdots & m_{2,N} \\
    \vdots  & \vdots  & \ddots & \vdots \\
  m_{N,1} & m_{N,2} & \cdots & m_{N,N}
\end{bmatrix} = \begin{bmatrix}
  h_{1,1} & h_{1,2} & \cdots & h_{1,N} \\
  h_{2,1} & h_{2,2} & \cdots & h_{2,N} \\
    \vdots  & \vdots  & \ddots & \vdots \\
  h_{N,1} & h_{N,2} & \cdots & h_{N,N}
\end{bmatrix}
\] \hfill (8.16)

The MC\(_{\text{next}}\) is the expected market correction given due the profitability of the next order. The expected market corrections of the next loading regions \(l\) are multiplied by the chance that these regions are the next loading region in matrix \(H\(_l\)\). Therefore by summing the results of all those
The expected market correction for delivery location \( d \) is calculated and given in Equation 8.17.

\[
E[H_{l,d}] = \sum_{i=1}^{N} h_{l,d}
\]  

(8.17)

\( h_{l} \) is multiplied by the chance that the next loading region is the same as the current delivery region, given by \( n_{d,d} \) in transition matrix \( P_n \). This result is multiplied by -1 due to the reverse nature of the MC, because the current order can give a discount if the next order acquires extra profit and the other way around. The MC\(_{\text{next}}\) for delivery region \( d \) is given by Equation 8.18.

\[
E[MC_{\text{next, } d}] = n_{d,d} \cdot E[H_{l,d}] \cdot -1
\]  

(8.18)

The same reasoning holds for the MC\(_{\text{previous}}\), although a couple of adjustments have to be made to the Equations. Instead of matrix \( P_y \), the chance that an order is loaded in region \( l \) given that the delivery region is \( d \) should be calculated. These one-step probabilities \( (d_{d,l}) \) can also be arranged in an \( N \times N \) matrix and is called the transition matrix \( P_d \). The same transformation should be done for matrix \( M_l \). Thus it should capture the expected market correction for all loading regions given the delivery regions and is called matrix \( M_d \). The expected market corrections of the previous delivery regions \( d \) are multiplied by the chance that these regions are the previous delivery region in matrix \( H_d \). Thus if matrix \( M_d \) is multiplied by matrix \( P_d \) matrix \( H_d \) is calculated. Therefore by summing the results of all those multiplications the expected market correction for loading region \( l \) is calculated and given in Equation 8.19.

\[
E[H_{d,l}] = \sum_{d=1}^{N} h_{d,l}
\]  

(8.19)

\( h_{d} \) is multiplied by the chance that the previous delivery region is the same as the current loading region, given by \( p_{l,l} \). The one-step probabilities \( (d_{l,d}) \) can also be arranged in an \( N \times N \) matrix; \( P_{p} \). The MC\(_{\text{previous}}\) for loading region \( r \) \( l \) is given by Equation 8.20.

\[
E[MC_{\text{previous, } l}] = p_{l,l} \cdot E[H_{d,l}] \cdot -1
\]  

(8.20)

**8.4 Validation**

The validation is concerned with checking if the model is built right. In other words, is the model an accurate representation of the real world? Therefore it should be determined if the model meets its intended requirements in term of the methods employed. Three assumptions are made to create a RC calculation model, in this validation these assumption are tested. Two of these assumptions are also used for the calculation method of the MC and are concerning the discrete-time Markov chain. The first assumption is that the network is time homogeneous. This assumption is tested in 8.4.1 for Matrix \( P_n \). The second assumption is the memory less property and is discussed in paragraph 8.4.2. The third assumption is only needed for the RC calculation model and concerns the equal distance to next loading location. This assumption does not hold and therefore a fix is given in 8.4.3.

**8.4.1 Time Homogeneous Network**

When calculating a discrete-time Markov chain it is assumed that the network is time homogeneous. This might not entirely be the case because Den Hartogh tries to acquire more profit and thus tries
also to obtain more orders. A large part of these orders are obtained by tenders, therefore a large amount of orders on only several lanes will be included to Den Hartogh’s network at ones. This can affect the transition probability matrix, if a lot of orders are delivered in a previously not so dense region, because a busy lane is won by the tender. All these trucks want to find a new load near that location and therefore it will be harder to find any, if the intensity of trucks per week increases, it is likely that they will drive further to find new load. Also the market price in the region will be affected because the supply of trucks increases and the demand remains the same. Seasonality effects may play a role in a region, especially for regions that have a less dense freight network. Given the reasoning above, if the assumption for matrix $P_n$ is violated than this assumption will also be violated for the matrix, $P_l$, $P_d$, $P_p$, $M$ and $R$.

The test if this suspicion is correct, the transition matrix $P_n$ of the intermodal department is tested to check whether the time homogeneous assumption holds. The average amount of days of an order is 15. As is shown in the summary statistics Table D1 in appendix D, the dataset contains 9 months of data. Therefore the time homogeneous assumption will be tested by calculating the variance of the elements of transition matrix $P_n$ for the 9 different months in the dataset. No assumption on the starting distribution has to be made for a DTMC, because the Markov chain converges to the stationary distribution regardless of where it begins (Kulkarni, 1999). Because Den Hartogh operates as a transport company for multiple decades it is assumed that if the network will converge to a stationary distribution, it has already happened. Table K1 in appendix K shows the average and variation for every $n_{dl}$ in $P_n$ over the 9 matrices $P_n$. The variance is given in the parentheses.

The variance of the elements in the matrix is larger than zero thus strictly speaking the assumption does not hold, but it can still be valid for short periods in time. There are only minor changes in the densest part of the network (Benelux, Germany and France), the homogeneous assumption seems to hold for the core area of Den Hartogh’s Network. As can be seen in table K1 the variance is less than 5 percent of the average for almost all $n_{dl}$ in the core region. The regions on the outside of the Network of Den Hartogh have a larger variation and the homogeneous assumption does not hold for those countries. Further research is needed to study if a longer time period to gather more data is needed and to develop a good forecasting model to predict those areas.

### 8.4.2 Memoryless Property

One of the assumptions of the discrete Markov chain is that the next load only depends on the previous delivery location. Although this is true for most of the orders it can also depend on the type of equipment. Especially if the equipment is very specific, the next loading location not only depends on the delivery location but also on where that specific kind of equipment is needed. Also a blacklist of the customer can influence that decision because on a blacklist certain previous loads are stated which are not allowed to be shipped before that order. Finally the planner can influence the choice of the next loading location, for example because the planner prefers to send one type of equipment to a certain region. Therefore the memory less property of all three matrices does not hold for these cases, further research is needed on what the impact is on the model.

In the calculation method of the MC it is assumed that only the next loading and previous delivery locations influence the network fit of the order. This assumption is based on the way planners and commercial managers deal with orders. As explained most of the demand of liquid transport is
clustered around the harbor areas and needs to be transported to the inland of Europe. Then the equipment is transported with or without freight back to the harbor areas to get better profit margins. But there will be cases that the order is expected to follow a route instead of a retour shipment, the possible benefits or disadvantages of this route are not taken into account in the MC. Also when a route is planned the memory less property does not hold, but given that almost all orders are planned as retour orders this violation is expected to have a very small impact on the model.

### 8.4.3 Core Area Adjustments

The financial settlement of an order is based on orders defined from one loading location to the next. This makes the computation of RC more difficult and makes a core area necessary, as is explained in paragraph 8.1. For these core regions it is assumed that the distance to the next is equal for every delivery location. Before the adjustment to the calculation of RC can be done, the core area must be defined. This has to be done separately for road and intermodal, because both networks operate separately from each other. The determination must be based on network density and only the densest regions are included in the core area.

The core area state space $S_c$ in Den Hartogh’s freight must be identified per department. This implies that only these regions are included in the RC as next loading location possibilities. Therefore the transition matrix $P_n$ has to be adjusted if a core area is used. First the one-step transition probability of the DTMC at time $n$, given in Equation 8.3, must be adjusted. Equation 8.3 gives the chance that if the current load is delivered in region $d$ the next loading region is $l$. But now the core area state space is a subset of the state space $S$ (defined in paragraph 8.3.1), $S_c \subset S$, it contains all delivery locations $d$ but only the next loading regions $l$ that are identified as core area. The one-step transition probability of the core area, gives the relative chance that if the current load is delivered in delivery region $d$, that the next core loading region is $l$. For every delivery region the sum of all probabilities to load in the next core loading region is 1. The probability that the next loading region is outside the core is 0 given delivery location $d$. This is shown in Equation 8.21.

$$
\text{If } l \in S_c, \\
\begin{aligned}
c_{d,l} &= P(X_{t+1}=l|X_t=d) \\
\sum_{l=1}^{N} c_{d,l} &= 1,
\end{aligned} \\
\text{else,} \\
c_{d,l} = 0
$$

(8.21)

If the adjusted one-step probabilities are arranged in an $N \times N$ matrix as shown in Equation 8.22, it is called the core transition matrix $P_c$. The transition matrix rows correspond to the delivery regions and the columns to the next loading regions. The core transition matrix $P_c$ will replace matrix $P_n$ in the calculation of RC given in paragraph 8.3.2. Hence, the only thing that changes in the calculation of RC when a core area is used is matrix $P_n$; it is replaced by matrix $P_c$.

$$
P_c = \begin{bmatrix}
c_{1,1} & c_{1,2} & \cdots & c_{1,N} \\
c_{2,1} & c_{2,2} & \cdots & c_{2,N} \\
\vdots & \vdots & \ddots & \vdots \\
c_{N,1} & c_{N,2} & \cdots & c_{N,N}
\end{bmatrix}
$$

(8.22)
The core area of the freight network of the road and intermodal department is based on the amount of orders in the region, thus the destiny. There is still a difference between the amounts of orders within the regions of the core area. Another region grouping would thus influence the core area. Because the density within the core area is not the same, the distance to the next loading location is not equal for every delivery location. This is a violation of the assumption, although the impact is expected to be minor. Because despite the difference in freight, the total amount of freight is still large.

8.5 Verification
The verification of the model is concerned with checking if the model is built, it gives the right results. In other words it is determined if the output generated by the model is equal to the output the model is expected to generate. This is independent of the validity of the model, it is only checked if the model does what it should do. This can be the case even if the model does not calculate the market correction and repositioning correction accurate.

The first verification method is a close check by the commercial managers and business analysts of Den Hartogh. They are the people who work daily with network data and have a good understanding of the financial data. They found no evidence of errors in the model and they think that this calculation method will improve the current MIC.

The second method is a close examination of the output of the model. To test the output of the model the MCs and RC for the intermodal department are calculated based on the financial dataset. The expected repositioning kilometers are calculated instead of the repositioning costs. This is done to avoid error in the form of an assumption on the rate per km of equipment. This does not have any effect on the results of the verification. The results of the RC calculation are given in Table L1 of Appendix L and are in line with the expected values based on the summary statistics presented in Table D1 of Appendix D.

As assumption for the MC calculation a required profit is set at 5% and an overhead at 9% of the total cost, the results are shown in Table L2 and L3 of Appendix L and seem also to be in line with the summary statistics in Table D1 in Appendix D. Therefore it can be concluded that the outcome of the calculation models is verified and correct.

8.6 Performance Parameters
The new quote structure described in this chapter makes it possible to analyze the quote performance more accurately. The quote performance parameters, introduced in chapter 6, are adjusted to the new quote structure and are given below. The parameters can be used to analyze a single order or multiple orders at once. It would be nice to compare these performance parameters with the old ones on a set of historic orders. But because the core area, required profit and the equipment cost rate are not determined, it would not be an accurate comparison.

*Job financial Profit margin (JFP%)* is the job financial profit including overhead cost, equipment cost and equipment revenue. It shows the profitability of a single order \( i \) on standalone basis as a percentage of the actual revenue.
Margin performance (MP) is the difference between the JFP% and the QJFP% of order $i$. The MP shows if the expected return on the revenue is realized.

$$MP_i = JFP\%_i - QJFP\%_i$$ (8.24)

Quote Performance (QP) is the difference between the quoted direct order costs and the actual costs plus the repositioning surcharge as a percentage of the quoted rate. The QP shows how well the commercial managers were able to predict the actual costs in the quote. The repositioning surcharge of the next order is added to the actual costs because the commercial manager could not foresee a next loading region outside the core area. The surcharge is financially settled in the next order, $i+1$, but the operational cost are made during order $i$.

$$QP_i = \frac{\text{Quoted Direct Order Cost}_i - \text{Actual Cost}_i + \text{Quoted Repositioning Surcharge}_{i+1}}{\text{Quoted Rate}_i}$$ (8.25)

Pass on Performance (PP) is the percentage of the extra costs that is passed on to the customer of order $i$. It shows if the quote was market out good and if Den Hartogh is responsible for the unforeseen costs.

$$PP_i = \frac{\text{Total Extra Revenue}_i}{\text{Total Extra Cost}_i} | \text{Total Extra Cost} > 0$$ (8.26)

$$PP^*_i = \frac{\text{Total Extra Revenue}_i + \text{Total Cost}_i}{\text{Total Cost}_i} | \text{Total Extra Cost} = 0$$ (8.27)

Network Performance (NP) is the profitability of an order as a percentage of the actual revenue including the market corrections made in the previous and the next order and the difference between the expected RC and the actual RC of the previous order plus the optional surcharge of the next order. The NP shows how good order $i$ performs within the network of Den Hartogh.

$$NP_i = \frac{JFP\%_i + (RC_{i-1} - \text{Actual RC}_{i-1}) + MC_{\text{Next order, } i-1} + MC_{\text{Previous order, } i+1} + \text{Surcharge}_{i+1}}{\text{Actual Revenue}_i}$$ (8.28)

$$Actual RC_{i-1} = Empty km_{i-1} * \left(C_{\text{equipment}} + C_{\text{trucking}}\right)$$ (8.29)

8.7 Discussion
The grouped regions used to calculate the MC and RC are based on the best practice, expertise and vision of the commercial managers and director. The question, if these grouped regions are the best possible regions, is kept outside the scope of the project and is therefore not known. But it should be investigated if other regions, in size or with other borders result in a more accurate calculation of the MC and RC. For now it can only be underlined that there are delivery locations near the border that will more likely find their next load in the neighbor region than in their own region. But whatever region is defined there will always be locations near the border.
In the calculation of the RC the repositioning kilometers are priced using an equipment price per kilometer. In appendix H it is explained that there are different types of equipment with different equipment costs per day. The equipment price per kilometer should be the average price of equipment per kilometer. Although this will introduce some error to the model, the impact will be minor.

The MC is based on a target profit set by the strategic management, it is essential that this is set realistic. If the required profit is set unrealistically high, then most orders will be indicated as not profitable. This will result in a high MC in the quote which will cause the profit to drop, assumed that the maximum rate remains the same. On the other hand if it set to low, the required return on allocated capital will not be realized.

The assumption made in calculating the repositioning surcharge is that a repositioning is needed from the core area. In reality this would not always be the case, if lucky another order outside the core area is delivered near the current loading location, but the chance that this will happen is very small. This would indicate that the repositioning surcharge is a little too high but on the other hand the calculation to the border of the core area may also be unrealistically low. The freight density on the border of the core area is more likely to be lower and therefore the expected repositioning kilometers would be higher than is expected by the RC.

If commercial managers have more information or another good reason, it must be possible to overrule the quote structure. But then they should get permission from the deputy director. Else it would be too easy again to adjust the profit without a good reason.

Den Hartogh freight orders are dedicated orders, these orders are not taken into account. Although no impact is expected on the network because dedicated shipments are roundtrips on a specified lane. Therefore these orders cannot add or destroy the values of other orders. A different quote structure is needed to value dedicated orders. Because network value and repositioning costs do not have an impact on dedicated orders, the expected costs can simply be calculated and the profitability can be determined.
9 Conclusion
In this thesis the pricing performance of the business unit liquid logistic is investigated. Den Hartogh has a very large amount of quote related data available, but they do not have the tools to analyze it. Den Hartogh currently uses a couple of parameters to determine the pricing performance, but these parameters contain too much error or do not give all the required information.

To improve the pricing analysis the equipment costs per order are added to the dataset using activity based costing. Also new parameters are introduced to measure the pricing performance of the quote. The first parameter is the job financial profit margin and it measures the profitability of the order. The second parameter, the network performance, is designed to show the value of a quote in relation to the network.

Besides that a quote must be profitable, a good quote should also be based on a solid prediction of the expected costs. Therefore the third parameter, the quote performance, shows how much the quoted costs deviate from the actual costs. A deviation is not a problem if all the costs can be passed on to the customer. This is measured by the pass on performance parameter. The last quote performance parameter is the margin performance. The margin performance measures if the quoted margin deviates from the actual margin.

These parameters are used to evaluate the financial quote performance of the business unit liquid logistic in the first nine months of 2011. The conclusion of this analysis is that the current quote structure does not provide guidelines to price the value of the quote in the network. Therefore a new quote structure is designed to include the value of the quote in the network. This is done by replacing the current market imbalance correction by a repositioning correction and a market correction. Both parameters can be calculated using the discrete-time Markov Chains. The market correction and the repositioning correction in combination with an optional repositioning surcharge can price the value of a quote request to the existing network.

The new quote structure is split in direct and indirect costs and profit. The direct costs are the costs that are related to the order in the financial settlement and consist of the operational calculation of the order and the RC. The indirect costs are the costs that cannot be found in the financial settlement of the order like the overhead costs, the RC surcharge and the MCs. The last part of the quote is the profit, which is the only element the commercial manager can adjust. A strategy element is added in the profit part to incorporate possible strategic decisions by the management in the quote.

Insights
Little literature is written about both the intermodal operator as well as pricing intermodal freight transport (Berckmans, 2012). This is one of the first contributions to the literature on pricing models for intermodal operators. It is the first attempt to price the full transportation costs of intermodal freight transport making use of Markov chains. Song (2007) used Markov models to create an optimal stationary policy for empty repositioning, but this is the first attempt to price not only the empty repositioning but also the profit imbalance in the European freight Network.

Next to Zhou and Lee (2009) it is one of the few contributions to the intermodal operator literature and in particular the pricing- setting of an intermodal operator. Little literature is written about
pricing performance parameters and this thesis can be seen as a first attempt to get some insights in the performance measures of the pricing in quotes.

Recommendations

- With the new equipment prices due to the activity based allocation, Den Hartogh should adjust the cost price of the different equipment types in the quote.
- Given that the quote structure, which is developed in this thesis, is better analyzable and leaves less room for errors, Den Hartogh should integrate this quote structure in its software and use it for future order requests. Both the road department as well as the intermodal department should use the same structure. Implementing this structure would also mean that the operational costs must be predicted as accurately as possible in the quote and the profit should be optimized by the commercial manager.
- The pricing-performance should be analyzed with the in this thesis developed pricing performance parameters.
- The overhead cost of an order is left out of scope for this research project but an improvement of the current allocation method is recommended. As discussed in the thesis an activity based overhead would be ideal but all improvements are welcome.
- Normally a Markov chain converges to the stationary distribution regardless of where it begins, but because some assumptions are violated, the calculation methods should be implemented with caution. Den Hartogh should have straight what will happen to the existing network if the model is implemented now.

Future research

Because this is the first attempt to combine the pricing of empty container repositioning and the profit imbalance, opportunities for future research are available. In the validation of the calculation model of the MC and RC some assumptions did not hold. Future research should determine the impact of these violations on the outcome of the models.

It will also be interesting to drop the time homogeneous assumption and adjust the model to forecasted data instead of historic data. The matrices with historic data can also be replaced with data provided by experts. This would make it possible to measure the value of an expert opinion.

In this project the best possible allocation of the regions is left out of scope, but future research can investigate if other region definitions would improve the pricing performance. The determinants of a good region differentiation for a MC and RC pricing model can be researched.

Further research is needed on the core area adjustment. A clear definition can be given and it can be investigated what time period is needed for the historic data or if a good forecasting model can be used to predict those areas. This can also generate new insights in the repositioning surcharge.

This model is developed for a European intermodal/road freight network. A fast growing amount of literature is written on the American and Asian freight sector. Therefore it will be interesting to investigate if this model can be generalized to capture the American and Asian freight networks.


10 References


