Visualizing business performance

Real-time BI-Dashboards

Bachelor project thesis

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Industrial Engineering & Management

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Koskamp

Qlik® Sense

UNIVERSITY OF TWENTE.

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Real-time BI-Dashboards

Bachelor Thesis Industrial Engineering & Management

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PREFACE

This research contains the bachelor's thesis "visualizing the business performance by using real-time business intelligence (BI-) dashboards" to complete my bachelor's program in Industrial Engineering and Management at the University of Twente.

I want to thank Tim Heinen, my company's supervisor and Gert Letteboer for giving me this opportunity at Koskamp. I also would like to thank Erik Bouwhuis for supporting me with the IT-systems at Koskamp.

Furthermore, I would like to thank my first supervisor at the University of Twente, Engin Topan, for his great feedback on concept versions of this report. Next to my first supervisor, I would like to thank Chintan Amrit for assisting and supporting me to bring this study to a higher level. Moreover, I would like to thank my fellow student Mark Bergman for his suggestions on writing this report.

Tim van Benthem *July the 3rd, 2018*

MANAGEMENT SUMMARY

Introduction
Koskamp is the market leader in the Netherlands, wholesaling more than 1.1 million different products to car dealerships and car maintenance shops. The company aims to deliver the goods within one hour or 1.5 hours to their customers by using their own logistics network. To do so, Koskamp currently has eleven local warehouses where they store their products. Each local warehouse has about five to fifteen fixed delivery routes that deliver the products regularly to a fixed set of customers that ordered.

Currently, the performance of these routes is monitored by using monthly updated Excel-sheets, displaying tables with the turnover per route and per local warehouse. The directors of Koskamp want to have a simple way to get real-time insight into the performance of the delivery routes by using dynamic dashboards. This way, they will be able to monitor the delivery routes in real-time, making it easier to recognize potential improvements. When this is all solved, it will allow the management to make quick substantiated management decisions. In this research, we therefore solve the core problem *"there is no simple way to get real-time insight into the performance of the delivery routes"* by developing dashboards and demonstrating the capabilities of the built-in analyses.

Approach
To develop the dashboards, we conducted a systematic literature review, held interviews and used our own expertise. For the demonstration of the dashboards, we performed data-analyses.

For the development of the dashboard we found the following:

1. The optimal KPIs and analyses to monitor delivery routes.
2. Real-time data flow possibilities as well as data cleaning and preparation methods to load the data correctly into a data model that forms a basis for creating dynamic visualizations.
3. Optimal chart types to visualize KPIs and analyses in a BI-dashboard.

The dashboards
Four dynamic BI-dashboards have been created in Qlik Sense to solve the core problem. The dashboards allow selecting and filtering within dimensions and they provide the following possibilities:

1. Routes | Pivot table: This dashboard includes a pivot table with financial metrics per route over time. There are also charts that display comparisons between the performances of the local warehouses and its deliver routes.
2. Routes | Turnover & Margin: The goal of this dashboard is to spot trends in the sales of the routes and its local warehouses over time. The trends are visualized by using charts.
3. Routes | Geographically: This dashboard shows the routes from a geographical point of view, allowing to get a visual understanding of the routes and its customers. The customers are visualized as bubbles. The size of the bubbles indicates the value of the financial metric.
4. Routes | Deliveries & Customers: The goal of this dashboard is to provide information about the workload of the individual delivery routes per hour. Also, the most important customers of each route can be visualized by using a pareto-analysis.

Analyzing the delivery routes
From the research in the dashboards, we found that the routes of local warehouse Nijmegen drastically needs improvements, especially the route numbers 02007, 02009, 02021 and 02024. We demonstrated the dashboards by doing sales trend-, workload and geographical route- analyses. It follows from these analyses that the average monthly turnover per route can be increased for the local warehouse Nijmegen from €29.500 to €40.600. To do so, three routes need to be eliminated, resulting in saving about €90.000 per year. Based on the results, possible route changes are recommended.

Conclusions & Recommendations

All in all, the implemented dashboards reached the norm set by Koskamp, solving the core problem. Meaning that Koskamp now has real-time insight into the performance of the delivery routes. This gives the company the possibility to monitor the performance of the delivery routes in real-time, find possible improvements for the delivery routes and have more insight if the turnover increase results in higher profits. So, the implemented dashboards allow the management of Koskamp to make quick substantiated management decisions about the delivery routes.

We recommend changing the routes of Nijmegen, so that the average monthly turnover per route increases from €29.500 to €40.600. To do so, three routes need to be eliminated, resulting in saving about €90.000 per year. We also recommend building more dashboards to get even more insight into the business. Furthermore, we recommend keeping the dashboards up-to-date by doing software updates regularly.

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READER'S GUIDE

This research contains the bachelor's thesis "*visualizing the business performance by using real-time BI-dashboards*". This report is structured in five chapters, which are briefly introduced below.

Chapter 1 | Introduction
This chapter introduces the company and the approach to finding the core problem of the assignment, including the motivation for solving the core problem. This chapter provides a problem-solving approach to achieve the research goal. It also describes the research questions as well as the problem quantification.

Chapter 2 | Theory on developing dashboards
This chapter provides the theory that will be used for the development of the dashboards. The theory involves a systematic literature review on the most suitable KPIs for the delivery routes. Furthermore, methods for data validation, data cleaning, and data preparation are explained. Next to that, the theory about designing a data model as well as the theory about real-time data connection methods are described. Moreover, chart types including their purpose to visualize KPIs and guidelines for building a dashboard are explained.

Chapter 3 | Implementation of the dashboards
The selected KPIs and analyses for the implementation are explained in this chapter. Next to that, the data validation-, cleaning- and preparation- methods used for the implementation are described. Furthermore, the optimal real-time data connection method for Koskamp is highlighted. Moreover, the four individual implemented dashboards are explained including the dashboard validation.

Chapter 4 | Analyzing and improving the routes by using the dashboard
In this chapter, the dashboards are demonstrated by doing sales trend-, workload and geographical route- analyses. The problems found during these analyses are highlighted. Furthermore, possible solutions to solve these problems are given including the estimated result when implementing the solutions for the delivery routes.

Chapter 5 | Conclusion, Recommendations & Discussion
This chapter concludes whether the implemented dashboards solved the core problem and to what extent the solutions reached the norm set by the company. This chapter also gives the recommendations for changing some delivery routes, as well as recommendations about maintaining the dashboards. Last, the limitations of the research are explained.

DEFINITIONS

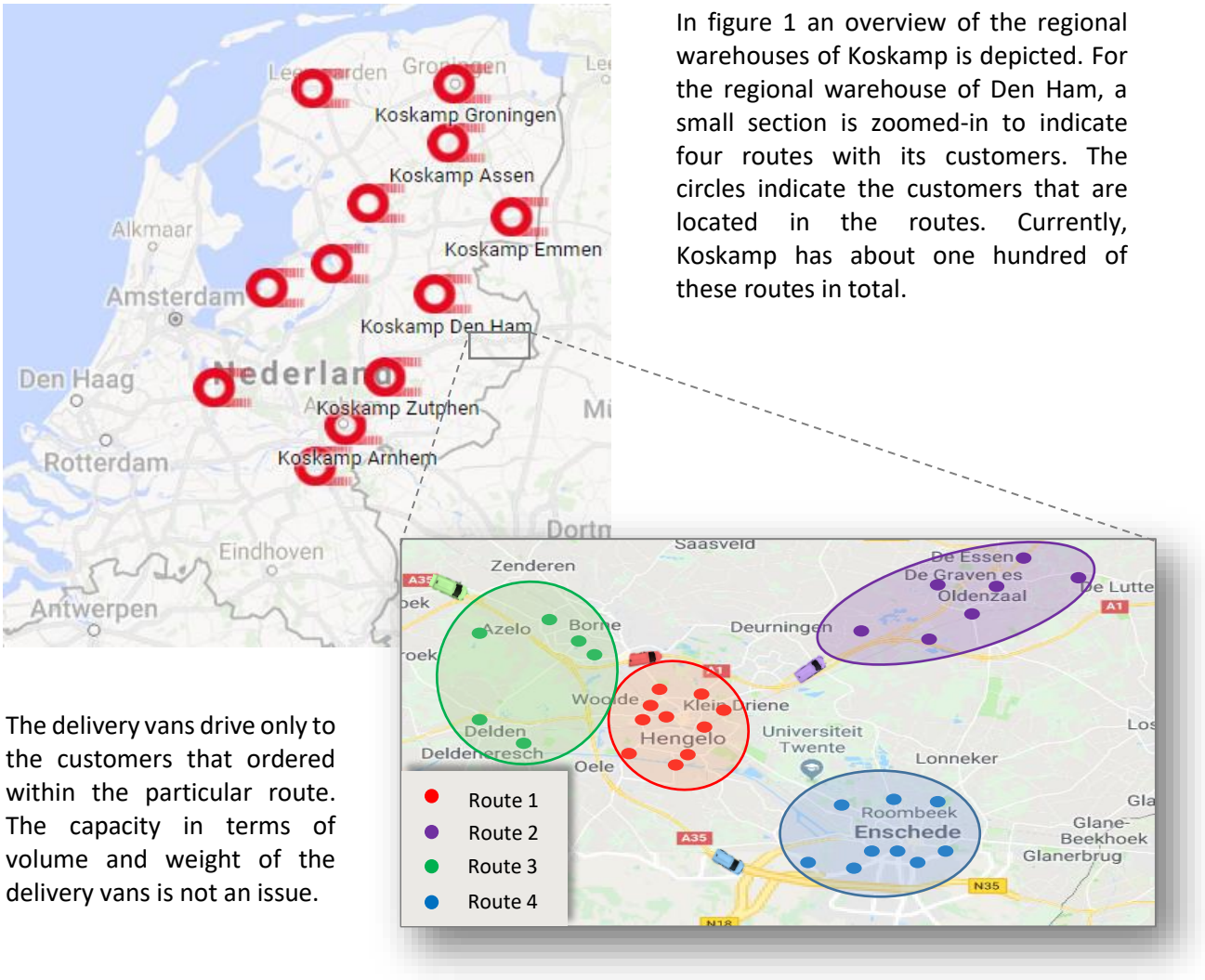
BI-Dashboard	A business intelligence dashboard is a management tool that provides information such as KPIs, metrics, and other key data points. The BI-dashboards are often used to monitor the performance of a business, department, or specific process. By using data visualizations, dashboards simplify complex data to provide users information about the current performance.
Data base	A data base is a place where data is structured so that is can be easily accessed, managed and updated.
Data model	A data model is a set of tables that are related to each other by using relationships. A data model structures data fields and standardizes how they relate to each other.
Data warehouse	A data warehouse is a large store that memorizes data. Often, the data comes from different data sources within a company.
Delivery route	A delivery route contains a fixed set of customers that can be delivered by a delivery van on a regular basis.
ERP-system	An enterprise resource planning system (ERP-system) is an information based software system that manages and integrates parts of a business.
Factor	A factor is a rather fixed parameter that influences KPIs.
KPI	A Key Performance Indicator (KPI) is a metric that indicates the performance of a business department, or a specific process.
Margin (€)	Margin (€) is a metric that measures the difference between the sales (€) and the costs (€) of a product or service.
Margin (%)	Margin (%) is a metric that expresses the margin (€) as a percentage of the sales (€) of a product or service.
Silikos	Silikos is the ERP-system of Koskamp. Silikos has a built-in data warehouse that integrates data from different software systems within the company.

1. INTRODUCTION

1.1 Introduction to Koskamp

Koskamp is the market leader in the Netherlands, wholesaling more than 1.1 million different products to car dealerships and car maintenance shops. The most sold product categories are car parts, tools, liquids and tires. The company aims to deliver the goods within one hour or 1.5 hours to their customers by using their own logistics network.

The logistics network of Koskamp currently consists of eleven local warehouses with about 250 delivery vans that deliver the sold products by driving to a fixed set of customers that ordered. The fixed set of customers that can be delivered by a delivery van is also called a route. In this report, we refer to these set of customers when mentioning the term 'route', because this term is commonly used at Koskamp. Each local warehouse has several of these routes with delivery vans driving a fixed number of trips per day to distribute the products to the customers on a regular basis. The short delivery times, and thus the delivery routes are a key selling point of Koskamp that differentiates the company from its competitors.



In figure 1 an overview of the regional warehouses of Koskamp is depicted. For the regional warehouse of Den Ham, a small section is zoomed-in to indicate four routes with its customers. The circles indicate the customers that are located in the routes. Currently, Koskamp has about one hundred of these routes in total.

The delivery vans drive only to the customers that ordered within the particular route. The capacity in terms of volume and weight of the delivery vans is not an issue.

Figure 1 | Overview of the regional warehouses and the delivery routes

1.2 Problem statement

Koskamp's turnover is increasing every year. The company invested in new local warehouses and they are hiring more and more employees, which comes with a lot of costs. It is hard for the directors to tell if the turnover increase also results in higher profits. To get more grip on this situation, it is necessary to know what is going on within the company. Because when the directors know what is going on, it is easier to tell if the turnover increase results in higher profits. Also, this will make it possible for the directors to make quick substantiated management decisions, which is hard to do right now.

Koskamp has different levels to get insight into the performance of the business. The company differentiates their processes between internal and external processes. External processes are related to direct stakeholders like suppliers and customers. The internal processes are processes that are necessary to run the company. The performance of the business processes gets expressed by Key Performance Indicators (KPIs). KPIs are numeric variables that indicate the past performance of a business for analyzing purposes. Key performance indicators get influenced and calculated by factors. Factors are rather fixed parameters that do not change regularly and they are important for analyzing purposes as well. For this research, we use the term 'KPIs' to indicate the performance of processes, and 'factors' to represent rather fixed parameters that influence KPIs. An overview of the different levels and relations between the levels to get insight into the business performance is depicted in Appendix 1 | Figure A1.

Currently, the directors do not have real-time insight into the performance of the delivery routes. Now, Excel files with tables showing static KPIs and factors are presented to the directors on a monthly basis. Meaning that they need to wait about one month before they receive the updated KPI values. Which is in today's business, where everything changes really fast, often too late. The directors make their decisions based on the static KPIs in the Excel files. Within these Excel tables, it is not possible to apply quick selections or filters. Furthermore, the KPIs are not visualized, but they are presented in numeric values in large tables. This makes it hard to get a quick understanding of the KPIs and their patterns.

Example of a common problem of an operations manager

Consider a route with number 00101 where a large customer retires and stops his business in the first week of a month. This customer had on average a 40% share of the total turnover of that route. So, the turnover of route 00101 drops a lot, causing the risk that the route is not profitable anymore to run. In the situation where the managers work with monthly updated Excel files, this might result in running a route that is losing money for at least three weeks, because the managers only have outdated data. Furthermore, when the managers receive the new Excel files, they will probably recognize that there is a large turnover drop in route 00101, but they cannot immediately select the route and see which customers caused this turnover drop, because the KPIs in Excel are static. A situation as in this example is very common and can be solved by using real-time data in a BI-tool where filtering and selecting is possible.

All in all, having no real-time visualizations of the KPIs of the internal business processes results in not having real-time insights into the performance of the internal business processes. This makes it hard to recognize potential improvements and hard to see if the turnover increase results in higher profits. This results in the fact that the directors cannot easily make quick substantiated management decisions. An overview of all the problems and their relations is depicted in Figure 2 | Core problem identification cluster.

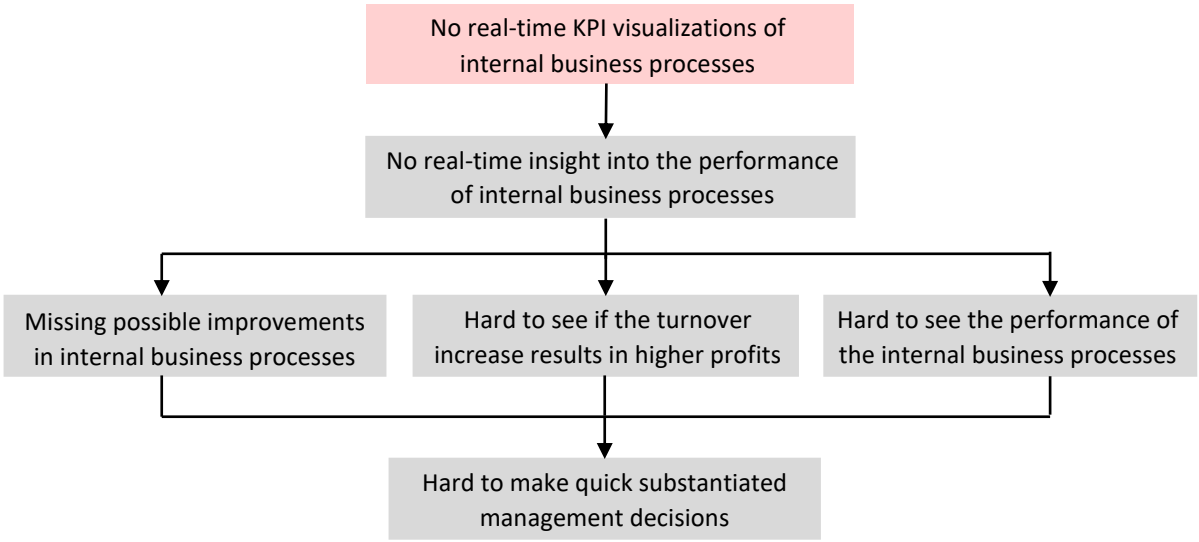


Figure 2 | Core problem identification cluster

1.2.1 Problem scope | focus of the assignment

There needs to be a focus in this assignment since it is not feasible to visualize the complete performance of every internal business process and aspect that the company has in a time-bound of ten weeks. Therefore, the company requested to focus on visualizing the performance of the fixed delivery routes per local warehouse.

1.2.2 Core problem

At first, from the problem identification cluster follows that the performance of the internal business processes needs to be visualized in real-time in order to be able to monitor the performance, recognize potential improvements and have insight if the turnover increase results in higher profits. Second, the core problem should focus on the performance of delivery routes per local warehouse. All in all, the core problem that needs to be solved is:

> *"There is no simple way to get real-time insight into the performance of the delivery routes of the local warehouses."*

1.3 The motivation for the research

The fixed delivery routes are one of the key selling points of the company, because the delivery routes network makes it possible that the company is able to deliver the ordered products within a few hours to their customers. Therefore, the company wants to always improve and optimize the fixed delivery routes. To do so, the right KPIs and analyses need to be determined. These KPIs and analyses need to be based on validated data. Next to that, the KPIs and analyses need to be visualized correctly to avoid any misinterpretations which can lead to making wrong decisions that can harm the company. So, research is needed in order to properly determine:

1. which KPIs and analyses are most suitable;
2. how to manage the data flow;
3. how to best visualize the KPIs and analyses.

1.4 Problem solving approach

Koskamp already uses Qlik Sense to monitor their sales performance. They started using Qlik Sense in February 2018. Some employees of the company are already familiar with this program since they are using the dashboards on a daily basis. Another reason is that Qlik Sense is easy to use for people that do not have a lot of knowledge about using BI-dashboards. Also, the program can be used to update data automatically and display it on several devices. Therefore, to solve the core problem, ideally, the directors of Koskamp want to have a real-time BI-dashboard in Qlik Sense. The Qlik Sense software will help to solve the core problem and thus help the directors to monitor the performance, recognize potential improvements and have insight if the turnover increase results in higher profits.

1.4.1 Research goal

The goal of this research is to get insight into the optimal performance indicators that will help the directors to monitor the performance of the delivery routes, recognize potential improvements, and have insight if the turnover increase results in higher profits. There needs to be researched how the data needs to be stored into a data model and how the KPIs can be visualized to get a valid representation of the performance of the delivery routes per local warehouse. Lastly, some possible improvements for the delivery routes need to be found by using the analyzing protocols.

1.4.2 Research questions

Research questions including specific sub-questions are defined that will help to achieve the research goal. The sub-questions give focus and a direction to the research, which will make the research more feasible.

1) What is the current situation?

a) How does the delivery route network of Koskamp work in practice?
b) What KPIs and factors are currently available and how are they calculated and visualized?
c) How much time does it take to update and maintain the available KPIs and factors?

First, a view on the current situation is necessary to understand how the delivery routes work and how the directors currently make their management decisions. It will become clear what factors have an influence on the performance of the delivery routes when understanding the current situation. This will give a focus on where to pay attention to when developing the dashboards. The current situation will define the 'reality', which will be used to measurable the difference between the initial and the improved situation.

2) What are the goals and preferences of the directors for getting insight into the delivery routes?

a) What are the main substantiated management decisions the directors want to make by using the dashboard?
b) Which KPIs do the directors prefer for the delivery routes, so that they can:
- *monitor the performance;*
- *recognize potential improvements;*
- *have insight if the turnover increase results in higher profits*

c) What compare, filter and sort options need to be implemented in the dashboard?
d) What are the preferences for the visualizations and the layout of the dashboard?

Second, it is necessary to identify the goals and preferences of the directors for the new dashboard. This will give an indication on what the directors really need in their point of view, so it will be easier to select the most suitable KPIs and analyses. The goals and preferences will define the 'norm', which will be used to measurable the difference between the initial and the improved situation.

3) **Which KPIs exist that can express the performance of the delivery routes according to the literature, and which are most suitable for Koskamp?**
   a) *Which KPIs exist that can express the performance of the delivery routes and which frameworks are used to categorize the KPIs according to the literature?*
   b) *Which data is needed to create the KPIs so that they are reliable and valid?*

Third, a systematic literature review is needed to find the answer to question 3. The delivery routes are a key selling point for Koskamp, therefore a systematic literature review will be done to find the existing KPIs that can express the performance. Finding the right KPIs is crucial in order to be able to monitor the performance, recognize potential improvements and have insight if the turnover increase results in higher profits. The results of this literature research will be used when making the final selection of KPIs that will be implemented into the dashboards.

4) **How to prepare and structure the required data in a data model for BI-tasks?**

Fourth, since the data in the dashboards need to be reloaded on a regular basis, an efficient data model architecture is required to ensure that the system can handle large amounts of data when reloading, and when using the dashboards. Next to that, it is important that the entity relations of the data are connected correctly. Therefore, it is important to use theory to design the right data model for Koskamp.

5) **How to visualize KPIs and analyses for BI-tasks?**

Fifth, it is important to visualize the KPIs and analyses correctly in order to avoid interpretation mistakes. Also, correct visualizations prevent graphs that are hard to read, understand and use. So, it is necessary to determine how to best visualize KPIs and analyses.

6) **How to use the dashboards to analyze the delivery routes to find possible improvements?**
   a) *What dashboard analyzing protocols can be used to find possible improvements in the delivery routes?*
   b) What are possible improvements for Koskamp to increase the performance of the delivery routes?

Sixth, protocols are needed showing how to discover possible improvements. This will make sure that the company understands and uses the dashboards optimally for what they are designed for. Next to that, some protocols will be demonstrated to discover possible improvements for the company by using the dashboards. These possible improvements will then be recommended to the company so that they can increase the performance of the delivery routes.

Research questions:

Research question 1:	Section 1.1, Section 1.5
Research question 2:	Section 1.5
Research question 3:	Section 2.1 (theory), Section 3.1 (implementation)
Research question 4:	Section 2.2 (theory), Section 3.2 (implementation)
Research question 5:	Section 2.3 (theory), Section 3.3 (implementation)
Research question 6:	Chapter 4

1.4.3 Type of research & research subject

The answers to research questions 1 and 2 will be collected by doing interviews with the operations director and the IT-manager of Koskamp. The operations director knows everything about the delivery routes. The operations director will also use the dashboards to make decisions to improve the daily operations of the company. The reason for interviewing the IT-manager is because this person knows everything about the IT-system of the delivery routes and thus he knows which data is available to measure the performance of the delivery routes. Furthermore, the IT-manager is planning to use the dashboards as well, so, also his goals and preferences need to be taken into account when developing the dashboard.

A systematic literature review will be used to find the answers to research question 3. Research question 4 and 5 will be found by doing non-systematic literature reviews. This because there is a fixed set of data model possibilities and a fixed set of possible visualizations that is recommended for a certain KPI and this can be found by doing a standard literature review. Research question 6 can be answered by doing data analyzes based on the provided information from the dashboard.

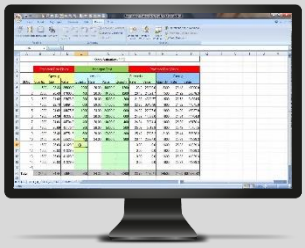
1.5 Problem quantification | Norm and reality

To be able to eventually say if the implemented solution solved the core problem, it is necessary to determine a norm on how the company aims to perform and to see how that holds in comparison to the reality. In this case, there are three variables to measure the difference between the norm and reality, namely:

1) **The available KPIs and factors**
   This variable expresses all the KPIs and factors available.
2) **The time it takes before the new KPIs and factors are updated and available**
   This variable can be divided into two sub-variables, namely:
   a) The average time it takes to handle a request for a common KPI.
   b) The average time interval between two sequential data updates.
3) **The hours of work per month needed to maintain the KPIs and factors**
   This variable measures the hours of work needed per month to keep the KPIs and factors up and running.

The situation before implementation (reality) and the preferences of the company (norm) are described in an overview in Section 1.5.1 below. After the implementation, the same three variables are assessed again to eventually be able to say to what extent the core problem has been solved.

1.5.1 Problem quantification | Overview

Reality | Current situation	Norm | Goal of the company
	
Excel based	*Qlik Sense based*
1) The available KPIs and factors	
Financial KPIs Turnover per: local warehouse, month, and route over the current year; Average turnover per: local warehouse, per route frequency and over all routes; Total costs as the percentage of the turnover	KPIs Visualizations of the financial KPIs Turnover (€) and margin (€) including the growth-rates in (€) and (%) of the two metrics. Non-financial KPIs are no priority
Non-financial KPIs The number of: failed deliveries, accidents, sickness, complaints about driving behavior per local warehouse and per month	Additional recommended KPIs to be able to monitor the performance, recognize potential improvements and have insight if the turnover increase results in higher profits.
Factors Local warehouses Routes per local warehouse Route frequencies Goals of the turnover per route Average drivers' age	Factors Local warehouses Routes per local warehouse Route frequencies Goals of the turnover per route
KPIs are all static and not visualized	KPIs need to be dynamic, visualized and allow selection-, filters- and compare-functionalities.
2) The time needed before the KPIs and factors are updated and available	
Time to handle a request On average, it takes about one day before a request for a KPI is fulfilled	Time to handle a request The ideal is that the directors can fulfill their KPI value requests themselves with just a few clicks on the screen or phone
Time to refresh the data The average time interval between two sequential data updates is about one month.	Time to refresh the data The data should be updated automatically every night
3) Time needed to maintain the system	
It took about eight hours of work per month to keep the system up and running	The system should almost automatically be maintained. Only some general settings should be updated manually. This should not take longer than one hour per month.

2. THEORY ON DEVELOPING DASHBOARDS

In this chapter, the answers to the research questions numbers 3, 4 and 5 are given in respectively the Sections 2.1, 2.2 and 2.3. The answers will be used to eventually select the right KPIs and analyses, design a proper data model and to create the most suitable visualizations for the dashboards of Koskamp.

2.1 Available KPIs in the literature | Systematic literature review

The delivery routes network is a key selling point of Koskamp, because this network allows Koskamp to deliver the products within one hour to their customers. Therefore, it is important to find the right KPIs that can indicate the performance of these routes. A systematic literature review will be done to find an answer to the question: Which KPIs exist to express the performance of the delivery routes and which frameworks are used to categorize these KPIs according to the literature? The reason why specifically this knowledge question gets answered by using a systematic literature review is described in Section 1.4.3. The steps taken to select literature systematically and the final selected articles from the systematic literature review are in Appendix 2.

2.1.1 Theoretical perspective

There are many KPIs available to express the performance of delivery routes, but only a few are relevant for Koskamp. To be able to select the right KPIs, it is first necessary to determine the point of view or a so-called theoretical perspective to be able to classify the KPIs. The articles from the systematic literature review consider in total five different perspectives, namely: management, employee, customer, society, and industry. A concept-matrix of the perspectives viewed per article is in Appendix 4 | Table A6.

For Koskamp, the industry perspective is not relevant since the delivery routes are completely run by the company and not by external parties from the industry. The management, employees, customers and the society are stakeholders of the delivery routes of Koskamp. Krauth, E., et al (2005) made a categorization between internal- and external stakeholders. The internal perspective covers the management and the employees. The external perspective covers the customers and the society. There needs to be a balance between the interests of the stakeholders in order to be successful (Krauth, E. et al., 2005). For example, the company wants the delivery frequencies low since each delivery costs money. But, the customers want the delivery frequencies to be high, because this makes the delivery time lower. So, there needs to be a balance between the interests of the stakeholders. Therefore, the KPIs will be selected based on the perspectives of the management, employee, customer, and society.

2.1.2 Framework to cluster KPIs

In this section, the framework to cluster KPIs to indicate the performance of delivery routes will be defined based on the literature. The articles that were selected describe many frameworks that categorize KPIs by using so-called concepts. The concept-matrix of the different KPI categories viewed per article is in Appendix 4 | Table A7.

From the concept-matrix follows that the concepts for indicating the performance of logistics can be divided into four main concepts, namely: Efficiency, Financial/Effectiveness, Customer/Society & Quality and other management related information. These concepts are similar to the concepts of the well-known balanced scorecard, which are: internal business process, financial, customer and learning & growth. (Robert S., et al, 1992) But, the balanced scorecard does not cover the perspective of the society. Therefore, the perspective of the society will be added to the framework, since this perspective is important for Koskamp as well.

For the management perspective, there is an extra refinement in categories to cluster the KPIs, since most of the KPIs will be management related. Financial / Effectiveness indicates the final results – 'what results did the delivery routes accomplish?' Efficiency indicates the results within the company by taking into account the resources used – 'how were the results of the delivery routes accomplished?' Learning & Growth is about learning and improving - 'How and where can the company be improved?'. Table 1 | Theoretical perspectives - concept clustering framework shows the final framework including perspectives to cluster KPIs that indicate the performance of the delivery routes.

Perspective	**Internal**				**External**	
	Management			**Employee**	**Customer**	**Society**
Category	Financial / Effectiveness	Efficiency	Learning & Growth			

Table 1 | Theoretical perspectives - concept clustering framework

2.1.3 Selecting KPIs from the literature

The relevant KPIs mentioned by the author(s) of each article are selected and clustered in the framework depicted in table 1. The selected KPIs are KPIs that can be used to indicate the performance of the delivery routes from the four perspectives. Some KPIs that were mentioned by the authors were not selected because they do not apply to the delivery routes of Koskamp. Examples of irrelevant KPIs are inventory levels, weight per truckload, supplier satisfaction, IT-equipment costs, number of products in the range, etc. Table A8 in Appendix 5 gives an overview of the available KPIs per article in a concept-matrix based on the framework depicted in table 1.

2.1.4 Outcome systematic literature review | Framework including KPIs

The duplicate KPIs have been removed from table A8 (the overview of the available KPIs per article) to create the final framework with available KPIs based on the literature to indicate the performance of delivery routes. This theory model is depicted in table 2 on the next page.

The theory model will be used together with the directors of Koskamp to select the right KPIs that will be implemented in the dashboard to indicate the performance of the delivery routes. The theory model will also be used as a layout overview for the dashboard for Koskamp.

Internal				External	
Management			Employee	Customer	Society
Financial / Effectiveness	Efficiency	Learning & Growth			
Total turnover	Order lead time	Absentee rate	# Working days	Transparancy	CO2 per km
Turnover/driver	Capacity utilization	Lack of resources	# Non working days	Lead-time	CO2 per time
Turnover/route	Fuel usage	Accident rate	Average # working days	Timelines of goods deliveries	Society satisfaction
Turnover/vehicle	Vehicle utilization	% Damages	Driver's weekly hours	On-time pickups	Chartiable actions
Turnover/time	% Fleet not used	# Drivers	Overtime hours	On-time delivery	Road maintenance costs
Turnover growth-rate	Labour productivity	Driver reliability	Employee satisfaction	# Delay	# Work places
Turnover per km	Labour utilization	Drivers experience	Km per trip	% Undamaged goods	# Of complaints
Subsidy received	Loading time	% Active customers	Weight to unload per hour	Customer satisfaction	
Profit margin	Vehicle operating hours	On-time loading	Driver's gross pay	# Customer complaints	
Return on investment	Order processing time	% Wrong delivery	Training received	Customer order path	
Total distribution costs	Frequency of driving	% Right delivery	Recognition	Customer query time	
Asset costs	Claims as % of costs	Shipment accuracy	Promotion rate	Range of services	
Overhead costs	Truck turnaround time	Claims rate		Responsiveness urgent deliveries	
Cost per route	Transit time	# Customer complaints			
Costs per vehicle	Quantity per shipment				
Maintenance costs	Orders per vehicle				
Fuel cost	Average # of stops				
Cost per weight	# Stops per route				
Driver's gross pay	Number of handling points				
# of deliveries					
# of orders					
# of customers					
# of profitable customers					
Km per day					
Perfect order - fulfilment					

Table 2 | KPI categorization in the framework / concept-matrix

2.2 Data management

This section gives an answer, regarding the situation of Koskamp, to research question four: “How to prepare and structure the required data in a data model for BI-tasks?”.

Data that powers BI-tasks usually comes from different sources. These sources can be different processes, departments or establishments of the company. It is also possible that the data comes from external sources, for example when loading the inventory levels of the suppliers. The difficulty when having different data sources is that the data quality varies. This can be caused by inconsistency in codes or data formats. For companies, it is a big challenge to overcome these issues, especially when reloading the data on a regular basis. To prevent data inconsistencies and reloading failures, it is important to manage the data. (Chaudhuri, S., et al, 2011)

Basically, there are three major data warehousing tasks: populating the data warehouse from different databases, storing and managing the data, and analyzing the data to make intelligent business decisions (Chaudhuri, S., et al, 2011). Since Koskamp developed an advanced ERP-system over the last decade called SiliKos, which deals mainly with the first two warehousing tasks, it is not necessary to go in depth on these two tasks. However, importing data from a data warehouse into BI-software needs data preparations, data model structuring, and data reloading. These three subjects are elaborated in the following three sub-paragraphs. The theories will eventually be brought into practice in Section 3.2. The data flow from SiliKos to the front-end dashboards in Qlik Sense is visualized in figure 3.

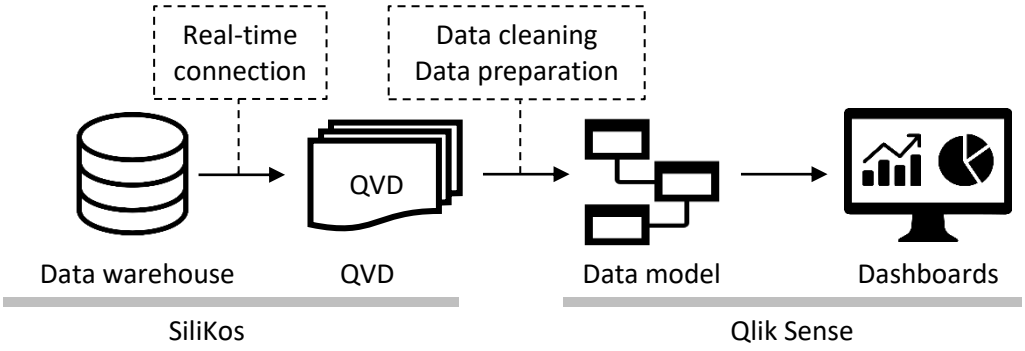


Figure 3 | Data flow from SiliKos to Qlik Sense

2.2.1 Real-time data connection

Businesses are nowadays so compatible that it is getting more and more important to have access to the most recent data. In Qlik Sense, there are three types of real-time data loading options. These three types are described below. An overview of the comparison between the real-time data load options is in table 3. We will use the real-time data loading overview in Section 3.2.1 to determine which loading type is best for Koskamp.

<u>Current status</u>

This type of real-time data is useful when only the data of the current situation is required. Examples are when a manager wants to know how many cars of the companies’ fleet are currently on the road. Or what is the value at this moment of the stock in the warehouse? So, this type of real-time data only remembers the last values of the attribute. A disadvantage of loading the current status into BI-software is that it is not possible to create historical reports.

Pushed data

Pushed data means that the new data that has not been added to the data warehouse gets added to the old data. The new data can for example be the sales of last hour and the old data the sales over this year. Pushed data is particularly useful for large data warehouses, where millions of rows are stored on a daily basis. When using pushed data, it is possible to create reports over time. A disadvantage when using pushed data for a real-time data warehouse is that the old data cannot be modified. If for example a customer name changes, this cannot easily be modified.

Refresh data

It is also possible to refresh the complete data warehouse in the BI-software. This is useful when the data warehouse is small so that reloading does not take too long. When using pushed data, it is possible to create reports over time. Another advantage of refreshing the complete data warehouse is that the old data can still be cleaned.

Nr.	Criteria	Current status data	Pushed data	Refresh data
1.	Dashboard updated in real-time when data is pushed	Yes	Yes	No
2.	Data stored permanently for historic analyses	No	Yes	Yes
3.	Create historic reports	No	Yes	Yes
4.	Possibility to edit data	No	No	Yes
5.	Data warehouse size	Only last values	Large (>0.5B rows)	Small (<0.5B rows)
6.	Reloading time	Short	Relatively short	Long

Table 3 | Comparison between real-time data connections in Qlik Sense (Microsoft BI, 2018)

2.2.2 Data cleaning & data preparation

When the data comes from different sources, chances are high that there are mistakes and the data resulting in errors when loading the data. These errors can be caused by inconsistencies, influencing the data quality. To ensure the data quality, the data needs to be cleaned, prepared and validated.

Data quality software can verify properties that hold in a data warehouse. For example, a given data warehouse contains a table with order information including the fields 'customer_names' and 'addresses'. Here, the 'customer_names' and 'addresses' are a unique combination. Another table in the data warehouse containing customer information, which is linked to the orders table, also has the fields 'customer_names' and 'addresses'. But, if the addresses are missing for some customers, it will not be possible to link the orders to these customers. The data quality software tool will verify if the uniqueness property holds. In practice, this is usually quantified by a percentage of successful unique combinations (Chaudhuri, S., et al, 2011). To overcome these kind of connection issues, it is often better to use unique IDs instead of combinations of fields. In this case, a unique CustomerID would make it possible to link the orders to the corresponding customers.

To solve any data quality issues, the data needs to be cleaned and prepared before getting loaded into the data model. This can be done by several data cleaning checks, namely: data type-, consistency-, range- and constraint validation. Data type validation checks for example if data from the column price is a number, like 10,00 with two digits and not text, like '10 euros'. Consistency validation checks if the data fields with the same meaning have the same text, like Mr. or M. or Man, have the same meaning but are not consistent. Range validation checks if the age of a person is for example between 18 and 99. Constraint validation checks for instance if the customerID has the following character types: XX####.

2.2.3 Data model architecture

BI-tasks need options such as filtering, joining and aggregation to be able to make sophisticated analyses. A so-called data model is required to operate these functions efficiently. The data model is explained by using the multidimensional view of data. Consider figure 4 and table 4, the metric that we are interested in is for example the sales (€). Other measures, such as margin (€), margin (%), stock levels or the amount of sold products are examples that could be measured as well. But, we are not interested in only the total sales of the company. We want to know for instance the sales in 2018 of route code 01 of warehouse number (01). To do so, the dimensions 'time (year)', 'local warehouse' and 'route code' are required to get the value €500,00. So, measures are associated with dimensions, which can be viewed in a multidimensional space, and dimensions are needed in order to operate functions such as filtering, joining and aggregation (Chaudhuri, S., et al, 2011).

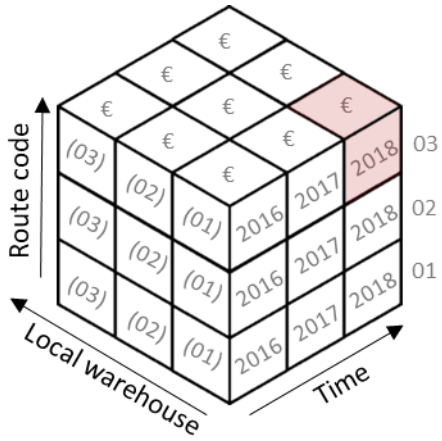


Figure 4 | Multidimensional space model

Time (year)	Local warehouse	Route code	Sales (€)
2016	(01)	01	€ 100,00
2016	(01)	02	€ 150,00
2016	(01)	03	€ 200,00
…	…	…	…
2017	(01)	01	€ 250,00
…	…	…	…
2018	(01)	01	€ 400,00
2018	(01)	02	€ 450,00
2018	(01)	03	€ 500,00
2018	(02)	01	€ 550,00
…	…	…	…

Table 4 | Data in a multidimensional space model

Within dimensions, it is also possible to drill-down. Take for example the dimension 'time'. Time can be measured in years, quarters, months, weeks, days, hours, etc. So, dimensions can be expressed by a set of so-called entities. These entities can often be ranked in a hierarchy, which makes the model more organized. For example, the dimension 'location'. The location can be measured per country, state, city, street, etc. (Chaudhuri, S., et al, 2011).

A data model consists of a single fact table, surrounded with connected tables for each dimension. The dimension tables contain columns that hold the entities that provide the drill-down dimensions. The fact table and the dimension tables are connected via so-called key-entities or IDs. These are unique values such as an orderID, customerID, employeeID, etc. (S. sumathi, 2007).

A well-designed data model makes the querying more efficient. For example, consider table 5 as a data model. If we are interested in the sum of the sales on 1-1-2018, we need to select in total three rows, containing 27 values. But if we re-design the data model, as depicted in figure 5 and tables 6 we only need to select three rows containing 20 values. In this example, the inefficient data model has in total 54 values, where the efficient data model has 40 values, containing the same information. So, this saves about 25% in memory in a data warehouse, making the data warehouse more efficient. Imagine the total savings in a large data warehouse.

OrderID	C_Name	C_Age	C_City	O_Date	O_Year	O_Month	O_Day	Sales
0001	John	27	Enschede	1-1-2018	2018	Jan	Mon	€ 100,00
0002	John	27	Enschede	1-1-2018	2018	Jan	Mon	€ 150,00
0003	John	27	Enschede	1-1-2018	2018	Jan	Mon	€ 200,00
0004	John	27	Enschede	2-1-2018	2018	Jan	Mon	€ 250,00
0005	Simon	35	Hengelo	2-1-2018	2018	Jan	Tue	€ 300,00
0006	Simon	35	Hengelo	2-1-2018	2018	Jan	Tue	€ 350,00

Table 5 | Inefficient data model table

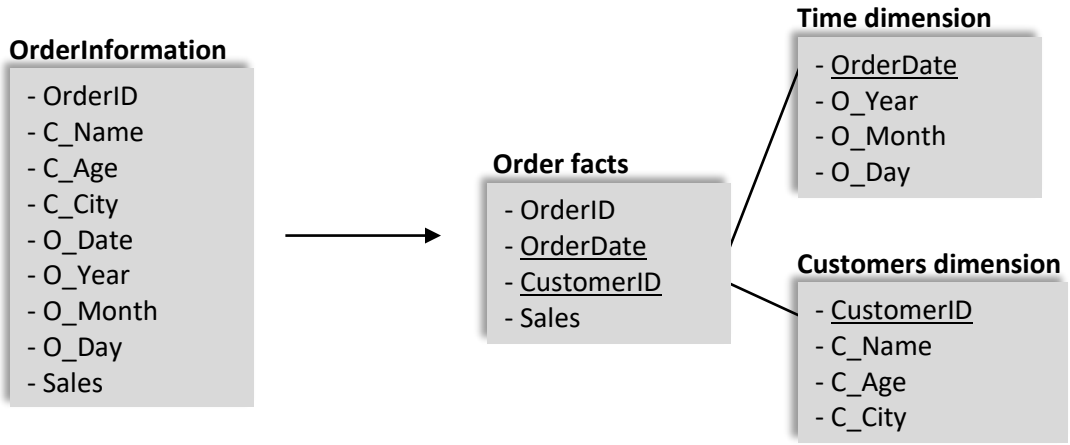


Figure 5 | Inefficient data model to efficient data model

OrderID	OrderDate	CustomerID	Sales
0001	1-1-2018	C100	€ 100,00
0002	1-1-2018	C100	€ 150,00
0003	1-1-2018	C100	€ 200,00
0004	2-1-2018	C100	€ 250,00
0005	2-1-2018	C200	€ 300,00
0006	2-1-2018	C200	€ 350,00

CustomerID	C_Name	C_Age	C_City
C100	John	27	Enschede
C200	Simon	35	Hengelo

OrderDate	O_Year	O_Month	O_Day
1-1-2018	2018	Jan	Mon
2-1-2018	2018	Jan	Tue

Table 6 | Efficient data model tables

All-in all, a well-designed data model allows doing operations such as filtering, joining and aggregating. This is possible using dimensions, which are connected to the facts table by using unique key-entities. Within these dimensions, it is possible to drill-down in the hierarchy to make more sophisticated analyses. Next to that, a well-designed data model works more efficient, because fewer values are needed for a data request and thus the storage memory in the data warehouse is minimized.

2.3 Data visualization

It is important to visualize KPIs and analyses correctly in order to avoid interpretation mistakes. Also, correct visualizations prevent graphs that are hard to read, understand and use. So, it is necessary to determine how to best visualize the KPIs and analyses so that the dashboards present the required information effectively to its users.

At first, when building a BI-dashboard, it is important to think about the purpose of the dashboard. Who is going to use the dashboard and what information do they need? Second, it is necessary to determine the KPIs and analyses that can present the required information. After that needs to be determined what chart types match best with the preferred KPIs or analyses. Third, the layout of the dashboard needs to be designed by taking into account the purpose of the dashboard, all the visualizations needed and the users of the dashboard. Furthermore, it is helpful to use checklists for common mistakes in designing the charts and layout of the dashboard.

Below is a plan containing the necessary steps in order to develop the front-end design of a BI-dashboard. This plan is written from a developers' point of view.

Purpose of the dashboard

1. What is the purpose of the dashboard?
2. Who is going to use the dashboard?
3. What information is required to reach the goals of the users?

Designing a dashboard starts with determining the purpose of the dashboard. Does the dashboard need to be detailed or should it give a general overview? Should the dashboard be of strategical or operational purpose? Who is going to use the dashboard – are they beginners in using BI-tools or experts? And most importantly, what information is required so that the users can make the right decisions? In this phase, it is important to understand and define what the users want and need to fulfill their tasks.

Chart type

4. What are the purposes of the visualizations that can display the required information?
5. What chart types fit best for the purposes of the visualization and the users of the dashboard?

The next step after having determined the purpose and required information is to think about how to visualize the information. Should the purpose of the visualization be a comparison, a distribution, a relationship, a composition or value measures per dimension (Bhatt, S., et al, 2017)? In table 7 is an overview of chart types available in Qlik Sense including the purpose of the visualization of the chart and a short chart type explanation (Qlik Sense, 2016). Next to that, in figure 6 are guidelines that are useful when designing charts. The chart type overview and the guidelines will help to determine and design a suitable chart type to visualize the required information.

Layout and design of the dashboard

6. Where to position the required charts on the dashboard?
7. What is the style that the users are used to?

When the charts are finished, the layout of the dashboard needs to be designed. In this step, it is important to know the preferences of the users. For example, do the users prefer the selection boxes on the left side of the dashboard or on top? Do they prefer to have textboxes explaining the visualizations? A good layout will increase the user experience, resulting in a more effective dashboard. In figure 7 are guidelines that are useful when designing the layout of the dashboard.

Chart type	Purpose of visualization	Chart explanation
Bar chart	Comparison	Bar charts show bars for each dimension. The measured value indicates the length of the bars.
Box plot	Comparison for range and distribution	The box plot is suitable for comparing range and distribution for sets of numerical data.
Combo chart	Compare sums and percentages	Combo charts can visualize bars and lines in the same chart. Combo charts are ideal for Pareto analysis.
Gauge meter	Single measure	The gauge displays a single measure. This chart is ideal for visualizing the distribution of the targets and reality.
Histogram	Distribution over intervals	A histogram is an option when visualizing a distribution of numerical data over intervals.
KPI	Single measure	The KPI is useful when displaying single measures.
Line chart	Display trends and comparisons	Line charts are useful when visualizing a trend in data, usually over many periods of time.
Map	Display point or area data	The map is useful when visualizing the measures geographically.
Pie chart	Composition	Pie charts visualize the share of the total for a single dimension.
Pivot table	Show summarized and single measures	Pivot tables allow more than one dimension for a single measure. The totals row can summarize the data in the rows.
Scatter plot	Relationship	Scatter plots are useful when showing the relation between two or three measures of one dimension. For example, the dimension 'product'. On the X-axis the total margin and Y-axis the total sales.
Table	Multiple measures	Tables are useful when displaying multiple measures for a single dimension. For example, the measures sales, margin, amount sold, etc. of products.
Tree-map	Composition	A tree-map shows a large number of single measures of one dimension in the hierarchy. For example, the total sales of products.
Waterfall chart	Composition	The waterfall chart shows the positive and negative fluctuations of an initial single value.

Table 7 | Chart types available in Qlik Sense including explanation (Qlik Sense, 2016)

Guidelines when designing charts

- Try to minimize the elements of labels, titles, reference lines, gridlines etc. This will make the charts look busy and therefore had to read. A minimalistic and clean chart is often better to use than a chart with a lot of information resulting in noise.
- Avoid using too many legends. Instead, color the same values so that one legend serves for the whole dashboard. Place the legend always in the same position, preferably on the right or bottom side of the chart.
- Use different styles such as coloring or padding to show different measures in a chart.
- Label x- and y-axis to avoid misreading the data.
- Sort the measures for better readability.
- Use mouse hovers when charts are too busy to show individual measures. When hovering the mouse over a visualization, the numeric measure value will be displayed for more detailed analysis.
- Always left align letters, right align numbers and center align headings in tables.
- 3D-designs or shadow effects may look good, but this can cause the user misinterpreting the information.
- Avoid using pie charts as comparison charts, instead, use bar charts in this case.
- When using pie charts, no more than six values should be displayed. If so, sum up the remaining values as 'others'.
- To avoid visual interruption, no more than four lines should be displayed in line charts.

Figure 6 | Guidelines when designing charts (Qlik Sense, 2016)

Guidelines when designing the layout of a dashboard

Layout

- Aligning visualization objects symmetrically is often appealing, resulting in better user engagement.
- The layout of the dashboard should be designed for the devices that will display the dashboards. Otherwise, there might be the chance that objects overlap or are hard to read.
- Two charts with X- and Y-axis next to each other should have the same axis length.
- Be consistent in the (white-) space between charts, this should everywhere be the same.
- Objects recurring on more than one dashboard, such as filter planes, selection boxes, text boxes, logos etc., should have the same position on every dashboard.
- Utilize all the space of the dashboard, but the dashboard should not be too dense.

Visibility

- There should be a contrast between the background colors and the charts.
- Use color schemes to indicate: sequentially – ordering measures, divergence – ordering measures from the mid-point (e.g. median), categories – segments of a group.
- The meaning of colors should be taken into account. For example, green often indicates positive values whereas red indicates the negative values.
- Choose the right font and the right font size. Arial, Calibri and Helvetia are professional fonts.

Figure 7 | Guidelines when designing charts (Bhatt, S., et al, 2017)

3. IMPLEMENTATION OF THE DASHBOARDS

3.1 Selecting KPIs for implementation

To find the most suitable KPIs in the literature, a systematic literature review was done in Section 2.2.1 and presented to the operations director during an interview. The operations director classified the KPIs into three categories, namely:

- Preferred KPIs to implement into the dashboard;
- KPIs available in another system;
- No priority right now

The operations director made the selection based on the benefits that the company would have when the KPIs are implemented in real-time dashboards. The KPIs were also presented to the IT-manager, but this time the KPIs were classified into practical categories, namely:

- Not feasible to implement in the dashboard within the time limit;
- No data available, so not possible to implement

The list of KPIs from the systematic literature review after having classified the KPIs into five categories is in Appendix 6 | Table A9.

The situation of Koskamp with its own delivery routes network is very unique. There are not many companies that have the same delivery process, let alone that there is literature available about all the possible KPIs to monitor the delivery routes network. The selected KPIs from the systematic literature review do not cover all the KPIs that the directors initially preferred. For example, only the financial metric turnover is in the literature, but the metrics margin (€) and margin (%) are interesting for Koskamp as well. Therefore, the following metrics were added to the list of KPIs: 'margin (€)', 'margin (%)', 'margin growth-rate (€)' and 'margin growth-rate (%)'. Furthermore, the dimension 'local warehouses' was added to the selected KPIs.

Dynamic KPIs

To make the KPIs dynamic instead of static, it is necessary to have a continuous time dimension. This dimension will also allow functionalities such as filtering and selecting within the dimension time, as shown in the example of figure 3.

Comparability

To be able to make quick comparisons between the performances of local warehouses and its routes, it is necessary to have KPIs that calculate averages. For example, if the operations director wants to know which local warehouse is performing the worst in terms of turnover per route, then he can quickly see which warehouse has the lowest average turnover per route.

Selecting, filtering within KPIs

To allow the functionalities selecting and filtering, it is necessary to have dimensions in hierarchy, so called drill-down dimensions. Consider the drill-down dimension 'local warehouses → routes → customers'. When selecting a local warehouse, the routes of the local warehouse should be displayed and after selecting a route, the customers within that route should be displayed.

In table 8 is an overview of all the metrics and (time-) dimensions to be implemented into the dashboards. The arrow indicates the hierarchy of the drill-down dimensions.

Final KPI selection

Metrics
Turnover (€)
Margin (€)
Margin (%)
Orders (#)
Customers (#)
Turnover growth (€)
Turnover growth (%)
Margin growth (€)
Margin growth (%)

Dimensions
Local warehouse
Route
Customer

Time dimensions
Year
Year-Quarter
Year-month
Year-week
Quarter
Month
Week
Weekday
Date
Delivery time
Last year (LY)
Last year to date (LYTD)
Year to date (YTD)
Yearly moving average
Last month to date (LMTD)
Month to date (MTD)

Table 8 | Metrics and (time-) dimensions selected for implementation

3.2 Data management

3.2.1 Real-time data connection

Qlik Sense allows three types of real-time data connections, as described in the theory in Section 2.2.1. These three data connections can be compared by using six different criteria as described in table 3. The six different criteria will be reviewed for Koskamp to determine the most suitable solution for the real-time data connection. The review on every criterion is in table 9.

Nr.	Criteria	Review	Explanation
1.	Dashboard updated in real-time when data is pushed	No	The reload takes place at night, so it is acceptable if there is no access to the dashboards during the reloading time.
2.	Data stored permanently for historic analysis	Yes	The possibility to monitor a process over time is one of the main reasons that Koskamp wants to develop BI-dashboards.
3.	Create historic reports	Yes	Koskamp is planning on developing automatically created historical reports in Qlik Sense.
4.	Possibility to edit data	Yes	For Koskamp it is important to have the possibility to edit historical data. For example, consider a customer ordered in the past. This customer decides to change the name of the company, ideally, the old name should be changed by the new name.
5.	Data warehouse size	Small (<0.5B rows)	On a yearly basis, SiliKos loads about 12 million new rows into Qlik Sense, which is less than 0.5 billion rows.
6.	Reloading time	Long	Currently, there are in total about 30 million rows in Qlik Sense, resulting in an average reload time of 11.5 minutes for a complete data reload. This is about 4.5 minutes per 12 million rows. So, the reloading time will increase by about 4.5 minutes per year, which is acceptable for a data reload at night.

Table 9 | Review on the criteria of the real-time data connections in Qlik Sense

All in all, the ‘refresh data connection’ fits best with the requirements of Koskamp. The 'refresh data connection' is a suitable option for now, and for the future, since it is not expected that Koskamp will easily reach the limit of 0.5 billion rows within their data warehouse.

3.2.2 Data cleaning & data preparation

Data cleaning and preparing is an important step to avoid errors or mistakes in the data, as described in Section 2.2.2. SiliKos, the ERP-system of Koskamp, has built-in software tools that clean the data. However, it might still occur that there are unforeseen mistakes in the data. Therefore, we check the data on the: data type-, consistency-, range- and constraint validation to prevent loading incorrect data into Qlik Sense. By using the Qlik Sense script editor, it is possible to let Qlik Sense do the last cleaning and preparation of the data before loading it into the dashboards.

In practice, the following four entities were added to the existing data model and had to be cleaned and prepared before loading into the Qlik Sense data model:

- Route codes: [TTRouteID];
- Delivery dates: [TTLeverDatum];
- Departure times: [TTVertrektijd];
- Local warehouse: [TTVestiging]

First, the TTRouteID's consist of five numbers. The first number must be 0, the following two numbers indicate the local warehouse (Den Ham = 01, Kampen = 02, etc.) and the last two numbers indicate the route numbers of the local warehouse. The TTRouteID's are getting checked on the data type-, consistency- and constraint validation using the following code, see figure 8. Here, the function left() and right() pick the x^{th} number of the inserted field. Some local warehouses started listing the route codes halfway 2016 where other warehouses started listing at the beginning of 2016. Therefore, some route codes are marked as 'GEEN' in the year 2016.

```
...
//Load route codes
if(isnum([RouteID])='true',                 //Validate data type (number)
   if(len([RouteID])='5',                   //Validate data consistency (5 numbers)
      if(left([RouteID],1)='0' and          //Validate constraint (code starts with 0)
         right([RouteID],2))>='1',          //Validate constraint (route number >= 1)
            [RouteID],                      //When correct, remember the route code
            'GEEN'                          //When incorrect, remember 'GEEN'
         )
      )
   )                        AS [TTRouteID]; //Load when validated
...
```

Figure 8 | Data cleaning and preparing the route codes

Second, the [TTLeverDatum] was initially in the format of YYYYMMDD when exported from the ERP-system. This data format had to be transformed to DD-MM-YYYY and it had to be validated on the data type-, consistency-, range- and constraint validation. This was necessary because there were some delivery dates in the ERP-system from the year 2015, but some local warehouses started listing the route codes from 01-01-2016. Therefore, the range of the dates is set from the beginning of 2016 until yesterday. Third, the constraints for the departure times ([TTVertrektijd]) are that they only get loaded into Qlik Sense when there is a valid route code and valid delivery date. It is not necessary to transform the delivery times into another format, because Qlik Sense can read the XX:XX (24 hours) format. Fourth, the values for the local warehouses for the field [TTVestiging] are derived from the first three numbers of the valid route codes and then loaded into the data model.

The scripts used to clean and prepare the data of the entities [TTLeverDatum], [TTVertrektijd] and [TTVestiging] before loading into the Qlik Sense data model are in Appendix 7.

3.2.3 Data model architecture

After the data is cleaned and prepared, it can be loaded into the data model by using the Qlik Sense script editor. The data model of Koskamp contains, as described in Section 2.2.3, one fact table and multiple dimension tables including drill-down dimensions. To be able to create all the selected KPIs, only four dimensions had to be added to the fact table 'VerkoopStats'. The table 'TT_MasterCalander' including the drill-down entities of the key-entity 'TTLeverDatum' (delivery date) was added to be able to make the KPIs dynamic over time. The final data model that is implemented in Qlik Sense is depicted in figure 9. The script used to automatically generate the TT_MasterCalander table is in Appendix 8.

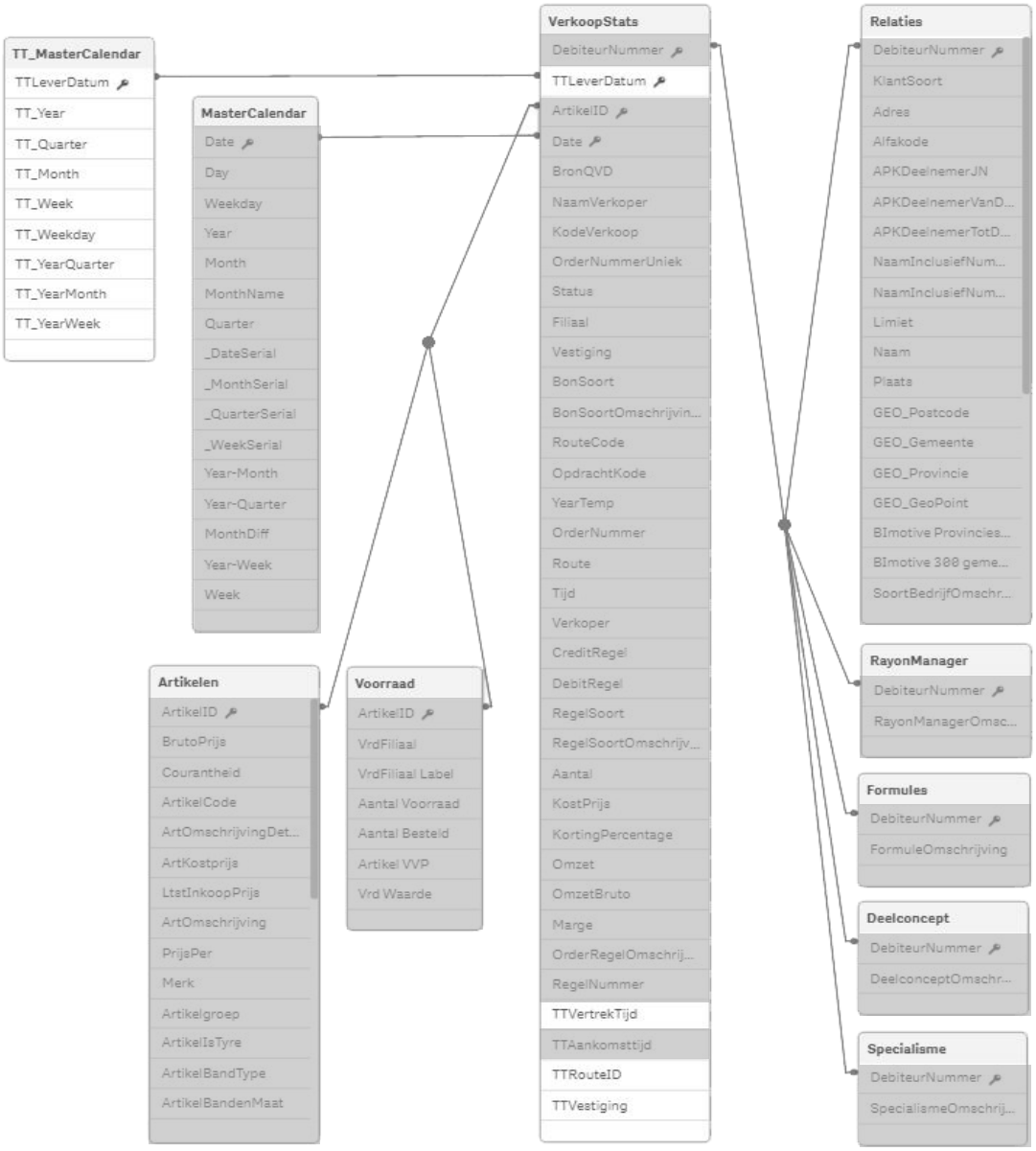


Figure 9 | Implemented data model in Qlik Sense

3.3 Data visualization

Referring to the theory in Section 2.3 about data visualization, the three main steps for designing a dashboard are: determining the purpose of the dashboards, finding the right chart types and designing the most suitable layout. The purpose of the dashboards is to monitor the performance of the delivery routes, recognize potential improvements and have insight if the turnover increase results in higher profits. To do so, we implemented the selected KPIs into the dashboards. In total four new dashboards are created for the delivery routes.

The purpose of the four different dashboards as well as the selected chart types to visualize the selected KPIs and the layout are described per dashboard below.

Dashboard 1: Routes | Pivot table

The purpose of the first dashboard, 'Routes | Pivot table' (see figure 10), is to get a general overview of which routes of the local warehouses are performing above, or below the goals. The performances are visualized by using gauge meters and a bar chart, since these charts are suitable for comparisons. To get an even quicker understanding of the situation, colors are used to indicate the positive and negative performances. The explanations of the charts and colors are described at the bottom of the chart. This will give a general expression for the user about the performance of the individual local warehouses and its routes. The metrics in the pivot table will be displayed for the selected dimension time and the routes of the selected local warehouses. For the pivot table, as well as the gauge meters and bar charts, it is possible to select and visualize the metrics: Turnover (€), Margin (€), Margin (%) and Orders (#). The visualizations smoothly change when a new selection is made.

Figure 10 | Dashboard 1: Routes | Pivot table

**Due to confidentiality rules, the customer names, margin (€) and margin (%) are excluded from this report.*

Dashboard 2: Routes | Turnover & Margin

The purpose of the second dashboard, 'Routes | Turnover & Margin (see figure 11), is to go more in depth on the trends of the routes and local warehouses. The trends can be analyzed on a year-to-date or month-to-date basis. The KPIs that indicate the trends and calculate the growth rates are in the table. The KPIs can be visualized in the bar chart by using the 'visualization box' for a quicker understanding. To avoid misinterpretations, text boxes including the chart explanation are displayed. Again, the dimension local warehouses and the metrics: Turnover (€), Margin (€), Margin (%) and Orders (#) are available.

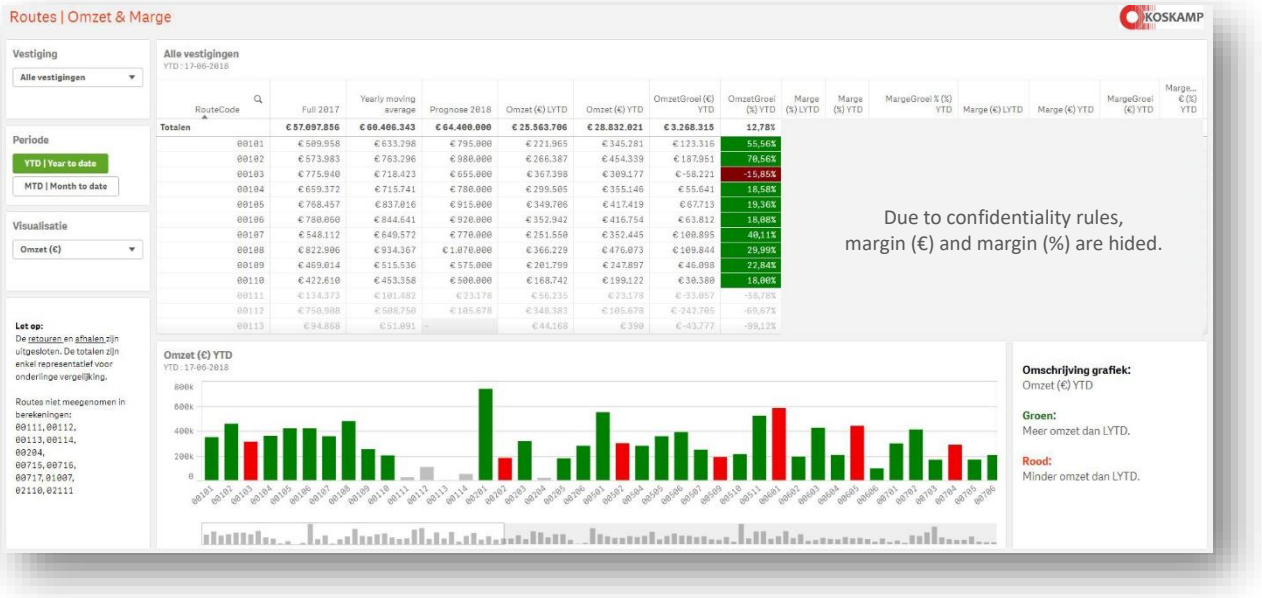
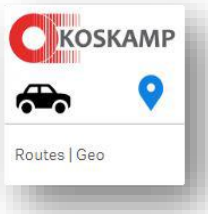


Figure 11 | Dashboard 2: Routes | Turnover & Margin

Dashboard 3: Routes | Geographically



The purpose of the third dashboard, 'Routes | Geographically' (see figure 12), is to get an overview of where all the customers are and how the routes are currently organized geographically. By using this dashboard, operations managers can for example easily determine if a customer is assigned to the right route from a geographical point of view. Furthermore, the operations managers can now easily assign a route to a new customer. When opening the dashboard, all the customers belonging to the local warehouses will be displayed as a bubble with the same color. After selecting a local warehouse, the map will automatically zoom-in on the routes from the selected local warehouse. The customers on the same route will have the same bubble color. The size of the bubble indicates the value of the metric. The larger the bubble, the higher the value. Possible metrics are Turnover (€), Margin (€) and Orders (#). Again, on the left side of the dashboard are all the dimension-related selection boxes. In the top of the dashboard are all the time related section boxes. On the right sight of the dashboard are text boxes that will show how many days are selected and how many customers are selected. There is also a legend indicating the meaning of the colors.

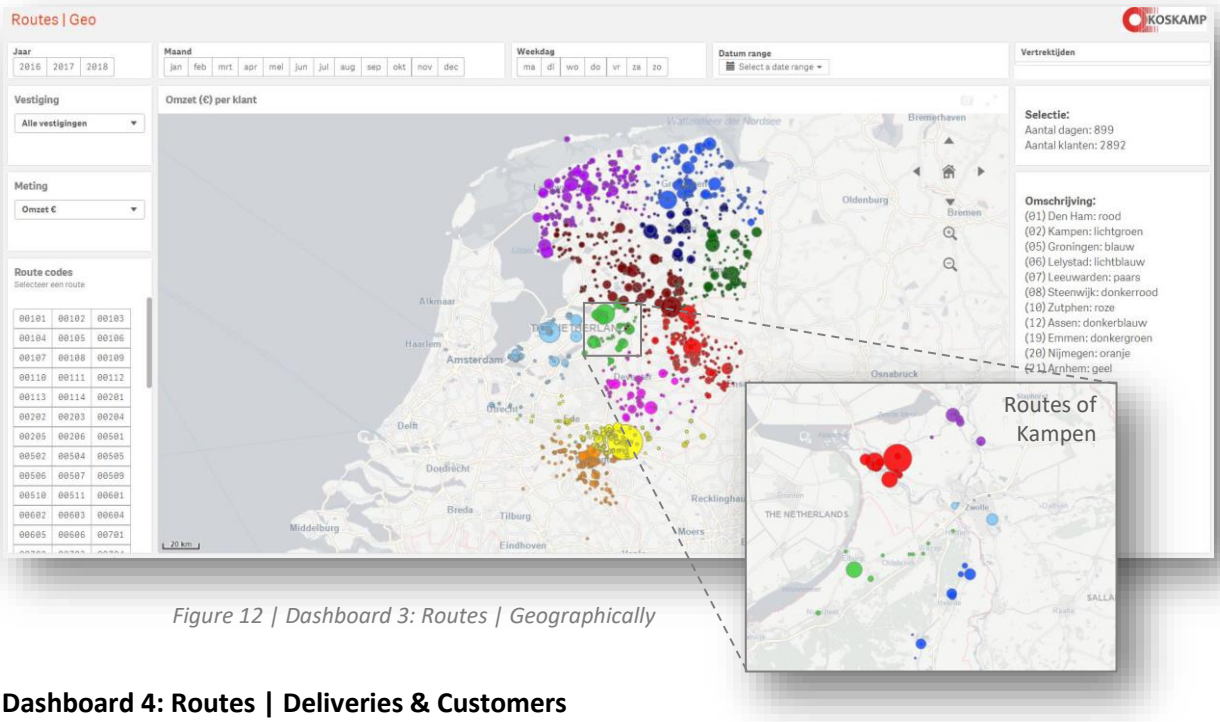


Figure 12 | Dashboard 3: Routes | Geographically

Dashboard 4: Routes | Deliveries & Customers

The purpose of the third dashboard, 'Routes | Deliveries & Customers' (see figure 13), is to go more in depth on the individual routes and its customers. This dashboard indicates which customers are the most profitable within a particular route and where they are geographically located by using a pareto-analysis chart and a map. This dashboard also visualizes the order patterns over a day by using a combo-chart showing which delivery times are the busiest and which delivery times are not busy. It is also possible to easily compare two routes and visualize for example how many customers a route needs to deliver at a certain time, making it possible to equalize the workload – the number of deliveries – of the routes. Again, on the left side are the dimension selection boxes and in the top of the dashboard the time dimension selection boxes. Possible metrics are Turnover (€), Margin (€) Orders (#) and Customers that ordered (#).

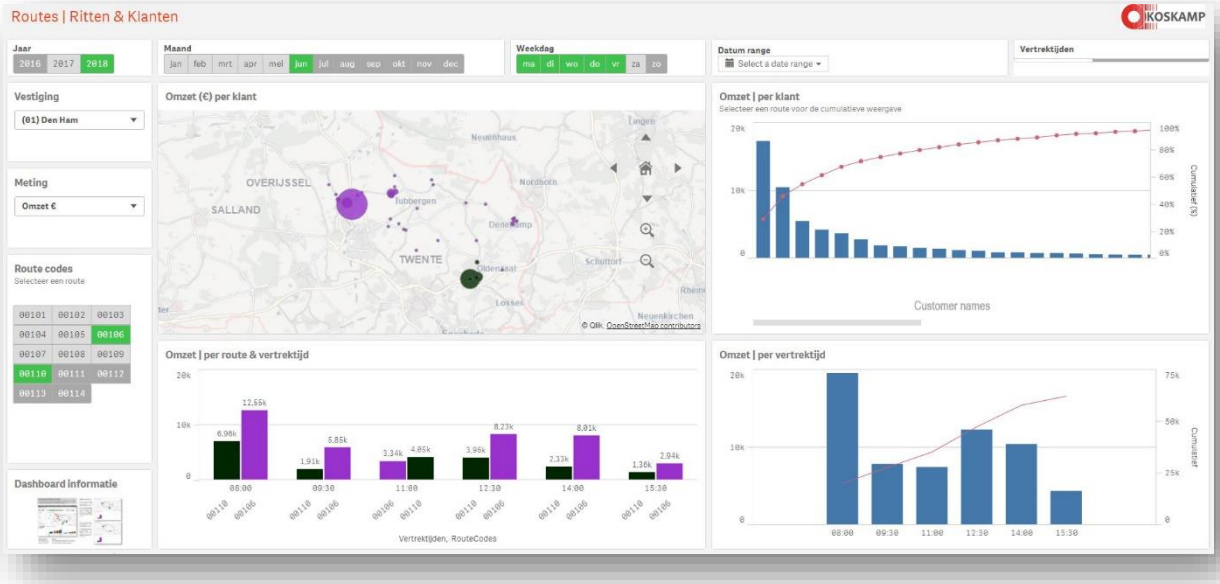


Figure 13 | Dashboard 4: Routes | Deliveries & Customers

3.4 Dashboards validation

Since the dashboards provide information to the users to make substantiated management decisions, the data including the visualizations need to be validated. Otherwise, there is a risk of making a wrong decision based on incorrect visualizations. Therefore, the data gets validated in two stages of the data flow and the visualizations get validated in the last stage of the data flow as depicted in figure 14.

In practice, the first stage validates the data in the ERP-system of Koskamp called SiliKos. After that, the data gets validated before importing into the data model of Qlik Sense as described in Data cleaning & data preparation So, only the last stage, the visualizations of the dashboard need to be validated.

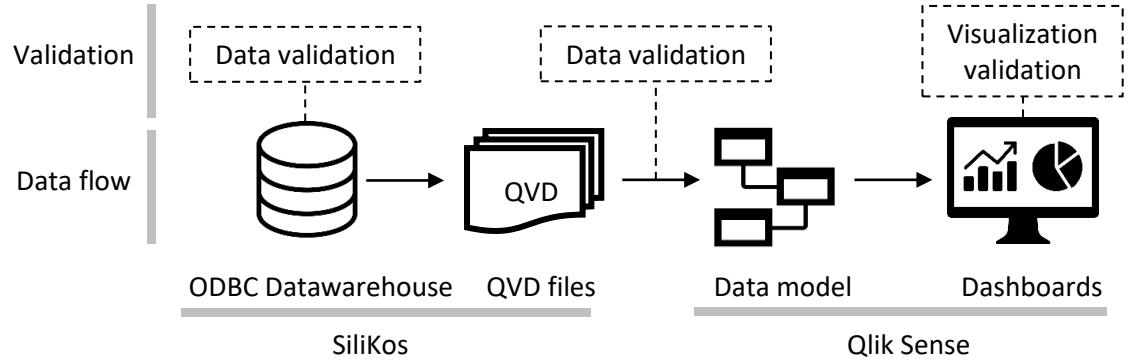


Figure 14 | Data validation within the data flow

The visualizations are validated by using 'white-box validation' and 'black-box validation'. White-box validation looks at small parts of the visualizations and determines if the small parts of the visualizations are sufficient accurate enough for the real world. Black-box validation determines if the visualization including all the KPIs is sufficient accurate enough to represent the real world. (Robinson, S., 2014)

For example, consider the map in figure 12 showing each customer as a bubble. The size of the bubble indicates the value of the KPI, in this case, the turnover per customer. The KPIs can be validated by using white-box validation. The dimension 'coordinates of the customer' can also be validated by using the white-box validation. The combination of the two in the map, thus the visualization, can be validated by using black-box validation.

In practice, white-box validation was mostly done by comparing the individual KPIs calculated in Qlik Sense with the numbers in the monthly- and annual reports. Also, the KPIs were validated by employees from the administration department. They compared the KPIs from Qlik Sense with the numbers that they have in their administration system. Also, cross-reference checks were used to check if individual KPIs were calculated correctly. For example, the sum of the prices of the returned goods of a customer needs to match with the absolute value of the sum of the credit invoice amounts of that customers.

Black-box validation was used when the charts were finished. The operations director, IT-manager and the operations managers validated the dashboards by comparing the visualization with the real world.

After the white-box- and black-box validation, the dashboards were published in the Qlik Sense stream and open to all employees having access to this stream.

4. ANALYZING AND IMPROVING THE ROUTES BY USING THE DASHBOARDS

4.1 Analyzing protocol

Below is a protocol that we use to improve the performance of the delivery routes of the local warehouses by using the implemented dashboards. This protocol is demonstrated in Section 4.2 and the results are in Section 4.3.

Find problems

First, we need to find problems by using the dashboards. We will find the problems by using two levels: the local warehouse level and the route level. Each level with the steps and corresponding questions that will help to indicate the problems and its causes are below:

1. **Local warehouse level:** Determine which local warehouse has the lowest performance on its routes and needs improvements.
2. **Route level:** Determine which routes of the selected local warehouse have the lowest performance and need improvements. Analyze these routes by doing sales trend-, geographical- and workload analyses.

   Sales trend analyses
   - Are there any negative trends in sales of the routes?
   - What are the causes of the negative sales trends?

   Geographical route analyses
   - Are the routes geographically located logically?

   Route workload analyses
   - What are the busiest delivery times of the routes?
   - Are there many small customers in a route causing a high workload?
   - Are there routes close to each other with a large difference in the number of deliveries per route?

Find possible solutions

Second, when the problems are identified, we need to think about possible solutions. Below are some possibilities that will help to come up with possible solutions to solve the problems:

Sales trend solutions:
- Improve the customer relationship when there is a negative growth-rate on sales

Geographical route solutions
- Eliminate one route
- Redesign a route geographically
- Find new customers when a certain area is not very dense

Route workload solutions
- Modify the driving times
- Drive less frequent to a customer

Analyze the solutions

Third, the solutions need to be analyzed in order to verify whether the solutions will solve the problems, and thus improve the performance of the routes of the local warehouse. Below are some questions that will help to verify if the solution improves the situation.

- Are the restructured routes of acceptable size when a route gets eliminated?
- What will be the number of estimated deliveries per route after restructuring the delivery routes?
- What will be the new total estimated result of the solutions?

4.2 Finding problems & Solutions by using the dashboards

Determine which local warehouse needs improvements to its routes | Local warehouse level

First, we use the dashboard 'Route | Pivot table', as described in Section 3.3, to identify which local warehouse has the lowest performance on the delivery routes. On the 22-6-2018, the average monthly turnover per route of Nijmegen was €29.500 (see figure 18) whereas the average monthly turnover per route on all routes was €53.480. The average year-to-date turnover per route of Nijmegen was €169.130 (see figure 16) whereas the average year-to-date turnover per route on all routes was €306.630. So, the routes of the local warehouse Nijmegen need improvements, see figure 15.

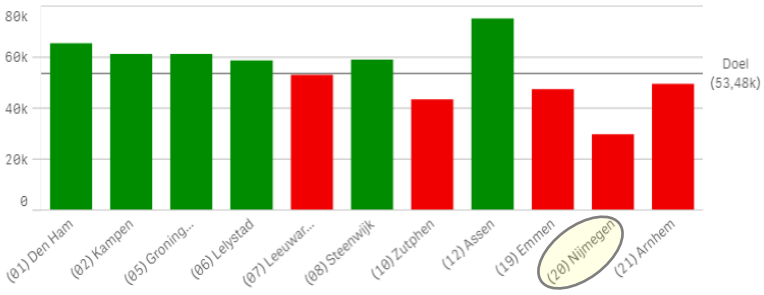


Figure 15 | Overview avg. monthly turnover per route per local warehouse

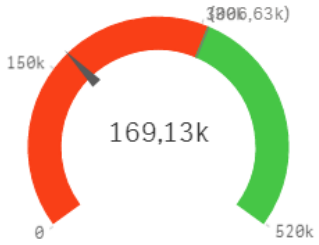


Figure 16 | Avg. year-to-date turnover per route - Nijmegen

Determine which routes of the local warehouse need improvements | Routes level

Second, we use again the dashboard 'Route | Pivot table' to identify which routes of the local warehouse Nijmegen have the lowest performance on the delivery routes. And thus, which routes need improvements. In figure 17 we see that the routes 02007, 02009, 02021 and 02024 have a significantly lower average monthly turnover than the other routes of Nijmegen. So, we will try to improve these routes.

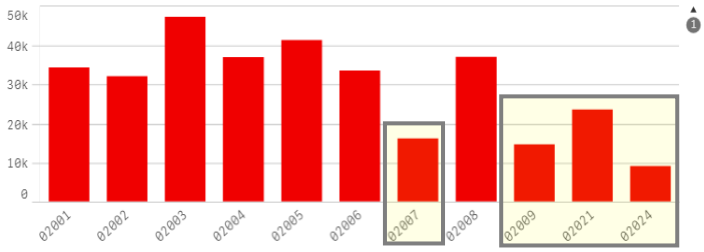


Figure 17 | Overview avg. monthly turnover per route - Nijmegen

Figure 18 | Avg. monthly turnover per route of all routes of Nijmegen

We will start searching for the causes why the selected routes (02007, 02009, 02021 and 02024) have such low average monthly turnovers by looking at the turnover growth per route. In figure 19 we see that route number 02007 decreased about €22.000 in turnover.

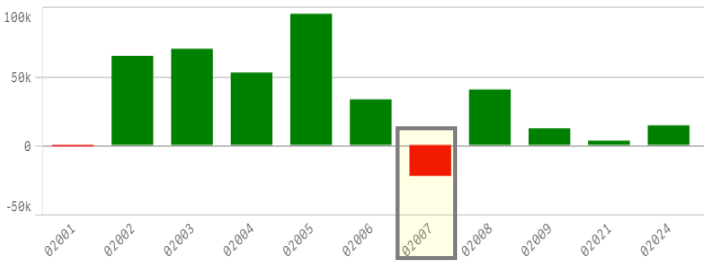


Figure 19 | Visualization of the turnover growth per route

Figure 20 shows a table with the exact numbers of the growth-rate. So, we can see that route 02007 has €22.212 less turnover on this year-to-date (YTD) than on last-year-to-date (LYTD).

Nijmegen
YTD : 22-06-2018

RouteCode	Full 2017	Yearly moving average	Prognose 2018	Omzet (€) LYTD	Omzet (€) YTD	OmzetGroei (€) YTD	OmzetGroei (%) YTD
Totalen	**€ 3.389.999**	**€ 3.767.452**	**€ 4.205.000**	**€ 1.499.986**	**€ 1.860.421**	**€ 360.435**	**24,03%**
02001	€ 428.786	€ 430.708	€ 425.000	€ 197.032	€ 196.043	€ -989	-0,50%
02002	€ 313.156	€ 378.316	€ 485.000	€ 118.586	€ 183.028	€ 64.442	54,34%
02003	€ 471.991	€ 543.190	€ 635.000	€ 200.635	€ 270.056	€ 69.421	34,60%
02004	€ 376.566	€ 430.608	€ 500.000	€ 158.537	€ 210.898	€ 52.360	33,03%
02005	€ 320.157	€ 417.109	€ 535.000	€ 141.232	€ 236.010	€ 94.778	67,11%
02006	€ 339.051	€ 374.793	€ 410.000	€ 158.411	€ 191.490	€ 33.079	20,88%
02007	€ 247.118	€ 225.348	€ 200.000	€ 114.280	€ 92.068	€ -22.212	-19,44%
02008	€ 386.990	€ 429.002	€ 475.000	€ 171.412	€ 211.463	€ 40.051	23,37%
02009	€ 152.469	€ 165.192	€ 180.000	€ 71.334	€ 83.437	€ 12.103	16,97%
02021	€ 263.802	€ 268.522	€ 270.000	€ 131.182	€ 134.275	€ 3.093	2,36%
02024	€ 89.913	€ 104.664	€ 125.000	€ 37.346	€ 51.653	€ 14.307	38,31%

Figure 20 | Table with the exact numbers of the turnover growth-rate per route

So, the low turnover of route 02007 might be caused by customers that were initially in route 02007 and are now in another route. Or, it could be the case that some customers buy less from Koskamp this year compared to last year. To find the causes of the growth-rate decrease in the turnover, we select all the customer with a turnover decrease of route 02007, see figure 21.

From the table with the selected customers, we see that the turnover decrease of €22.216,74 matches with the turnover decrease of route 02007. The small difference of €4,74 is due to the fact that the values in the customer table are not rounded. So, the customers in figure 21 caused the turnover decrease. But, from figure 22 we see that most of these customers were assigned to route 02008, starting from April 2018, see figure 22.

Customer names	Full 2016	Full 2017	% vTot YTD	Omzet (€) LYTD	Omzet (€) YTD	OmzetGroei (€) YTD	OmzetGroei (%) YTD
	€ 54.788,89	**€ 247.019**	**100,00%**	**€ 114.513**	**€ 92.297**	**€ -22.216,74**	**-19,40%**
	€ 26.266,29	€ 125.608	38,23%	€ 60.275	€ 35.288	€ -24.987,20	-41,46%
	€ 11.268,94	€ 41.468	16,39%	€ 19.463	€ 15.127	€ -4.336,50	-22,28%
	€ 1.724,02	€ 1.971	0,00%	€ 1.971	€ 0	€ -1.971,31	-100,00%
	€ 249,40	€ 620	0,00%	€ 450	€ 0	€ -449,95	-100,00%
	€ 3.569,66	€ 13.641	6,17%	€ 6.102	€ 5.699	€ -402,82	-6,60%
	€ 0,00	€ 378	0,00%	€ 331	€ 0	€ -330,65	-100,00%
	€ 0,00	€ 2.178	0,32%	€ 447	€ 292	€ -155,14	-34,67%
	€ 207,16	€ 458	0,21%	€ 266	€ 192	€ -73,73	-27,75%
	€ 0,00	€ 608	0,32%	€ 335	€ 292	€ -43,14	-12,88%
	€ 10,52	€ 98	0,03%	€ 73	€ 32	€ -41,15	-56,09%

Figure 21 | Customers that caused the turnover decrease of route 02007

So, we now select the customers that are still in route 02007 to see if some customers buy less from Koskamp, causing a small part of the turnover decrease, see figure 23.

RouteCode	Periode					
	2018-jun	2018-mei	2018-apr	2018-mrt	2018-feb	2018-jan
Totalen	**€12.063**	**€13.243**	**€11.527**	**€12.664**	**€12.561**	**€12.788**
02007	€2.153	€2.523	€8.329	€12.664	€12.561	€12.788
02008	€9.910	€10.720	€3.199	-	-	-

Figure 22 | Customers from route 02007 were moved to route 02008

From figure 23 we see that there are eight customers that are still in route 02007 that buy less compared to last year. Especially the customer in the top row needs some attention from the sales department.

Concluding on the turnover decrease of €22.212 of route 02007, about €12.922 was caused by moving the customers from route 02007 to route 02008 and about €9.290 was caused by customers buying less from Koskamp.

	Full 2016	Full 2017	% vTot YTD	Omzet (€) LYTD	Omzet (€) YTD	OmzetGroei (€) YTD	OmzetGroei (%) YTD
	€ 161.939,18	**€ 174.599**	**100,00%**	**€ 84.382**	**€ 75.092**	**€ -9.290,94**	**-11,01%**
Customer names	€ 36.658,71	€ 34.122	14,12%	€ 17.156	€ 10.604	€ -6.552,36	-38,19%
	€ 107.170,37	€ 117.417	73,87%	€ 56.711	€ 55.469	€ -1.242,33	-2,19%
	€ 3.803,26	€ 2.630	0,39%	€ 900	€ 292	€ -607,18	-67,50%
	€ 1.413,08	€ 671	-0,03%	€ 501	€ -22	€ -522,70	-104,29%
	€ 0,00	€ 378	0,00%	€ 331	€ 0	€ -330,65	-100,00%
	€ 620,90	€ 458	0,26%	€ 266	€ 192	€ -73,73	-27,75%
	€ 317,14	€ 578	0,39%	€ 335	€ 292	€ -43,14	-12,88%
	€ 114,54	€ 98	0,04%	€ 73	€ 32	€ -41,15	-56,09%

Figure 23 | Customers in route 02007 that have a turnover decrease

After having determined that the low average monthly turnover on the routes 02007, 02009, 02021 and 02024 are not only caused by a decrease in sales, we are going to look at these routes from a geographical point of view. The goal is to find out if the routes are geographically located logically. By using the dashboard 'Routes | Geo', we select 'Nijmegen' and its routes, see figure 24.

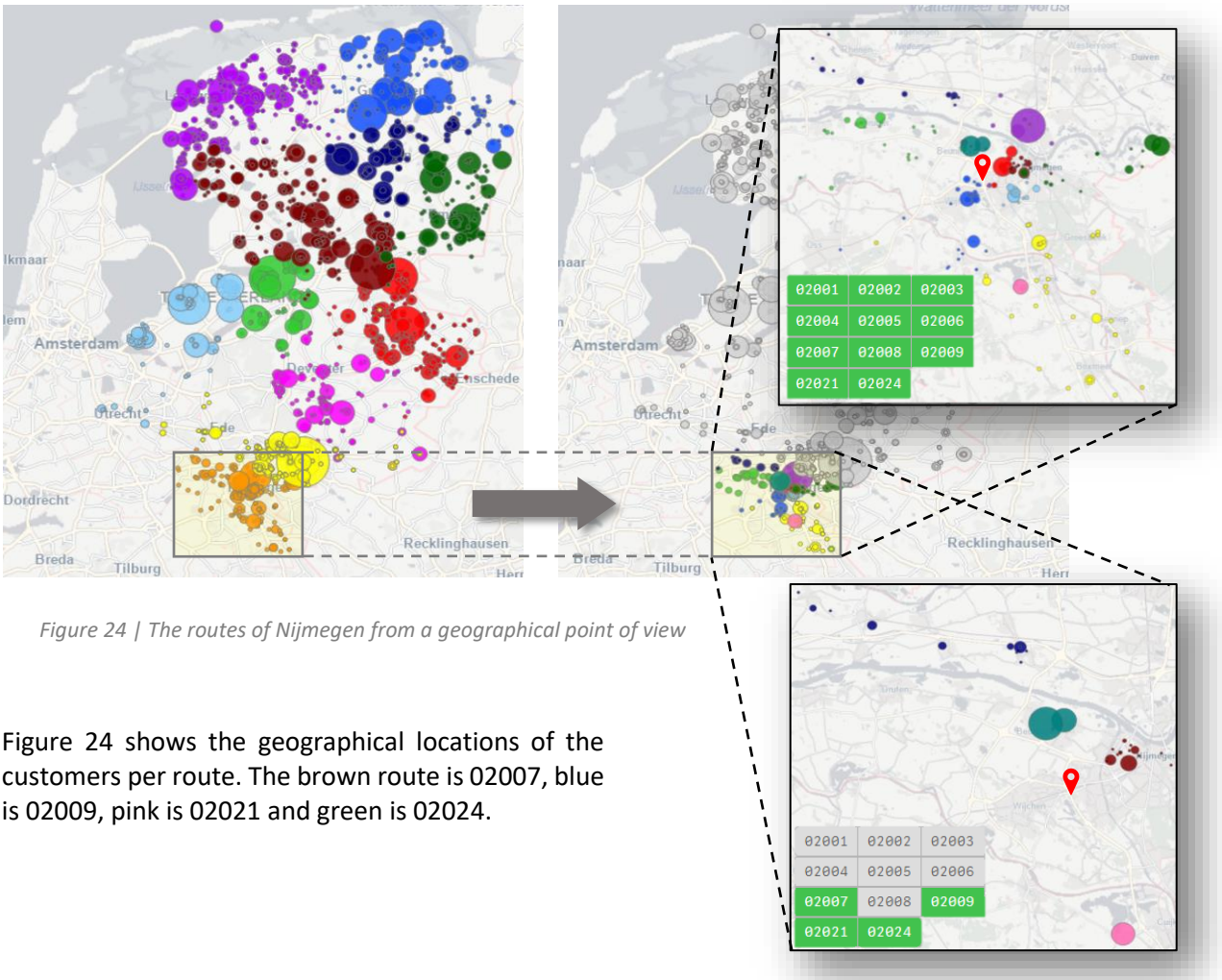


Figure 24 | The routes of Nijmegen from a geographical point of view

Figure 24 shows the geographical locations of the customers per route. The brown route is 02007, blue is 02009, pink is 02021 and green is 02024.

Starting with route number 02007, this route is located closely to route number 02006 (purple). Route 02006 has only four customers that can get deliveries up to eight times a day. Route number 02006 is performing below average as well, see figure 17. So, it might be interesting to combine these two routes. The geographical combination of the routes 02006 and 02007, as well as the maximum number of deliveries per hour per route including the combination of the two routes are in figure 25.

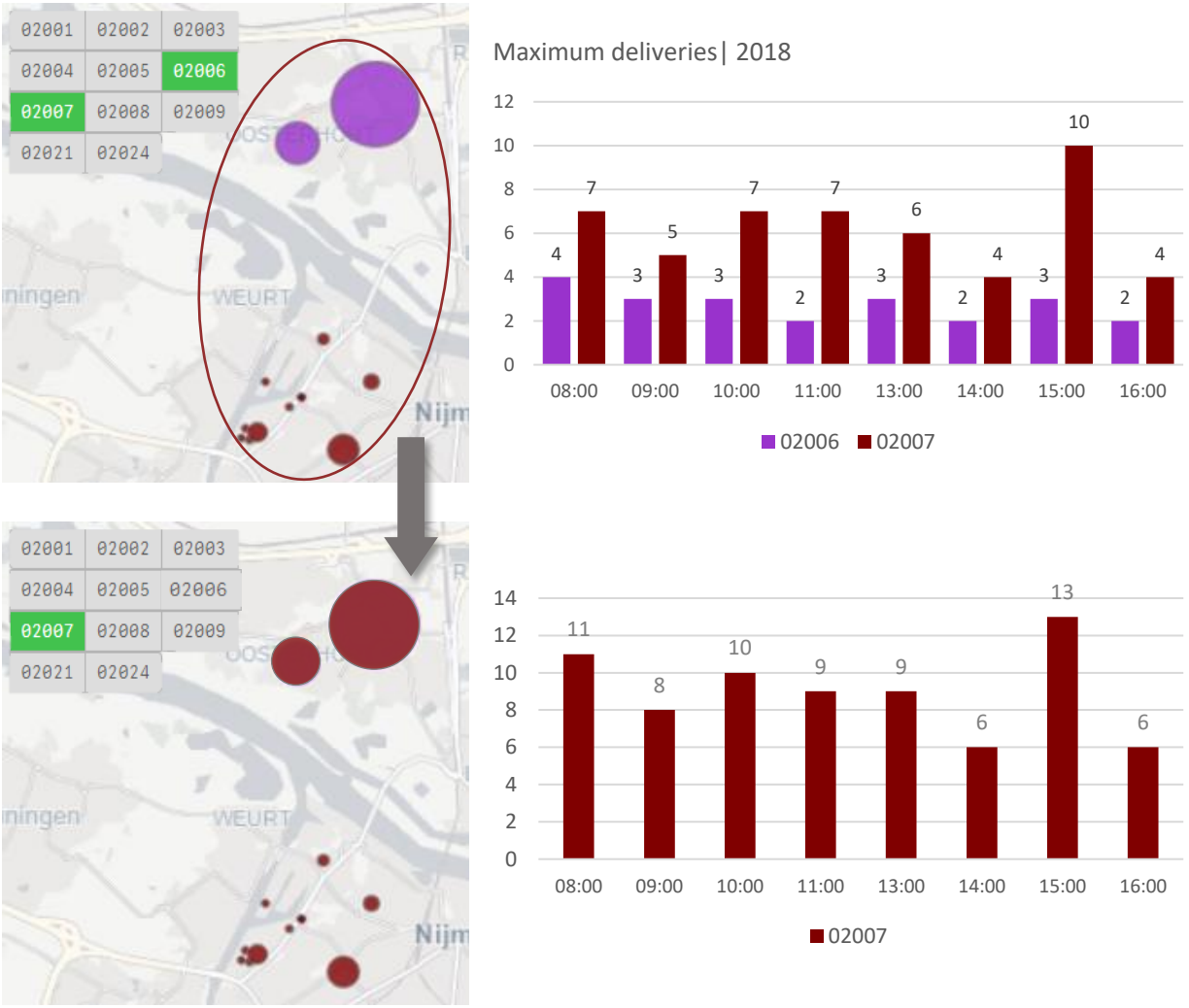


Figure 25 | The geographical locations of the routes 02006 and 02007 & the maximum number of deliveries per route

Figure 25 shows the geographical location of route 02009 (blue). The closest route to route 02009 is 02002 (green). But, route 02002 already has a lot of customers to serve, so it will not be ideal to combine the two routes. Additionally, there is a river in between the two routes with just two bridges, causing less possibilities to drive in between the two areas. So, to improve route 02009, ideally, more customers need to be found in that area.

Figure 25 | The geographical location of route 02009

Looking at route number 02024 (pink), this route is located closely to route number 02003 (blue) and route 02004 (yellow). Route 02024 has only one customer that can get deliveries up to six times a day. Route number 02003 and 02004 are performing below average as well, see figure 17. So, it might be interesting to combine the two routes. The geographical combination of the routes, as well as the maximum number of deliveries per hour per route are in figure 26.

As can be seen from the top left map, the two customers from route 02004 will be allocated to route 02003, resulting in less driving kilometers for the two routes combined.

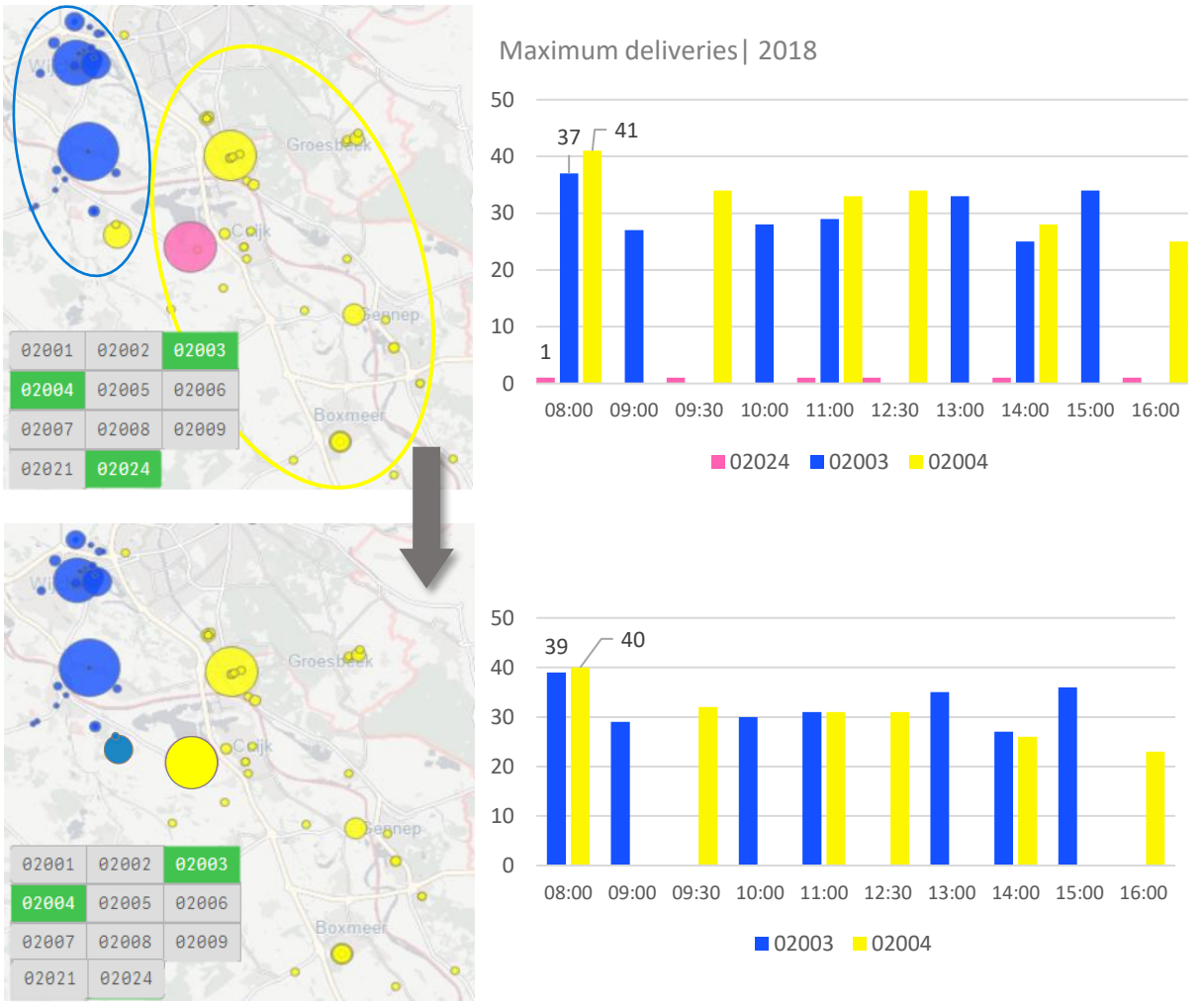


Figure 26 | The geographical locations of routes 02003, 02004 and 02024 & the maximum number of deliveries per route

Looking at route number 02021 (dark green), this route is located closely to route number 02001 (red) and route 02002 (green). Route 02021 has only two customers that can get deliveries up to eight times a day. Route 02001 allows up to eight deliveries as well. Route number 02001 and 02002 are both performing below average, see figure 17. So, it might be interesting to eliminate route 02021 by assigning the customers from route 02021 to route 02001. Additionally, when expanding route 02001, the customers of route 02002 that are located closely to route 02021 can be added to route 02001 as well. The geographical combination of the routes, as well as the maximum number of deliveries per hour per route are in figure 27.

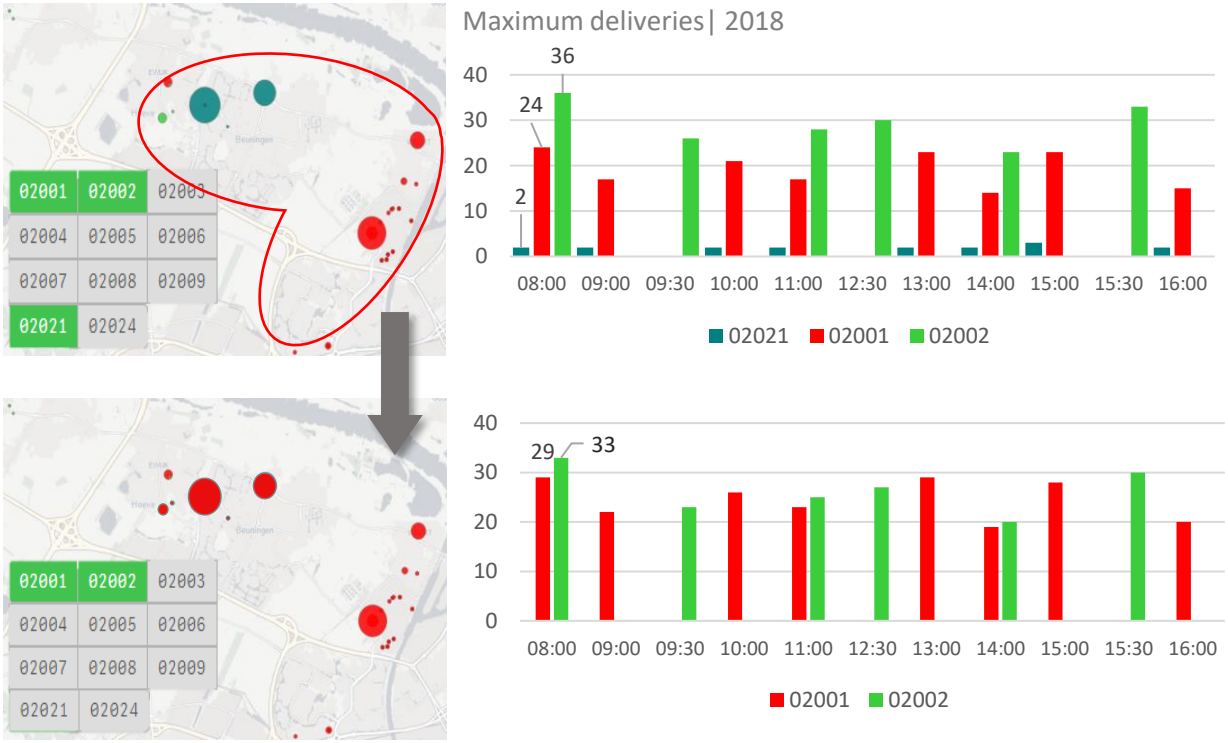


Figure 27 | The geographical locations of routes 02001, 02002 and 02021 & the maximum number of deliveries per route

4.3 Results of the analyses

So, we came with possible solutions for the routes 02007, 02009, 02021 and 02024 of Nijmegen. Now, we need to accurately estimate what the consequences of the solutions will be before recommending any of the solutions for implementation. We will estimate the new average monthly turnover per route for the routes that will be restructured. After that, we will estimate the new average monthly turnover over all routes of Nijmegen.

We will estimate the new average monthly turnover per route by adding or subtracting the average monthly turnover per customer that was assigned to a new route. We assume that the average monthly turnover of a customer stays the same. The results are in figure 28. The green bars mean that the KPI increased in value since there are new customers assigned to the route. Red means that the KPI decreased in value, because some customers from this route are assigned to a new route since this results in more efficient routes. The black bars indicate the routes that are eliminate, because the customers in these routes are assigned to other routes. Each route that gets eliminated saves about €30.000 per year in costs, €20.000 for the chauffeur and €10.000 for the car. We assume that the costs of every route are about €30.000 per year. So, when eliminating the route numbers 02006, 02021 and 02024, a total savings of about €90.000 is possible.

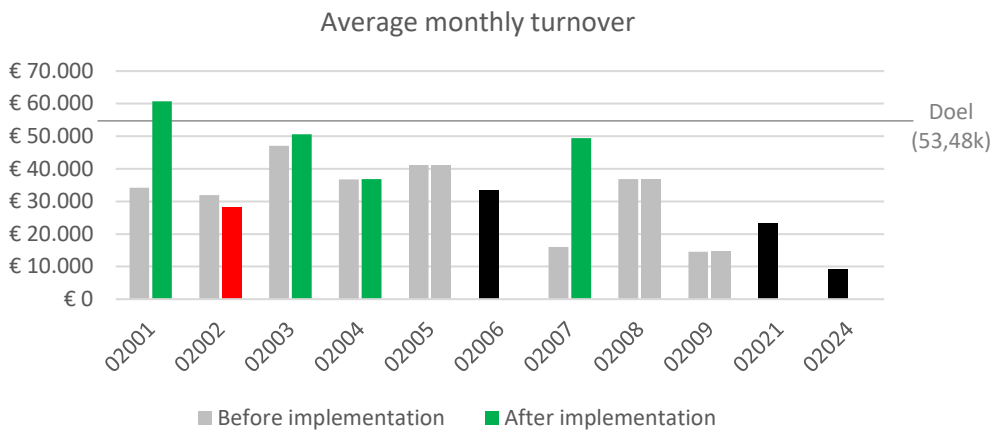


Figure 28 | Avg. monthly turnover per route, before and after implementation

After calculating all the individual new average monthly turnovers per route, we will calculate this KPI for all routes of Nijmegen. The new average monthly turnover of the routes of Nijmegen is €40.600 instead of €29.500 as depicted in figure 29.

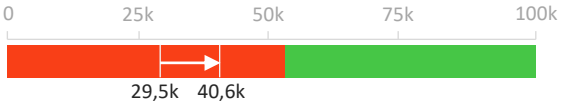


Figure 29 | Avg. monthly turnover of all routes of Nijmegen, before and after implementation

The new situation of Nijmegen compared to its initial situation and compared to the other local warehouses of Koskamp is depicted in figure 30.

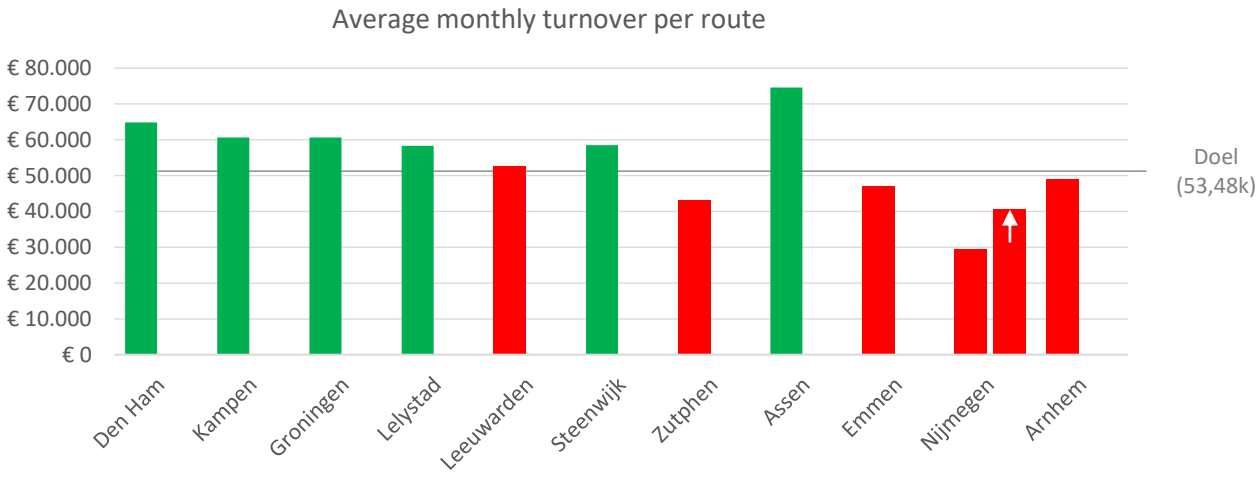


Figure 30 | Avg. monthly turnover of local warehouses, before and after implementation

5. CONCLUSION, RECOMMENDATIONS & LIMITATIONS

The goal of this project was to solve the core problem: *''There is no simple way to get real-time insight into the performance of the delivery routes of the local warehouses.''*. When solving the core problem, all the other problems from the problem cluster should be solved as well. Meaning that the company is able to monitor the performance of the delivery routes in real-time, recognize potential improvements for the delivery routes, and have more insight if the turnover increase results in higher profits. When this is all solved, it will be easier to make quick substantiated management decisions.

The research was done to find the optimal performance indicators for Koskamp, to find a suitable data flow and to find how to best visualize the selected KPIs. Next to that, the capabilities of the dashboards were demonstrated by doing analyses according to a protocol.

We will conclude to what extent our solution reached the norm set by Koskamp. We will then conclude whether our solution, the implemented dashboards, solved the core problem and thus solved all the problems in the problem cluster. After the conclusion, based on the results of this research, we provide recommendations. We will take the limitations of this research into account.

5.1 Conclusion

The core problem would be solved if we reach the norm set by Koskamp. The overview of the comparison between the norm and the current situation after implementation of the dashboards is in figure 31. From this comparison, we can conclude that the implemented dashboards reached the norm set by Koskamp. So, we can conclude that Koskamp now has a simple way to get real-time insight into the performance of the delivery routes of the local warehouses. Now, we only need to conclude whether we solved all the problems from the problem cluster.

First, the company is after implementation of the dashboards able to monitor the performance of the delivery routes in real-time. In practice, the company can for example see which delivery routes are performing according to the set goals. Next to that, the company can for instance monitor the trends and the workload of the delivery routes.

Second, the company is after implementation of the dashboards able to recognize potential improvements for the delivery routes. For example, the company can now recognize if a customer is assigned to the right delivery route, or they can recognize if the workload on a certain delivery moment is too high or too low.

Third, the company has after implementation of the dashboards more insight if the turnover increase results in higher profits. For instance, when Koskamp accepts a new set of customers in a new area, requiring opening a new delivery route, they can now easily monitor if the turnover increase coming from the new customers outweighs the costs of opening a new route.

Next to that, we demonstrated the dashboards by doing sales trend-, workload-, and geographical route- analyses. From these analyses follow that the average monthly turnover per route can be increased for the local warehouse Nijmegen from €29.500 to €40.600. To do so, three routes need to be eliminated, resulting in saving about €90.000 per year, assuming that the yearly costs per route are €30.000. Based on the results, possible route changes are recommended.

All in all, the implemented dashboards reached the norm of Koskamp, solving the core problem. Meaning that Koskamp now has real-time insight into the performance of the delivery routes. This results in the fact that the company is able to monitor the performance of the delivery routes in real-time, find possible improvements for the delivery routes and have more insight if the turnover increase results in higher profits. So, the implemented dashboards allow the management of Koskamp to make quick substantiated management decisions about the delivery routes.

Norm | Goal of the company	Reality | After implementation
1) The available KPIs and factors	
KPIs	KPIs
Visualizations of the financial KPIs Turnover (€) and margin (€) including the growth-rates in (€) and (%) of the two metrics.	Visualizations of the following financial metrics are available: Turnover (€), Margin (€), Margin (%) and the growth-rates in (€) and (%) of the three metrics.
Non-financial KPIs are no priority.	The following non-financial metrics are available: Orders (#) and Customers (#)
Additional recommended KPIs to be able to monitor the performance, recognize potential improvements and have insight if the turnover increase results in higher profits.	The following recommended visualizations are available: Geographical visualizations, pareto analysis, compare visualizations and workload analyses.
Factors Local warehouses Routes per local warehouse Route frequencies Goals of the turnover per route	Factors Local warehouses Routes per local warehouse Route frequencies Goals of the turnover per route Customers
KPIs need to be dynamic, visualized and allow selection-, filters- and compare-functionalities.	The KPIs and analyses are visualized and dynamic. The dashboard allows selection-, filters- and compare- functionalities.
2) The time needed before the KPIs and factors are updated and available	
Time to handle a request	Time to handle a request
The ideal is that the directors can fulfill their KPI value requests themselves with just a few clicks on the screen or phone	When knowing the basics of Qlik Sense, it is possible to easily find the values of the requested KPIs on a computer, phone or any other device
Time to refresh the data	Time to refresh the data
The data should be updated automatically every night	The data gets updated automatically every night
3) Time needed to maintain the system	
The system should almost automatically be maintained and updated. Only some general settings should be updated manually. This should not take longer than one hour per month.	The dashboards almost automatically maintain themselves. Qlik Sense software updates need to be done manually. Furthermore, some general settings such as adding a new local warehouse need to be set manually. The time needed to maintain the dashboards depends on various things, but on average it will take about one or two hours per month.

Figure 31 | Comparison between the norm and the reality after implementation

5.2 Recommendations

In this section, we will provide the recommended changes to the routes. Next to that, we provide recommendations about maintaining and expanding the dashboards for future usage.

Route changing recommendations

We demonstrated the dashboards in Chapter 4 by doing analyses according to a research protocol. To find possible improvements for Koskamp, we analyzed the sales trends, the geographical allocation and the workload of the routes

From the research in the dashboards, we found that the local warehouse Nijmegen drastically needs improvements, especially the route numbers 02007, 02009, 02021 and 02024.

From the sales trend analyses follows that route 02007 shows a negative turnover growth-rate of €22.212 compared to last-year-to-date. This trend was caused mostly by customers that were assigned to route 02008. But, about 30% of the turnover decrease was caused by customer X[1] who decreased by €6.552 compared to last-year-to-date. Therefore, we recommend to identify why customer X decreased in turnover to try to increase the sales again, recovering the growth-trend.

From the geographical route analyses follows that the routes 02006, 02021 and 02024 can be eliminated, resulting in saving about €90.000 per year, assuming that the yearly costs per route are €30.000. To do so, we recommend to assigning the customers of route 02006 to route 02007, the customers of route 02021 to route 02001 and the customer of route 020024 to route 02003.

From the route workload analyses follows that workload of the routes, meaning the number of deliveries per route, can be equalized by assigning two customers of route 02004 to route 02003 and three customers of route 02002 to route 02001. This will result also result in less total kilometers of driving.

All in all, by implementing the recommended changes, the average monthly turnover per route can be increased for the local warehouse in Nijmegen from €29.500 to €40.600. To do so, three routes need to be eliminated, resulting in saving about €90.000 per year. These changes will also result in a more equalized workload and less driving kilometers in total.

Maintaining & Expanding the dashboards

We recommend keeping the dashboards up-to-date, meaning that the Qlik Sense software should be updated periodically. Also, when eliminating a route or when adding a local warehouse this should be set manually in the dashboards by editing the Qlik Sense variables.

For the route dashboards, we recommend including the metric returns (€), because this will make it possible to calculate the net turnover (€). To do so, data needs to be collected when and which route picks-up the returned goods.

We also recommend building more dashboards to get more insight into the business. Examples of new dashboards that could be implemented are dashboards that for example automatically recognize the decreasing sales trend of a customer, alerting the responsible sales manager. Or for example, dashboards that monitor the stock levels of the products, visualizing the backorders and the dead stock and then report this information to the purchasing- and marketing department.

[1] Due to confidentiality rules, the customer names are excluded from this report.

5.3 Limitations

There are several limitations that could have an influence on the results of the research.

At first, there is a lack of prior knowledge about doing research to create a dashboard that visualizes the performance of business processes. This could result in not having a good foundation to start the research study, causing several research loops before finding the answer.

Second, the sample size of the interviews was low, since there are only a few employees in the company that have the knowledge about the operations of the delivery routes that the research needs. Because the sample size is low, it could be possible to miss some important options, for example missing KPIs that are not yet implemented that could express the performance of the delivery routes.

Third, the metric turnover (€) in the dashboards is including the returns (€). This because there is no data available when the returned products are collected. In practice, the products that a customer wants to return will be collected when there is a new delivery for the customer or when the product has backorders. So, it is for example not yet possible to assign a returned product to a delivery timeslot. Because of this, it is not possible to calculate the net turnover (€).

Fourth, it is impossible to internally validate all the real-time data that will be imported into Qlik Sense since there is a lot of data, so this will be very time consuming. It is possible to do some validation checks automatically, but this is not a 100% guarantee that all the data represents the real world. Therefore, it is important that the users of the dashboard always check is the data is correct before making a decision based on the data.

Furthermore, the time to solve the core problem was only ten weeks. Because of this short amount of time, it was not possible to externally validate whether the dashboards solved the starting problem of the directors – *"it is currently hard to make quick substantiated management decisions"*. At the time of writing, the dashboards are implemented for about two weeks. The dashboards are used on average thirty minutes on a daily basis and the users already made some changes to the routes. But, at the time of writing, it is not possible to validate whether the decisions are successful, and thus, it is not yet possible to externally validate the dashboards.

Moreover, we assumed that if a customer moves to another route, this customer will generate the same sales as in the initial route. In practice, this might not be true. It could be the case that a customer needs to wait longer before delivery than in the initial situation, resulting in customer complaints and a decline in sales. But, it could also be the other way around. If the customer initially had to wait longer than in the new situation, this customer might decide to buy more from Koskamp than before.

Next to that, we were not able to accurately estimate the savings on the recommended changes. On average, the costs per route are €30.000 per year. But obviously, these costs are subject to change, depending on the fuel price, the kilometers to drive, the salary of the drivers, etc. Therefore, we assumed that the total savings are €90.000, but in practice, the savings will vary.

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APPENDICES

Appendix 1 | Overview of the levels to get insight into the business performance

In figure A1 is a diagram that shows different levels to get insight into the performance of a business. The business departments are categorized into external- and internal related processes and aspects, which are in the figure distinguished by the dashed line. Each department has several processes or aspects of which the performance can be expressed by KPIs. The KPIs get influenced and calculated by the so-called factors.

The arrow points in the direction of a deeper level of detail to get insight into the performance of a business. The selections, specifically for this study, are marked red. Each next level of detail gives some examples that are covered by these selections.

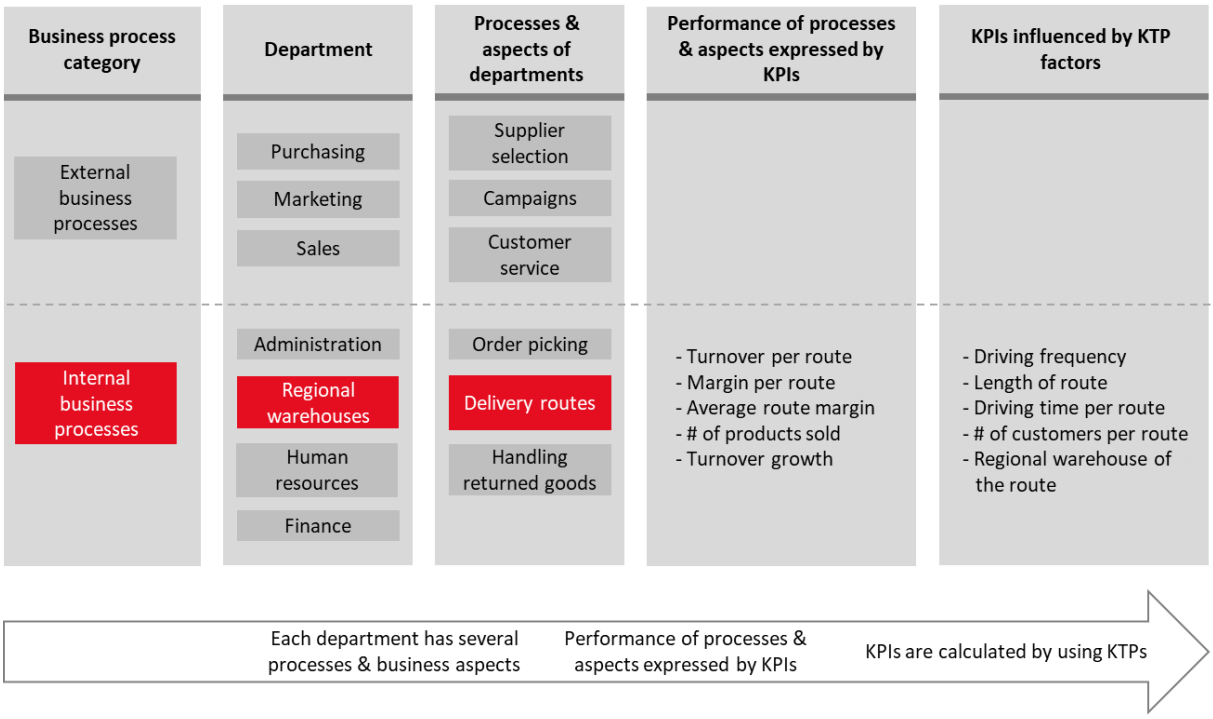

Figure A1 | Overview of the levels to get insight into the business performance

Appendix 2 | Selecting literature systematically

Webster & Watson (2002) described the following 4-steps to do a systematic literature review:

1. Define the keywords, search strings, and inclusion & exclusion criteria to search in scientific databases such as Scopus and Web of Science. The following was used to find relevant articles:
   - Search strings: "Transport" AND "KPI", "Transport" AND "Dashboard", "Logistics" AND "KPI", "Logistics" AND "Dashboard".
   - Key words: Key Performance Indicators, logistics, KPI, supply chains, measures, management, optimization, logistics service, metrics
   - Date range: >1990 since it is not likely that there were any BI-dashboard presenting the performance of a supply chain by using KPIs at that time.
   - Inclusion & exclusion criteria: see Appendix 2 for detailed criteria.
   - Titles and abstract: check if the articles could answer the knowledge question.
2. After scanning and reading parts of the articles, the reference list of the interesting articles was checked for other articles that could contribute to answering the knowledge question. When interesting, the article was added to the literature list.
3. The process between step 1 and 2 was done several times until most relevant articles were selected. This way, an overview of the current theory from relevant literature can be collected.
4. A framework or a so-called concept-matrix will be formed based on the literature. (Webster & Watson, 2002) This concept-matrix will then give an overview of the theory concepts collected from each article. The theory concepts collected from each article can then be used to conclude what the literature presents about each concept. Forming the framework is done in Appendix 4.

The final selected articles from the systematic literature review are in Appendix 3 | Literature list.

Search strings

Both, the key words “Logistics” and “Transport” were used in search strings to make sure that the articles cover KPIs and frameworks to cluster KPIs that are useful to indicate the performance of the delivery routes of Koskamp. Next to that, the key words “KPI” and “Dashboard” were used in search strings to find articles that include KPIs that measure parts of the logistics chain. When an article discusses dashboards, KPIs will be included as well since dashboards are based on KPIs. Combinations of these four keywords were used to cover both fields, see ‘Table A1 | Search strings’. Results of the search strings are in ‘Table A4 | Search results of the systematic literature review’.

	Transport	Logistics	KPI	Dashboard	Search string
Search 1	X		X		"Transport" AND "KPI"
Search 2	X			X	"Transport" AND "Dashboard"
Search 3		X	X		"Logistics" AND "KPI"
Search 4		X		X	"Logistics" And "Dashboard"

Table A1 | Search strings

Inclusion- & exclusion criteria

Extra key words were included to filter relevant articles from the database search results. Next to that, exclusion criteria were used to filter irrelevant articles from the findings. The inclusion- & exclusion criteria are in ‘Table A2 | Inclusion criteria’ respectively ‘Table A3 | Exclusion criteria’.

Nr.	Inclusion criteria	Reason for exclusion
1	Keywords: Key Performance Indicators, logistics, performance, KPI, supply chains, measures, management, optimization, logistics service, metrics	These were typical keywords found in the selected articles for reading.

Table A2 | Inclusion criteria

Nr.	Exclusion criteria	Reason for exclusion
1	Subjects: Biochemistry, Chemical, Neuroscience, Chemistry, Medicine, Energy, Social science and Environmental	This does not refer to the company
2	Journals: Biological Chemistry, Plant Physiology, American Chemical Society	This does not refer to the company
3	Keywords: protein, public transport, traffic	This does not refer to the case
4	Non- Dutch and non-English articles	Hard to read and understand foreign languages
5	Articles that focus on the hierarchy of specific KPIs	
6	Articles that only refer to planning KPIs	Not relevant, the company delivers at standard times

Table A3 | Exclusion criteria

Systematic literature review search results

The protocol and the numeric search results from the systematic literate review are depicted in 'Table A4 | Search results of the systematic literature review'. These results follow from the 4-steps process described in section 'Appendix 2 | Selecting literature systematically'. The eight selected articles and books are in 'Appendix 3 | Literature list'.

Search string	Scope	Date	Date range	# entries
Search protocol for Scopus				
"Transport" AND "KPI"	Title, abstract and keywords	9-4-18	1990 - present	83
"Transport" AND "Dashboard"	Title, abstract and keywords	9-4-18	1990 - present	78
"Logistics" AND "KPI"	Title, abstract and keywords	9-4-18	1990 - present	76
"Logistics" AND "Dashboard"	Title, abstract and keywords	9-4-18	1990 - present	55
Search protocol for Web of Science				
"Transport" AND "KPI"	Topic, title	10-4-18	1990 - present	46
"Transport" AND "Dashboard"	Topic, title	10-4-18	1990 - present	35
"Logistics" AND "KPI"	Topic, title	10-4-18	1990 - present	42
"Logistics" AND "Dashboard"	Topic, title	10-4-18	1990 - present	29
Total in Endnote				**444**
Selecting based on inclusion/exclusion criteria				-412
Removing duplicates				-8
Removed after reading				-19
Included after a complete reading				+3
Total selected for review				**8**

Table A4 | Search results of the systematic literature review

Appendix 3 | Literature list

The final ten articles and books selected from the systematic literature review described in section 'Appendix 2 | Selecting literature systematically' are in table A5.

Nr.	Author (year)	Title	Citations	Publisher
1	Kovacs, GY. (2017)	Development of performance evaluation software for road freight transport activity	0	Polish Journal of Management Studies
2	Dalmolen, S., et al. (2013)	Transportation performances measures and metrics: Overall Transportation Effectiveness (OTE): A framework, prototype and case study	2	School of Management and Governance, University of Twente, Netherlands
3	Krauth, E., et al (2005)	Performance Measurement and Control in Logistics Service Providing.	74	Erasmus Univeristy, VU Amsterdam
4	Collins, T.R. & Rossetti, M.D. (2004)	Tracking Logistics Performance in the Trucking Industry	2	Department of Industrial Engineering University of Arkansas and University of Texas
5	Bowersox et al (1996)	Logistical management, the integrated supply chain process	-	New York: McGraw-Hill
6	Gunasekaran, A., et al (2004)	Performance measures and metrics in a supply chain environment.	1231	International Journal of Operations & Production Management
7	Chan, F.T.S. (2003)	Performance Measurement in a Supply Chain.	199	International Journal of Advanced Manufacturing Technology
8	Ramdas, K. & Sprekman, R.E. 2000)	Chain or Shackles: Understanding What Drives Supply-Chain Performance	174	Institute for Operations Research and the Management Sciences

Table A5 | Final literature list from the systematic literature review

Appendix 4 | Identification of framework for clustering KPIs

Table A6 is a concept-matrix to identify which perspectives are used in the literature to select KPIs that will indicate the performance of the delivery routes.

	Perspective				
Source	**Management**	**Employee**	**Customer**	**Society**	**Industry**
(Kovacs, G.Y., 2017)	X	X	X	X	
(Bowersox et al., 1996)	X		X		
(Gunasekaran, A. et al., 2004)	X		X		X
(Ramdas, K. & Sprekman, R.E., 2000)	X		X		
(Chan, B.K., 2003)	X		X		
(Dalmolen, S. et al., 2013)	X				
(Collins, T.R. & Rossetti, M.D., 2004)	X	X	X		
(Krauth, E. et al., 2005)	X	X	X	X	

Table A6 | Perspectives used in the literature

Table A7 is a concept-matrix that identifies the categories to cluster KPIs, based on the frameworks used in the literature to select KPIs. The column 'Efficiency' categorizes KPI categories that take resources into account. The concept 'Financial / Effectiveness' is related to the final results of the process. The third column categorizes the stakeholders and its interests. The fourth column is about other things where the company can improve and what is already satisfied. Text in gray is not relevant for the delivery routes of Koskamp.

	Concepts of framework			
Sources and titles of the framework	**Efficiency**	**Financial / Effectiveness**	**Customer, Society & Quality**	**Management related information**
(Kovacs, GY. 2017)	Productivity	Costs	Quality and service	
(Bowersox et al., 1989)	Asset-management Productivity	Costs	Customer Quality and service	
Managerial approach (Gunasekaran, A., et al 2004)		Costs	Customer service	Planning Evaluation of supply links Production level Delivery link
Time based approach (Ramdas and Spekman 2000)	Time	Order-fulfilment	Quality Customer-satisfaction	Inventory
Qualitative and quantitative approach (Chan, F.T.S. 2003)	Resource utilization	Cost	Quality Trust Visibility	Flexibility Innovations
Horizontal / Vertical approach (Dalmolen, S., et al. 2013)	Availability Productivity Efficiency	Effectiveness	Partners Customer Quality	
Balansed Scorecard (Collins, T.R. & Rossetti, M.D. 2004)	Internal Business-Process	Financial	Customer	Learning and growth
Internal & external point of view (Krauth, E., et al 2005)	Efficiency	Effectiveness	Customer Society	Management satisfaction IT Utilization & innovation

Table A7 | Categorization of common concepts used in the clustering frameworks in the literature

Appendix 5 | Concept-matrix: selecting KPIs from the literature

Table A8 gives an overview of the KPIs per article in a concept-matrix based on the framework defined in Section 2.1.2.

Perspective / Source	Internal				External	
	Management			Employee	Customer	Society
	Financial / Effectiveness	Efficiency	Learning & Growth			
(Kovacs, GY. 2017)	Fuel costs	Fuel usage	Damages % throughput	Working days	Traceability	CO2 per km
	Claims % freight costs	Vehicle time utilization	% right delivery	Non working days	On-time pickups	
	Maintenance costs	Quantity per shipment		Total working days	On-time delivery	
		Transit time			% undamaged goods	
		% fleet not used				
		Truck turnaround time				
		Average # of stops				
		Number of handling points				
		Labour productivity				
		Loading time				
(Bowersox et al., 1989)	Return on - investment	Capacity - utilization	Damaged in - transit		Transit time	
	Cost per weight	Orders per vehicle			Delay	
	Transportation-cost per loading	Full vs partial - loads				
(Gunasekaran, A., et al 2004)	Total distribution-costs	Order lead time	Driver reliability		Customer order-path	
	Asset costs	Capacity - utilization			Range of services	
	Return on-investment	Frequency of-delivery			Customer - satisfaction	
	Information - processing costs				Customer query - time	
					Responsiveness-urgent deliveries	
(Ramdas & Spekman 2000)		Order processing-time	Shipment-accuracy		Cutomer-satisfaction	
(Chan, F.T.S. 2003)	Distribution costs	Labour utilization	Lack of resources-in a time period		Customer-response time	
	Subsidy	Vehicle utilization	Wrong delivery		Lead-time	
	Overhead costs	Capacity-utilization			On time delivery	
		Fuel utilization			Accuracy	
					Customer-complaints	

Table A8 | KPI categorization in the framework / concept-matrix

{Continues on next page}

Appendix 5 | Concept-matrix: selecting KPIs from the literature

Perspective / Source	Internal				External	
	Management			Employee	Customer	Society
	Financial / Effectiveness	Efficiency	Learning & Growth			
(Dalmolen, S., et al. 2013)	Vehicle - effectiveness	Used time				CO2 emission
	Equipment - effectiveness	Production time				
		Running time				
		Real running time				
		Real operation time				
		Effective time				
		Truck availability				
(Collins, T.R. & Rossetti, M.D. 2004)	Costs per truck	Loading size	Absentee rate	Driver's gross- pay	Claims settling-rate	
	Maintenance costs	Average speed	Accident rate	Average # - working days	Re-purchase rate	
	Driver's gross pay	Average length	Education-received	Driver's weekly-hours	% Order on time	
	Turnover	Operating - hour/truck/day	Truck operator's-experience	Training received	Complete order-rate	
	Turnover/driver	Load factor	# truck operators	Recognition	Damage free rate	
	Turnover/driving time	Km/truck/week	% active - customers	Promotion rate	On-time delivery	
	Turnover/trip	Average loaded miles	Delivery accuracy			
	Turnover/truck	Average empty miles	% Correct orders			
	Turnover/hour	# stops per route	% Order returned			
	% return on asset	Time between stops	Claims rate			
	% return on - investment		On-time loading			
	Turnover growth-rate					
(Krauth, E., et al 2005)	Turnover per - route	Labour utilization	% absent employees	Overtime hours	Customer - satisfaction	Society - satisfaction
	Profit margin	Overhead - percentage	% failed orders	Salaries and-benefits	Response time	CO2 emission
	Capacity utilization	Average fuel use - per km	% Realized vs - requested orders	Employee - satisfaction	Transparancy	Chartiable actions
	Km per day		% On-time - delivery	Km per trip	Timelines of - goods deliveries	Road-maintenance-costs
	Labour - productivity		# customer - complaints	Weight to - unload per hour	Possibility to - change order	# Work places
	Turnover per km				# Contact points	# Of complaints
	# of deliveries					
	Perfect order -					
	# of orders					
	# of customers					
	# of profitable customers					
	Distribution costs					

Table A8 | KPI categorization in the framework / concept-matrix

Appendix 6 | Initial KPI selection

Internal				External	
Management			Employee	Customer	Society
Financial / Effectiveness	Efficiency	Learning & Growth			
Total turnover	Order lead time	Absentee rate	Km per trip	On-time delivery	CO2 per km
Turnover/route	Frequency of driving	Accident rate	Weight to unload per hour	# Delay	CO2 per time
Turnover/time	# Stops per route	% Damages	# Working days	% Undamaged goods	Chartiable actions
Turnover growth- rate	Average # of stops	# Drivers	# Non working days	Customer satisfaction	# Work places
# of profitable customers	Transit time	Driver reliability	Average # working days	# Customer complaints	# Of complaints
# of deliveries	Labour utilization	Drivers experience	Driver's weekly hours	Customer order path	Society satisfaction
# of orders	Fuel usage	% Active customers	Overtime hours	Customer query time	Road maintenance
# of customers	Vehicle utilization	% Wrong delivery	Driver's gross pay	Range of services	
Turnover per km	% fleet not used	% Right delivery	Training received	Responsiveness urgent deliveries	
Km per day	Labour productivity	Shipment accuracy	Recognition	Timelines of goods deliveries	
Turnover/driver	Loading time	Claims rate	Promotion rate	On-time pickups	
Cost per route	Vehicle operating hours	# customer complaints	Employee satisfaction	Lead-time	
Costs per vehicle	Order processing time	Lack of resources		Transparancy	
Maintenance costs	Claims as % of costs	On-time loading			
Driver's gross pay	Truck turnaround time				
Return on investment	Quantity per shipment				
Distribution costs	Orders per vehicle				
Perfect order - fulfilment	Capacity utilization				
Overhead costs					
Subsidy received					
Fuel cost					
Profit margin					
Asset costs					
Cost per weight					
Turnover/vehicle					

Preferred KPIs

Not feasible within time limit

KPI available in another system

No priority right now

No data available

Table A9 | Initial KPI selection of Koskamp of the SLR

Appendix 7 | Data cleaning & data preparation

```
...
//Load route codes
if(isnum([RouteID])='true',                 //Validate data type (number)
   if(len([RouteID])='5',                   //Validate data consistency (5 numbers)
      if(left([RouteID],1)='0' and          //Validate constraint (code starts with 0)
       num(right([RouteID],2))>='1',       //Validate constraint (route number >= 1)
            [RouteID],                      //When correct, remember the route code
            'GEEN'                          //When incorrect, remember 'GEEN'
         )
      )
   )                        AS [TTRouteID]; //Load when validate
...


...
//Load delivery dates
if(isnum([LeverDatum])='true',              //Validate data type (number)
   if(len([LeverDatum])='8',                //Validate data consistency (8 numbers)
    //Verify range >= 01-01-2016 (in numbers: 42370)
    //Verify range <= yesterday
    if(floor(max(date(date#([LeverDatum],'YYYYMMDD'),'DD-MM-YYYY')))>='42370'
    and(floor(max(date(date#([LeverDatum],'YYYYMMDD'),'DD-MM-YYYY'))))<=today(0)-1,
          //When correct, remember and transform to the right format
          date(date#([LeverDatum],'YYYYMMDD'),'DD-MM-YYYY')),
          null()
         )
      )
   )                        AS [TTLeverDatum]; //Load when validate
...


...
//Load delivery times
if([TTRouteID]='GEEN',           //Validate constraint, if the route code is valid
    null(),
    isnull([TTLeverDatum],       //Validate constraint, if the delivery date is valid
      null(),
      [Vertrektijdtijd]          //When correct, remember the delivery time
      )
  )                         AS [TTVertrektijdtijd]; //Load when validate
...


...
//Load local warehouses
//Connect the left 3 numbers of the validated TTRouteID to the related warehouse
if([TTRouteID]='GEEN',           //Validate constraint, if the route code is valid
    null(),
    if(left([TTRouteID],3)='001',' (01) Den Ham',
    if(left([TTRouteID],3)='002',' (02) Kampen',
    if(left([TTRouteID],3)='005',' (05) Groningen',
    if(left([TTRouteID],3)='006',' (06) Lelystad',
    if(left([TTRouteID],3)='007',' (07) Leeuwarden',
    if(left([TTRouteID],3)='008',' (08) Steenwijk',
    if(left([TTRouteID],3)='010',' (10) Zutphen',
    if(left([TTRouteID],3)='012',' (12) Assen',
    if(left([TTRouteID],3)='019',' (19) Emmen',
    if(left([TTRouteID],3)='020',' (20) Nijmegen',
    if(left([TTRouteID],3)='021',' (21) Arnhem',
      null()
      ))))))))))))
   )                AS [TTVestiging]; //Load when validated
...
```

Appendix 8 | Script used to create the master calendar

```
//First, define the range of the dates (01-01-2016 ; yesterday)
DateRange:
Load
	'42370'                          as MinDate,  //From 01-01-2016
	Floor(Num(Today(0)-1),1)         as MaxDate   //Till yesterday
Resident TempTableDD;

//Create variables for the min. and max. date values from DateRange
Let varMinDate = Peek('MinDate', 0, 'DateRange');
Let varMaxDate = Peek('MaxDate', 0, 'DateRange');

DROP Table DateRange;

//Create table 'AllDates' and list all dates between the min. and max. date
AllDates:
Load
	Date($(varMinDate) + IterNo() - 1) as TempDate
	AutoGenerate (1)
	While $(varMinDate) + IterNo() - 1 <= $(varMaxDate);

//Create the MasterCalendar by using the list of dates from 'AllDates'
TT_MasterCalendar:
Load
	TempDate                                          as TTLeverDatum,
	Year(TempDate)                                    as TT_Year,
	'Q' & ceil(month(TempDate)/3)                     as TT_Quarter,
	Month(TempDate)                                   as TT_Month,
	Week(TempDate)                                    as TT_Week,
	WeekDay(TempDate)                                 as TT_Weekday,
	Year(TempDate) & '-' & 'Q' & ceil(month(TempDate)/3) as TT_YearQuarter,
	Year(TempDate) & '-' & Month(TempDate)            as TT_YearMonth,
	Year(TempDate) & '-' & Week(TempDate)             as TT_YearWeek
Resident AllDates;
Drop Table AllDates;
```