MSc Thesis

A performance indicator framework for providing data-driven services to European truckload carriers

From identification of performance indicators to framework development

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TU Delft

SAP

A performance indicator framework for providing data-driven services to European truckload carriers

From identification of performance indicators to framework development

by

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Preface

This research marks the final stage of my time as a student at the Delft University of Technology. It presents the final stage of the Master of Science degree in Transport, Infrastructure and Logistics. In collaboration with SAP, this research is conducted.

Setting up a research during the coronavirus pandemic produced some challenges. I was very eager when I was introduced into the topics of the research. By combining my transportation and logistic knowledge with business views and learning about IT, I was motivated to tackle the challenges at hand.

This thesis would not have been realised if it weren't for the help of others. I would like to take this opportunity to express my gratitude to the people that have guided me throughout this process.

First, I would like to thank the chair of my committee, Lori Tavasszy, for his guidance throughout the whole process. With his inspiration on the topic, I have always felt motivated. The use of my topic as a case study for the master introduction class helped me reflect on my research. I would also like to thank committee members Bilge Atasoy and Henk Taale for their feedback, which has always acted as a trigger for me to improve. I also want to thank my SAP supervisor Tom Hornstra, who has helped me throughout the overall project. The insight I developed during the meetings, interviews, training courses and presentations have provided valuable information to this research and my personal development. Even though the pandemic led to me performing my research at home, I have always received the help I needed for this research.

I would also like to express my gratitude to my friends and family. I have valued the reflection on the thesis with fellow TIL students. My family have always provided support during my entire studies. Finally, I would like to thank Paula for her support.

Raymond van Zwieteren
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Executive summary

The past decade has seen a rise in ability to collect, store and manage large amounts of data. With data becoming increasingly available to businesses, organizations are looking for new ways to gain insight into their organization. This also applies to the transportation industry. Acquired information can help companies cope with industry trends of increased competition, the increasing pressure for lower transportation costs and higher service levels. The challenge for companies lies in determining what data is of value to the business. The truckload carrier industry is no exception. Truckload carriers are companies that are focused on the transportation of truckloads, where the goods transported belong to a single customer. Using data in a valuable way can lead to making data-driven decisions. To achieve these data-driven decisions, it is important to understand how performance indicators can be measured.

For road carriers, the main challenge is to identify relevant information and data sources. This research proposes a framework, in which clear performance indicators are reported, as well as how these can be measured. Using the framework, the relevant information and data sources are identified. Using correct measurements and analytics, carrier operations can be made insightful. At the moment, few carriers measure their operations in an optimal way that they can use the information gathered. In recent years, operations have improved, with new sensors, applications and computers onboard the truck, as well as improved software for corporate functions. Carriers are often unaware of the possibilities available in these software tools. Once performance measurement is clear, the next step is identifying the data sources that need to produce the information.

Identification of performance indicators and essential data sources

Literature is yet to produce a useful method for developing a performance indicator framework. Therefore, a proposed method is designed. The method can be described in four steps; identification, definition, association and tracking of performance indicators. A top-down approach by Ganesan & Paturi described how identification, definition and association of performance indicators can be determined. A mechanism developed by Lim et al. identifies a bottom-up approach which describes how data can lead to value creation. By combining both approaches, a proposed method is created to develop performance indicators. In the addition to Ganesan & Paturi, the Lim mechanism identifies a more detailed approach for tracking performance indicators, and how new and improved data sources can be used to identify performance indicators.

The identification of the performance indicators is done by analysing the carrier business and company characteristics. Literature and interviews with European road carriers provide further insight into critical areas from which four key focus areas are identified. First, operational excellence covers performance indicators related to cost efficiency, processing times, resource use and success rates. Second, customer centricity identifies the performance of communications, customer satisfaction and success and the quality of service. The third key focus area includes financial aspects, measured in customer orders, agreements and revenue. Fourth, sustainability is measured in safety, environment and employee satisfaction. The identification of these key focus areas is used to determine goals. Using goals, performance indicators are identified. Performance indicators are defined as strategical or operational, where operational are used for specific activities and relatively short periods. Strategic performance indicators form the base for long term goals. An extensive list of performance indicators is identified and associated using the relevant business areas and activities. To do so, the road carrier business is divided into various business units. Strategic freight selling, order management, transportation planning, transportation execution and freight charge and calculation. In each of these business units, activities, objectives and relevant employees are identified.

The next step is determining what information is needed per performance indicator. More than twenty data sources are analysed using the Lim mechanism. The mechanism is used to define the data source, the data collection method, a description of the data and how the data is analysed. For each performance indicator, the required information is identified. Required information is connected with available data sources.

A distinction can be made between data sources. IT indicates all information that can be retrieved using software applications. The truck and trailer provide a range of data sources including the tachograph, cameras, sensors and driver devices. External data sources can also be used to produce essential information. Main external data sources are used to gain information on weather, road conditions, traffic and toll. A fourth area includes surveys. Surveys are used to produce information which cannot be produced using the previously mentioned data sources. A distinction can be made between operational and experienced data. Operational data is used to determine the performance using own operations, while experienced data is produced by the customer. Using experienced data, better insight into the experiences of clients is produced. Performance indicators can sometimes be tracked in different ways and it is up the specific business to determine which combination is best. This study shows that the majority of performance indicators can be derived from IT, while sensors also produce large amounts of valuable information. The external data sources can be applied in certain aggregation levels, while they also have the potential for future activities. Surveys are focused on the satisfaction of the customers and driver.

A performance indicator framework

Using the information gathered, a performance indicator framework is developed. The objective of the performance indicator framework is to report performance indicators for the right stakeholder, and indicate how that indicator can be measured. The framework consists of an input section, where the specific stakeholder is chosen. Stakeholders of the framework choose between reporting performance indicators for executives, management and specific roles. For management and specific roles, the input also gives opportunities to identify the relevant focus group, business unit or activity. The combination leads to performance indicators relevant to 37 different stakeholders. The output reports a selection of 96 performance indicators and respective data sources. For executives, the ten most relevant performance indicators are identified. These include ten performance indicators often mentioned in literature and interviews, as well as covering most of the focus areas.

The framework is also used to determine the impact of scenarios on the performance of road carriers. Three scenarios are considered, a pandemic, changing oil price and changing regulations within the European Union. The actual Covid-19 situation and Brexit provide useful information. Using the framework, performance indicators affected positively or negatively by the scenario can be identified.

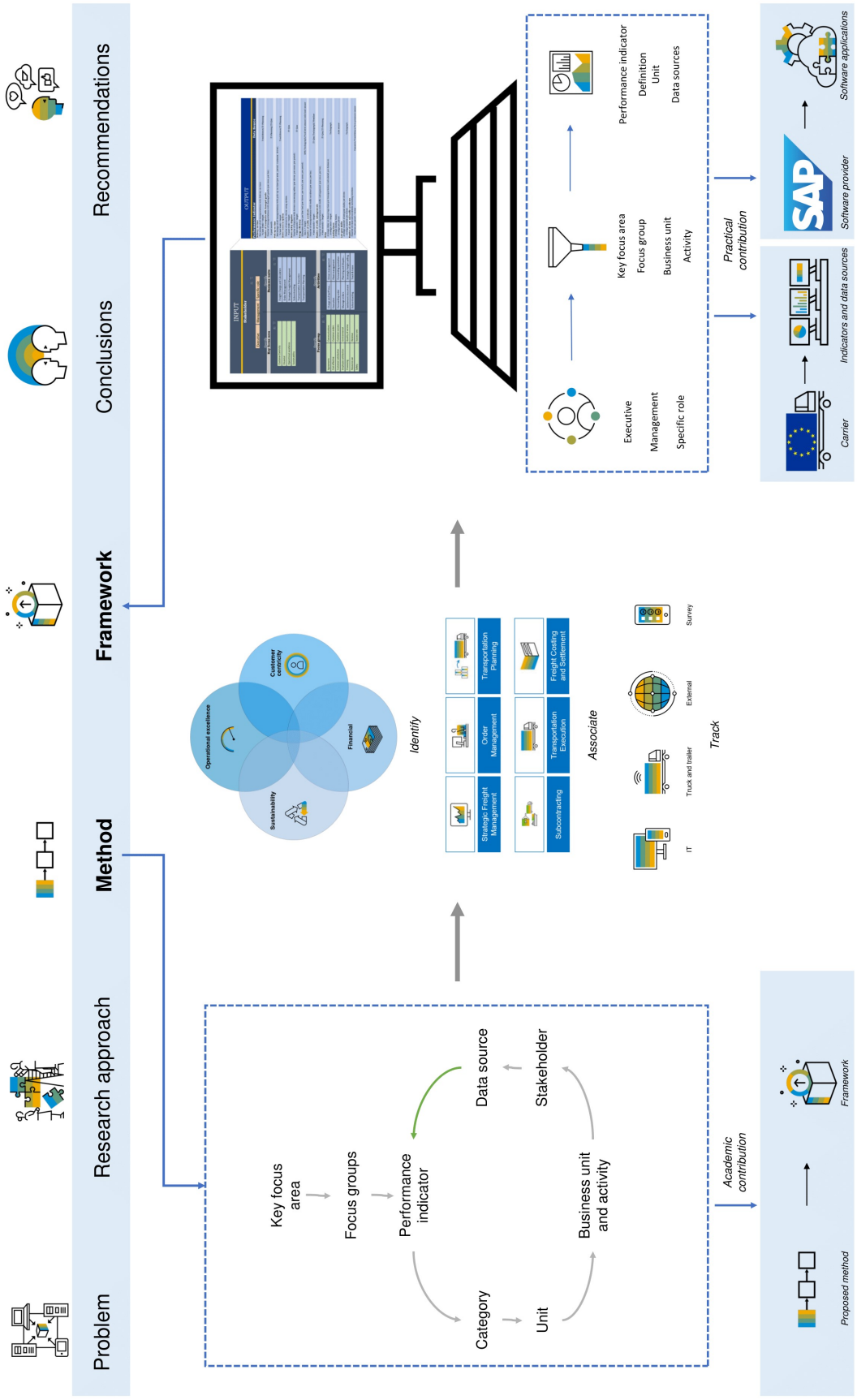
Academic and practical contribution

The academic contribution of this research lies in the method proposed to develop a performance indicator framework. No previous approach has established a clear method for developing a performance indicator framework. The combination of the approach of Ganesan & Paturi and Lim et al. results in a usable framework. This research has also identified areas in which the method can improve. The improvements lie in identifying performance indicators from business units and activities, as well as the identified indicators by analysing the data sources. The proposed method indicates how a performance indicator framework can be developed. The steps taken, identification, association and tracking are successful and future studies can apply the method to other cases.

The practical contribution to carriers lies in the use of the framework for various stakeholders. Carriers and software providers can use the framework. Using the framework, a carrier can create insight into the important performance indicators per area or activity. With available data, the performance indicators can be measured. Currently, a small number of carriers have resources to measure these indicators and produce the necessary information. Therefore, software providers can develop software which includes the relevant aspects. Developers can use the framework to identify important indicators for carriers. For example, a KPI dashboard can be developed. The insights in the performance indicator framework will act as a starting point for further development.

Infographic

A select summary of the research is described in the infographic on the next page. The research areas are listed above and visualizations on the method and developed framework are shown. The proposed method indicates the steps taken. The results indicate the information areas used to develop the performance indicator framework. The framework is used as an addition to the summary and as an overview of this study.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Research approach
Method
Framework
Conclusions
Recommendations
Key focus area
Focus groups
Performance indicator
Data source
Stakeholder
Business unit and activity
Unit
Category
Academic contribution
Proposed method
Framework
Identify
Associate
Track
Operational excellence
Customer centricity
Financial
Sustainability
Strategic Freight Management
Order Management
Transportation Planning
Subcontracting
Transportation Execution
Freight Costing and Settlement
IT
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Acronyms

BMM	Business Motivation Model
BSC	Balanced Scorecard
CEBA	Composite Enterprise Business Architecture
EDI	Electronic Data Interchange
FO	Freight Order
FSD	Freight Settlement Document
FTL	Full Truck Load
FWA	Forwarding Agreement
FWO	Forwarding Order
FWQ	Forwarding Agreement Quotation
FWSD	Forwarding Settlement Document
GPS	Global Positioning System
HR	Human Resources
IoT	Internet of Things
IT	Information Technology
KPI	Key Performance Indicator
LSP	Logistics Service Provider
LTL	Less than Truck Load
PI	Performance Indicator
QIM	Quality Issue Management
RFQ	Request For Quotation
SFM	Strategic Freight Management
SFS	Strategic Freight Selling

1

Introduction

An introduction to the research is given in this chapter. The problem statement is followed by the research objectives. The main research question is introduced followed by the sub-questions. The scope will give an indication of the areas covered in the study. The approach will indicate the path to answering the questions. This chapter will conclude with a report outline, indicating where each topic is discussed.

1.1. Context introduction

The past decade has seen a rise in ability to collect, store and manage large amounts of data. With data becoming increasingly available to businesses, organizations are looking for new ways to gain insight into their organization (Wang et al., 2017). As Wang et al. describe in their study, the aim of the data should be to identify the added value of data, rather than focusing on the ability to master the huge amounts of data.

This also applies to the transportation industry. Acquired information could help companies cope with the industries trends influenced by increased competition, the increasing pressure for lower transportation cost and higher service levels (Christopher, 2016)(Waberer's, 2020)(Girteka, 2020)(TroostGroup, 2020). Looking at the huge number of logistics companies available, the competition is based on prices and quality. A key part of the industry that the majority of logistical companies rely on, is road transportation. The inland freight transport modal split in 2018 indicates a split of 75,3% by road, 18,7% by rail and 6% by inland waterways (Eurostat, 2020a). Although the overall volumes increased with 10% between 2013 and 2018, the split has remained unchanged.

The challenge for companies is determining what data can be of value to the business (Wang et al., 2017). This also applies to the truckload carrier industry. Truckload carriers are companies focused on the transportation of truckloads in which the goods transported belong to a single customer. The data available could be used to make data-driven decisions. Data-driven decisions can include maintenance planning, where data about truck utilization can be used to determine the optimal maintenance time. At the moment, only some steps have been made to realize this goal. Of the large carriers in Europe, two have now implemented software from SAP. SAP is a company that provides software solutions in order to store and process data. Implementations indicate that providing services can be valuable to road carriers and the expectation is that similar services can be of value to the rest of the carrier industry. To achieve making data-driven decisions, the issue is determining what needs to be measured.

For the truckload carrier industry, little is known about the possibilities that lie in data-driven decision making. Some examples in which data has the possibility to be of added value include optimizing operations, increasing efficiency and improving forecasting. To achieve this added value in the future, the first step can be taken. This step includes identifying relevant information and data sources. In this study, these first steps are taken. The focus will lie on how to identify and produce the information relevant to European road carriers.

1.2. Problem statement and research gap

For road carriers, it is a challenge to identify relevant information and data sources. To visualise the way information can be valuable, a measurement cycle has been developed (see Figure 1.1). This figure indicates how a performance measurement cycle can be viewed (Tavasszy, 2020). The controlled system in this example is the truck and trailer. However, the controlled system can also include other devices or software. Using

measurements, the controlled system can be analysed in analytics. At the moment, few carriers measure the controlled system in a way they are able to use the information gathered. The next step in the measurement cycle is designing an action. An example would be to plan an action when a certain measurement level is reached. A decision is made and the controller is used to chose the modification to the controlled system.

In recent years, the controlled system has been improving, with new sensors, applications and computers aboard the truck, as well as improved software for corporate functions. In this research, several aspects of the controlled system are analysed.

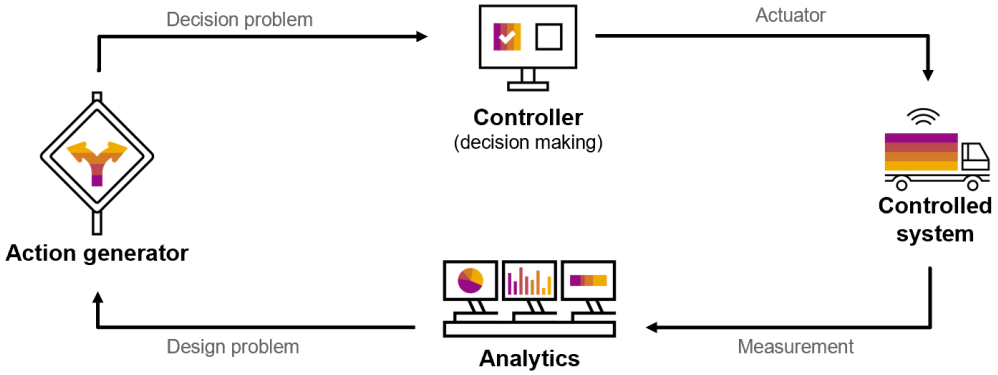


Figure 1.1: Performance measurement cycle (TIL4030,2020)

The figure indicates how a performance measurement system works in theory. This systems also introduces a few challenges, specifically for the road carrier industry. First, it is unknown what needs to be measured, partially due to the fact that carriers are unaware of the possibilities that lie within the controlled system. Once it is known what needs to be measured, the next step is identifying the data sources that need to be used to do so. To provide solutions to these problems, **this research will propose a framework, in which clear performance indicators are given, as well as how these can be measured.**

In literature, little is known about these challenges (Punte et al., 2017). A method to develop a performance indicator framework is not defined in studies. A study by Ganesan & Paturi in 2009 provided a generic step by step approach to developing performance indicators (Ganesan & Paturi, 2009). This method does not identify how to measure performance indicators. The study also includes a single top-down approach to determine performance indicators.

A second study identifies a second approach to fill these gaps. A more recent mechanism will be used which focuses on how the increasing amount of data can be used to create value (Lim et al., 2018). This mechanism, developed by Lim et al. in 2018, also provides a more detailed approach to the tracking of performance indicators. This mechanism is yet to be applied to the road carrier industry and could provide valuable information for road carriers. **The academic contribution of this research lies in the proposal of a method combining the Ganesan & Paturi method with the Lim mechanism**. By combining the two studies, a complete approach is established. The truckload carrier industry will provide a case study for the proposed method.

1.3. Research objectives

This section will identify the objectives of the research. As mentioned, the goal is to develop a framework. The framework will be able to give insight in the performance indicators for road carriers and be used to understand how to track these performance indicators. The development of this framework can be transformed into the main research question and several sub research questions. The following research question is formulated:

How can a framework be developed that links important performance indicators with relevant data sources for European truckload carriers?

In order to answer the research question, the following sub-questions and objectives are formulated, split into three sections. These questions will be discussed briefly per question.

1. *What are the important performance indicators to assess future road carrier operations?*
   This question is similar to the problem statement. It is currently not known what the important performance indicators of road carriers are. The answer(s) to this question will be used in the development of the performance indicator framework. The focus will lie on performance indicators that can be used and substantiated. The steps taken will be derived from the Ganesan & Paturi method, with additional performance indicators produced using the Lim et al. mechanism.
2. *What data sources are required to produce the information needed for performance measurements?*
   A complex question is determining the information needed. For each performance indicator, a clear indication of available data sources should be given. To answer this question, the first step is understanding the information needed per performance indicator. An indicator could demand information from different sources. Each information part is analysed and suitable data sources will be given.
3. *How can road carriers use the framework to improve their operations?*
   The final question will explain how the framework can be used. Road carriers need to be able to identify themselves in the framework. Analyzing these needs and describing how this can be used will be of added value. To do so, a clear and useful description to the framework is provided.

1.4. Scope of the research

To further define the research area the scope is specified. An important factor to take into account is that focus will lie on the transportation side of road carriers. The research is focused on the European road carrier industry. Therefore, the priority in performance indicators will lie in road carrier-specific areas. This does not mean the road carrier business is not fully analysed, but a focus will lie on transportation specific areas. This is partly due to studies already conducted on how business management uses performance indicators.

Another aspect is that this research is focused on road carriers. This means that logistic companies which also provide transportation could find valuable information, but the input for performance indicators and data sources is only from road carriers.

A final aspect to consider is that the road carrier companies focused on in this study transport mainly full truckloads (*FTL*). Full truckload carriers are also described as truckload carriers. A truckload carriers operations focus on the transport of goods in which the load belongs to a single customer. This means that, some indicators important to less than truckload (*LTL*) or companies transporting their own goods are not taken into account. In other types of trucking, truckload planning, scheduling and consolidation are operations carried out by the carrier. In the FTL industry, the whole trailer is rented and the activities mentioned are operations for the customer.

1.5. Research approach

To answer the research question and subsequent questions, a systematic approach is conducted. The first step will be to analyse the road carrier business, and what a typical carrier company's activities are. Next, the Genasan & Paturi approach is conducted, in combination with the Lim mechanism, to propose a method. This method is explained in Chapter 3.

The method includes identifying business goals and performance indicators. Next, an association of these performance indicators will be given, associating each performance indicator to a responsible stakeholder. Data sources will be analysed and connected to performance indicators. Using all the information gathered, a framework is developed.

Information will be gathered through literature and interview sources. Interviews with road carriers from different sizes will provide useful information on key aspects. The interviewed parties include Girteka, Waberer's, Peter Appel and Troost Group. Respectively, two large, one medium and one small carrier. For large carriers, a distinction of more than 1000 trailers is used, while a medium-sized carrier owns between 100 and 1000 trailers.

Due to the learning's of implementing SAP solutions at Waberer's, SAP will also provide information on carrier business overviews. SAP is also a key information source regarding IT data sources. Interviews will also add to areas which remain incomplete in literature.

1.6. Report outline

To structure the report, chapters will be combined in parts. The first part will conduct as background information, on theories and road carriers. The second part will follow the proposed method and describe the development of the performance indicator framework. The final part will combine the discussion of results, conclusions and recommendations.

- Part I: Literature, materials and method
  - Chapter 2: Truckload carriers in Europe.
  - Chapter 3: Theoretical background and method.
- Part II: Define, associate and track performance indicators
  - Chapter 4: From business goals to performance indicators.
  - Chapter 5: Association of performance indicators.
  - Chapter 6: Connecting data to performance indicators.
  - Chapter 7: A performance indicator framework.
- Part III: Discussion, conclusions and recommendations
  - Chapter 8: Discussion of methods used.
  - Chapter 9: Conclusions for this research.
  - Chapter 10: Recommendations for road carriers, service providers and further researchers.

I

Literature, materials and method

- Chapter 2: Truckload carriers in Europe
- Chapter 3: Theoretical background and method

Part I elaborates on background information used for the research. First, an introduction on the road carriers will identify the road carrier business overview. A theoretical background, focused on Ganesan & Paturi and Lim et al., will identify the theories used. The section will conclude with a proposed method, to be conducted in part II.

2

Truckload carriers in Europe

In this chapter the road carrier industry is introduced. This includes the current 'playing field' and trends. Next, an indication of road carrier company characteristics is given. In this section, the key units in the company are described. The chapter concludes with a note on analytics and reporting and how this is important for road carriers.

2.1. Network of business relations

The definition of a road carrier differs in studies. To clarify the function of the road carriers in this research, four main actors are described. The customer (consignee), shipper (product owner), logistics service provider (*LSP*) and carrier (see Figure 2.1). Demand for goods is generated by the customer. The owner of the goods is also responsible for the shipment, which is noted as the shipper (Bask et al., 2018). The shipper will demand transportation services from a carrier, but a shipper can also use LSP to outsource their logistical processes. In this last case, the LSP will supply logistical processes for the shipper. A LSP will place a transportation request with a carrier. The carrier can provide services directly to the shipper, but also the LSP.

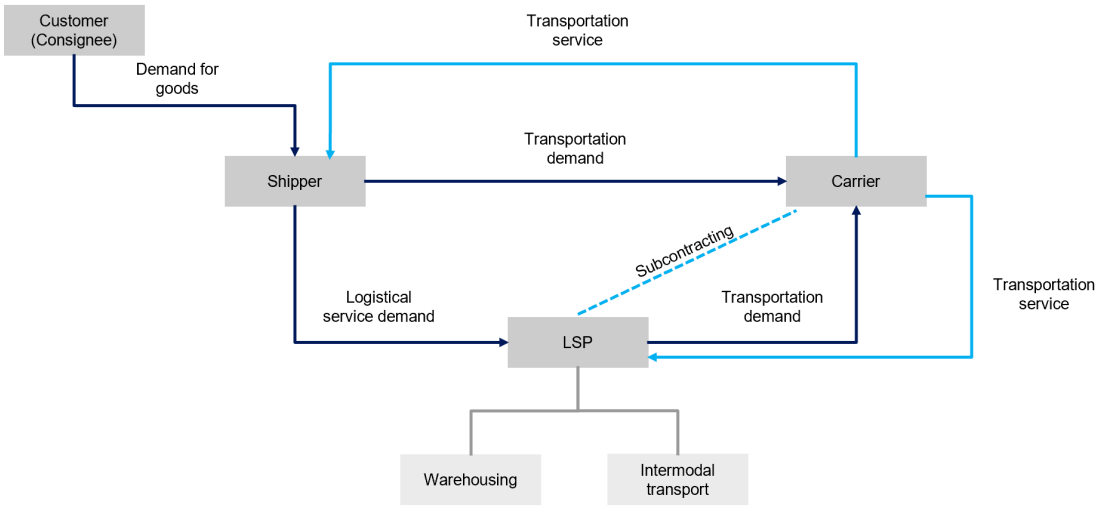


Figure 2.1: Actors involved with road carrier

This figure is a simplified overview of the actors involved. There are other actors which also find a business within this scope, but for this research, the main actors have been named. Another aspect to take into account is the changing activities per actor. In the past years, LSP companies have been looking to strategically take over parts of the logistical process. Not only are LSP's growing, but carriers are looking to expand their operations to other areas (TroostGroup, 2020). Examples include more logistic companies who supply their own warehousing and transportation. The more of the process can be consolidated, the better. These changes influence the actor field, and pose challenges but also possibilities for road carriers.

Future trends

Current changes are an indication of the changing road carrier industry. Because of this, it is important to look at some of the future trends. These trends can be taken into account when analysing the activities and setting up performance indicators. Areas of change and trends can be identified in markets, technologies and client behaviour.

Markets

Many trends in the transportation sector develop new aspects to the road carrier market in Europe. This includes the pressure of transportation cost and service level in the goods sold. Studies show that transportation costs account for 8.2% of the cost of goods sold (Berger, 2018). For customers, the trade-off between prices and the quality shows that prices are just as important as quality (TroostGroup, 2020). Market trends also include improving inter-connectivity and digital services. As logistics services are also improving, providers also see options for expansion of services. This also leads to overlapping abilities of these services.

Technologies

In the technology sector, many trends are visible. The network in which this data explosion occurs also introduces opportunities for service providers. New data is often more complete and more sources lead to better databases and data confidence (Wang et al., 2017). Big data analytics is a hot topic with usage for machine learning and data mining (Bello-Orgaz et al., 2016). Blockchain is also expected to revolutionize data and business management (Koh et al., 2020). The value of big data lies in the use of it in operations. Tracking, predictive maintenance, planning of traffic and routing are some of the operations that can improve using big data.

Another technology trend is the introduction of electric trucks. Now a lot of passenger vehicles are becoming electric, the pressure on freight transport to do the same is increasing. Comparing 2019 to 2018, an increase of 64% more battery-electric trucks in the EU is seen (ECTA, 2020). In 2020, 18 European companies formed a coalition, in an attempt to improve decarbonisation within the road freight industry in Europe. This deal between the companies which employ a total of 1.6 million people in Europe, is an important step to reach the European Green Deal. As said by the Vice President of the EU Commission and Commissioner for Climate Protection, Frans Timmermans, the coalition can accelerate the move towards sustainable transport for a healthier future and stronger economy (Girteka-Logistics, 2020). These initiatives show the importance of the sustainability goals and the role road transport plays a role.

An important part of the sustainability goals is energy efficiency. In recent years, tests with platooning of trucks have been conducted. Platooning is the activity where trucks drive coordinated behind each other to improve fuel efficiency. In the future, multiple trucks could be connected using platooning to reduce fuel use (Tsugawa et al., 2016). Another possibility for the future is driver wearables (Kundinger et al., 2020). Heart rate data can be used to detect drowsiness and prevent unsafe situations.

Client behaviour

A trend can also be seen in client behaviour. The main aspect is the valuation of the environment. Not only due to national policies, but consumers are also making choices with an interest in sustainability (Statista, 2018). Another aspect of consumer behaviour is the importance of privacy concerning data sharing. With the development of data sharing, the issue of digital trust between users companies is also growing.

These trends show the changing environment in which road carriers operate. In several areas trends can be seen which could play a role in the long term strategies of road carriers. Now an understanding of the road carrier industry is established, a more detailed insight into road carrier businesses and activities is given in the next section.

2.2. Road carrier company characteristics

In Europe, road transport accounts to 75% of the total inland freight volume (ton/km) transported (Eurostat, 2020b). In Europe, 30% of the road freight market (in €) is FTL, while 17% is LTL. The other 26% and 27% respectively belong to specialized transport and bulk freight (Effigy-Consulting, 2017) (see Figure 2.2). Looking at the number of trucks, there are currently 6.6 million freight transport trucks in Europe (ECTA, 2020). This number also considers all the trucks including privately owned. This sector is most successful in the small shipments over small distances, and high-value goods.

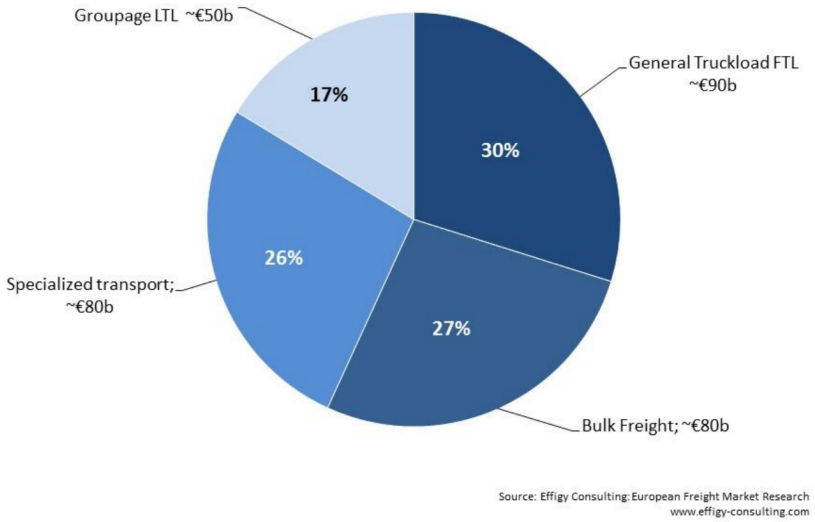


Figure 2.2: Total European road freight market by revenue (2015)

Analysing the largest road carriers in Europe, the chart seen in Figure 2.3 is formed. This graph shows the size in the number of trailer differences between road carriers. A first glance at the figure will show that there a just a few large (compared the rest) road carriers. In this research, the size of the companies is determined by the number of trailers in their name. That means that this indicator is not taken into account subcontracting trailers.

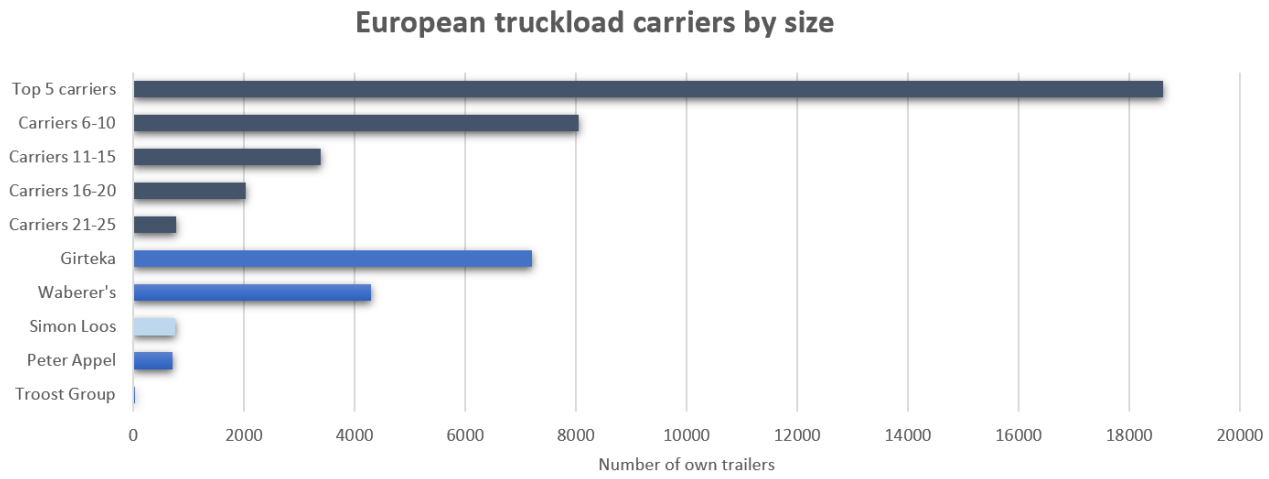


Figure 2.3: EU road carrier companies by number of trailers (*Peter Appel and Simon Loos will merge in 2021)

Looking at the carriers on the road today, it is estimated that 90% of the trailers in Europe does not belong to one of the top 25 largest road carrier companies (Effigy-Consulting, 2017). This means the majority of road carriers can be considered medium to small in size (up to 1000 trailers). The top 25 largest companies are focused in areas as seen in Figure 2.4. Two of these large carriers have sought services in SAP transportation management software. This also substantiates the claim that data-driven services such as SAP provides, are currently only interesting for large road carriers. This is due to the size and budget carriers have for similar services. Therefore, this research also hopes to attribute the development of possible software templates focused on road carriers. This could make it interesting to carriers who are categorized as large.

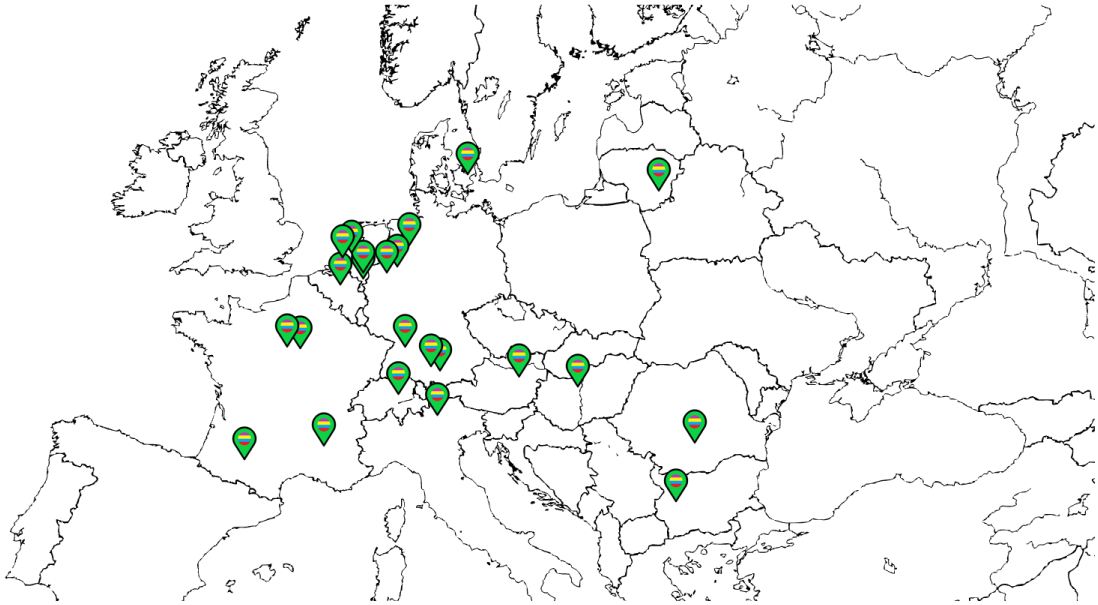


Figure 2.4: Largest road carriers in Europe (number of trailers, location of headquarters)

The road carrier business described in this chapter will be a simplified version of the activities. As not all road carriers have the same company or organizational structure, the main characteristics are discussed. Therefore, carrier companies may use other formulations or names for processes. The formulations used in the sections to follow are used in the SAP environment.

Road carriers in Europe encounter many processes which include important documentation (see Figure 2.5). This figure shows the demand for transport on the left side and the supply side on the right. In the figure, the documents indicate the steps that are taken in the process. In the case of contractual transport, which is different from the spot market, a forwarding agreement (*FWA*) is set up. The next step is determining the quotation (*FWQ*). Once this is accepted, a forwarding order (*FWO*) with all the detailed of the transport is made. The FWO is then planned and a freight order (*FO*) is set up. Once the order is planned, it is time for the execution. After execution, settlement documents are set up for both parties (*FWSD* and *FSD*). The document created is the invoice.

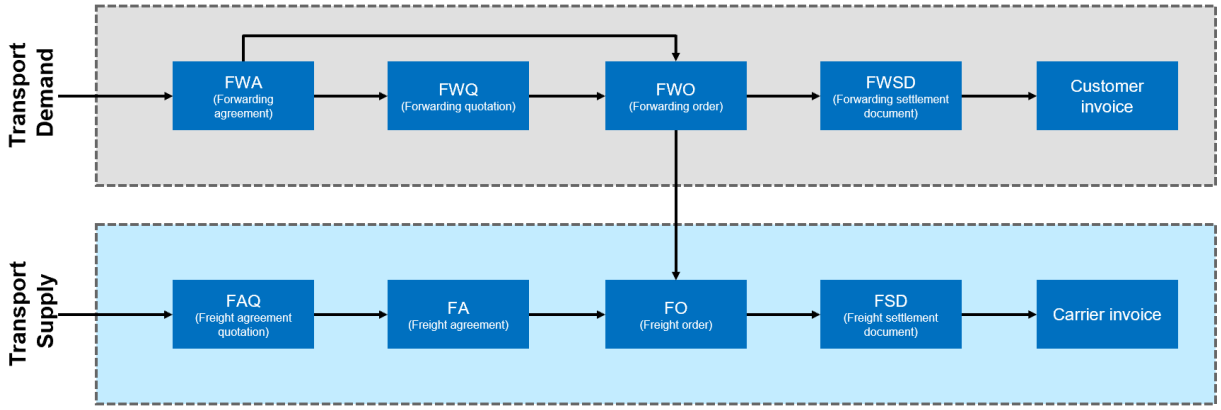


Figure 2.5: Document overview supply and demand side (SAP,2019)

The figure above is an indication of the activities that take place in the road carrier business. In the next section, further analysis of the activities at a carrier takes place. Analysing these processes, it can be stated that a lot of data is collected. Each document is a potential data source and with the right software services, these steps are taken faster. This document overview can also be used as an overview of the company characteristics. When analysing the different business areas of a road carrier. The areas can be divided into six core areas shown in Figure 2.6 (SAP SE, 2019).

The first area is strategic freight management. In this area, all strategic choices concerning freight selling and procurement are handled. The second area is order management, in which customer orders are processed and handled. The third step is the transportation planning, in which capacities are calculated and drivers managed. It is also the core area in which the planning and routing take place. A fourth core area is subcontracting. All transport demand that a company cannot handle but wants to transport, needs to be subcontracted. Subcontracting is a term used for a business that takes over certain obligations of another companies contract. This can include the trailer being loaded onto a train, routes with a ferry and or the contracting of trailers able to transport dangerous goods. In the fifth core area, the transportation execution takes place, including the track and tracing of loads and assets. The final core area is the freight charge and calculation. This is were the final charges are calculated, settlement documents are made and invoices are sent. In Chapter 5, each business area and activity will be discussed in more detail.

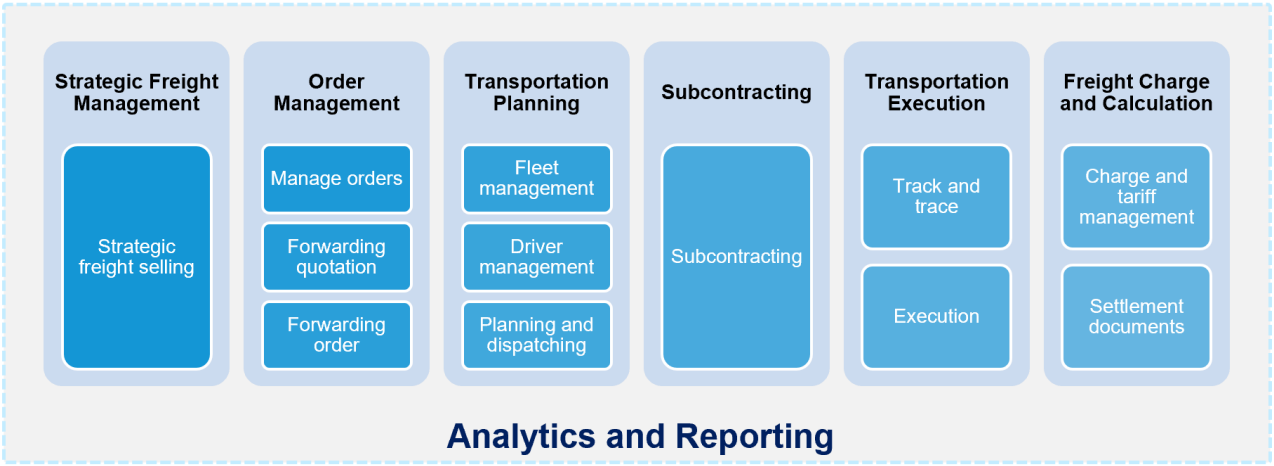


Figure 2.6: Activities of a road carrier business

Analytics and Reporting

Another important area which covers all of the other areas is analytics and reporting (SAP SE, 2019). Analytics and reporting are how companies analyse their data and report it. Business analytics is described as ”the use of data, information technology, statistical analysis, quantitative methods, and mathematical or computer-based models to help managers gain improved insight about their operations, and make better, fact-based decisions”(Harris & Davenport, 2017). A classification can be made between descriptive, predictive and prescriptive analytics (Appelbaum et al., 2017). Descriptive analytics is the use of analytics to describe a situation and answer questions regarding the situation. Predictive maintenance is used to analyse possible future situations and what the impact of a situation would be. Prescriptive analytics can be used to determine what needs to be done. By analysing the possible outcomes and current situation, a decision needs to be made.

As most road carriers are small companies, there is no clear distinction between these areas. Analytics can be very different per company. There is no one way to report data. A key performance indicator dashboard can be used by managers to identify the performance and be used to make decisions. A road carrier can also use data to classify areas where improvement is needed. As mentioned in the performance measurement cycle (see Figure 1.1), analytics can be used in the decision making for actions. Activities can include strategical decisions such as fleet procurement, but also operational, such as daily operations.

At the moment, companies don’t use data to structurally make these decisions. The goal of analytics and reporting is to gain insight into the business and use this to make data-driven decisions. An up-to-date, in-depth insight could prove as an objective. SAP focuses on three strategic imperatives for transportation companies (SAP SE, 2020b). These include digitizing the customer experience, to attract new customers. New business models need to be generated to increase the current offerings. The third is related to digitizing operations, which will improve efficiency. These three imperatives are indications of how analytics and reporting can also be important to road carriers.

3

Theoretical background and method

In this chapter the literature and proposed method will be discussed. First, an introduction on how the literature is used is given. Next, theories are identified that indicate the steps that need to be taken. The chapter will conclude with a proposed method for indication of how the studies are used and how they lead to the steps taken in this research.

3.1. Introduction to literature

To answer the research questions, the literature on several subjects is analysed. To understand how these questions can be answered, the literature on the identification of performance indicators is analysed. Studies on this subject have been conducted in different areas, but not in the road carrier industry. Therefore, this study is used as an application for the road carrier case.

Two important studies are used as a guide to answering the research questions. The first study is by Ganesan & Paturi in 2009. In their study 'Key Performance Indicators Framework - A Method to Track Business Objectives, Link Business Strategy to Processes and Detail Importance of Key Performance Indicators in Enterprise Business Architecture', structured steps are identified. These steps are used to: a) identify the performance indicator, b) define the characteristics of the indicator, c) associate and tie-up performance indicator to stakeholder and d) track and monitor the performance indicator (Ganesan & Paturi, 2009). This study can be considered a top-down approach, where first the key focus areas of the organization are determined.

Different studies also show recent trends in data collection show the use of big data, *IoT* devices and cloud services. These trends can be valuable to the carrier but are not directly considered in the study of Ganesan & Paturi. A study by Lim et al. in 2018, used a framework to identify value from data sources. The approach by Lim is bottom-up, and indicates how different data sources produce data that is analysed and can become valuable information for stakeholders (Lim et al., 2018). Both studies can be applied and are an addition to each other, in the development of a performance indicator framework.

In this chapter, the steps in the Ganusan & Paturi study are described. For each step, a description of what the substantiation is, is noted. The descriptions include detailed information on theories related to the identification, definition and association of performance indicators. Next, the data to value chain described by Lim et al. is used to show how performance indicators can be identified by analysing the data sources. The chapter will conclude with an overview of the proposed method of this research. This will indicate how studies are used and the steps that are taken.

3.2. Ganesan & Paturi: method to develop performance indicators

A method in identifying performance indicators is the top-down approach described by Ganesan & Paturi in 'Key Performance Indicators Framework - A Method to Track Business Objectives, Link Business Strategy to Processes and Detail Importance of Key Performance Indicators in Enterprise Business Architecture" (Ganesan & Paturi, 2009). The study describes the steps that are taken to develop performance indicators. The steps taken can be summarized into four areas. The first step is identifying what needs to be measured. The next step is classifying and defining characteristics for performance indicators. Third is associating performance indicators and allocating responsibility. The final area covers the monitoring of performance indicators and how to report results. For each step, a number of sub-steps are described and theories related to these are discussed.

In the list below, a detailed description of the method used by Ganesan & Paturi is shown (see Figure 3.1). This shows the four steps and their sub-steps. The framework developed in 2009 is generic, as it does not focus on a certain business or industry. In this research, a road carrier business will act as a case study. Using these steps will also allow the possibility for discussion and reflection, which will be discussed in Chapter 8.

Identify: "identify what to measure".		
a	Define goals through goal modelling techniques	*Use business motivation model and balancedscorecard to identify key focus areas for road carriers.*
b	Define performance measures for goals	*Define key focus groups and measurements per group.*
c	Define objectives - quantify goals.	*Identify the objectives.*
Define: "classify and define characteristics of performance indicator".		
a	Classify the performance indicator using performance indicator classification scheme.	*Use of classification scheme to classify strategical and operational indicators.*
b	Define characteristics of performance indicator - metrics, targets and benchmark levels.	*Define metrics and units needed to measure performance.*
Associate: "tie-up performance indicator and allocate responsibility".		
a	Identify key business process affecting objectives of performance indicator	*Analysis of business units within road carrier and corresponding activities.*
b	List business participants.	*Identify stakeholders.*
c	Associate performance indicator to processes and business participants	*Use framework to associate performance indicators to processes and participants.*
Track: "monitor performance indicator over a period of time and report results".		
a	Collect data related to performance indicator.	*Identify data sources and how they can be used to measure PI.*
b	Analyze data.	*Using the Lim data to value chain, describe how data can be analyzed.*
c	Report performance indicator.	*Describe how analytics and reporting can use the framework to report.*

Figure 3.1: Ganesan & Paturi method

This framework is a top-down approach to develop performance indicators. It shows a systematic approach to developing a performance indicator framework. For each step, a description of how that step can be carried out is given. These descriptions are shown in the right column, in italic.

As mentioned in the introduction, the last decade has also seen a shift to the importance of data and how this is of value. In the framework of Ganesan & Paturi, the data source is only used to determine how data can be collected. In a more recent study by Lim et al. in 2018, a bottom-up approach is introduced. The method described by Lim et al. is that data sources can produce valuable information.

3.3. Lim et al.: identifying value through the data to value chain

Lim et al. in 2018 developed a nine-factor framework indicating data-based value creation for information-intensive services. Looking at the trends and the increasing amount of data and data sources used in the road carrier industry, this factor framework could contribute to creating value from data. The goal of the study was to contribute to indicate how data management can lead to service value creation (see Figure 3.2). Using several empirical studies, nine factors are identified. This factor framework can be used to describe and analyse different services. It is not specifically used to determine performance indicators or measure business performances. The factor framework is developed using studies from healthcare and fitness tracking, to building energy management services. Using the framework as a contribution to the Ganesan & Paturi method, a more complete framework can be proposed. This will be due to the bottom-up approach for performances measurements using available data sources.

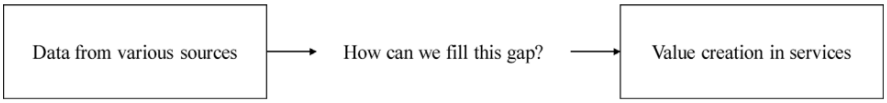


Figure 3.2: Gap: data to value creation (Lim et al.,2018)

The mechanism also has some overlap with the steps taken in the Ganusan & Paturi research, which will be discussed. In the study, several different industries are used as an example to show how the data to value chain works. Visualised in Figure 3.3, the steps of the mechanism are shown. The key areas in this mechanism include the starting point, which can either be a customer data source or provider data source. The mechanism also shows that the provider network of the service provider plays a role.

As can be seen in Figure 3.3, the first step is the customer or provider data source. This can be from people of objects. The next factor is data collection, which can indicate physical or social sensing. Data can either be about health or condition but also about behaviours or operations. The data analysis can be automated or human-involved. Looking at the information of the data sources, there are two types of levels. The first is a descriptive level, the second predictive. Information can either be delivered automated of human-involved. The seventh factor is the customer (information user), which can be an individual or organizational user. These factors indicate how data can be used. The framework also shows how information use is of value.

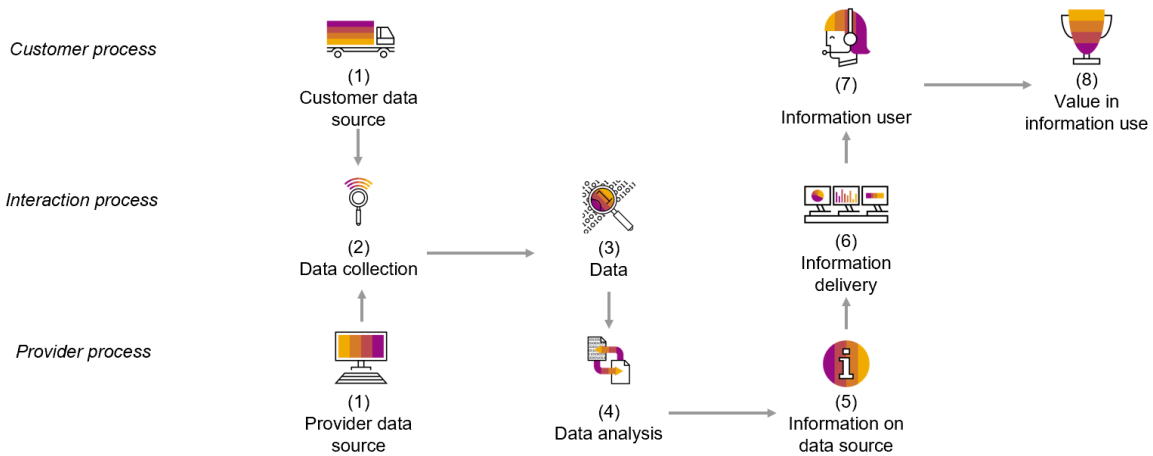


Figure 3.3: Data-based value co-creation mechanism of information-intensive services (Lim et al., 2018)

The connection of this framework to this research consists of two ways. The first is that new performance measurements can be identified. To do so, the data sources used need to be analysed. Analysing the data

source can indicate whether the information is gathered that could potentially be of value. This can be seen as a feedback loop in the framework of Ganesan & Paturi. New data sources can be examined to determine if new performance measurements can be identified.

The second aspect in which the mechanism of Lim is used in this study is in determining the data source. The framework consists of steps from the data source to information. Looking at these steps also shows that the steps can be viewed from information to data source. In the framework of Ganesan & Paturi, the step 'tracking of performance indicators' is not described in sub-steps. Using the framework, a more precise description of how performance measurement data can be collected.

Visualized in the framework of Lim, a clear flow can be seen (see Figure 3.4). Taking the customer information user (7) as a starting point, a choice is made for a certain user. The mechanism of Lim can therefore be used to track the steps that need to be taken to produce the information. Summarized, these steps are figured below:

Figure 3.4: Steps to tracking performance indicators

To explain how these steps can be used, the following example is provided. Some of the performance indicators could need the location of the truck. This would be seen as the information needed (5). To produce this information, the truck will need to have a *GPS* tracker. Using the Lim mechanism, the data source is therefore the truck (1). Then, the data is collected using a GPS tracker (2). Next, the data is in the form of coordinates (3). The final step is analysing the data and transforming the coordinates into a location (4).

The factor framework developed by Lim will be an important part of the method used in this research (*further referred to as Lim mechanism*). As described, there are two key areas in which the framework is used. In Section 3.5, a more detailed description of the proposed method with the necessary steps is provided.

3.4. Literature related to specific research areas

The framework of Ganesan & Paturi has a clear indication of how performance measurement indicators can be developed. First the identification of the performance indicator. Next, the definition of the performance indicator is determined. The third step is associating the performance indicator to the relevant areas and stakeholders. For these areas, specific theories are used to conduct them. In this section, for the first three areas, several theories are described which will be used in the research. As described in Section 3.3, the Lim framework can be used as the fourth step, to determine data sources.

3.4.1. Theories related to the identification of performance indicator

The first step is the identification of performance indicators. To do so, the business motivation model is a good starting point (BusinessRulesGroup, 2010). The model describes how a company connects means and ends. The model also indicates how goals and strategy are connected, as well as the connection between goals and objectives. The model also shows that the first step is determining the vision and connected vision. Using that, goals and strategies can be determined, as well as tactics and objectives. The second model that is used is the balanced scorecard by (Kaplan et al., 2005). This perspective is used to determine the goals of the organization. First, a vision is chosen, and this can be derived from the four sections of the balanced scorecard.

Business motivation model (*BMM*)

In the framework, the following (below) model can be used to determine goals and objectives. It indicates the connection between vision, goals and objectives. To identify the performance indicators, this overview will help structure the steps taken.

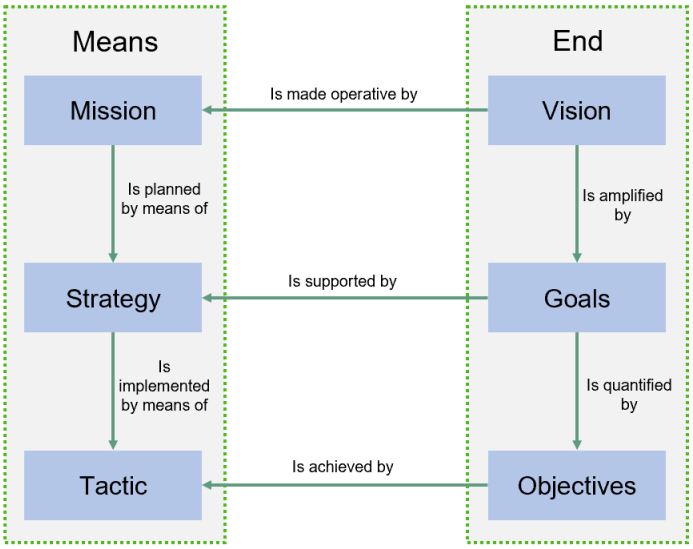


Figure 3.5: Business Motivation Model: End-Means Concept (Business Rules Group,2010)

The model shows a clear distinction between means and end. A company will identify a vision, focused on where the company should be heading in the future. To amplify the vision, goals are set. The model also indicates that for each goal, a measurement can be found. That also implies that each goal can be quantified in objectives.

The means column of the model shows the means that can be taken. A vision can become operative by a clear mission. For a mission, a strategy can be developed. The identified goals should support the strategy. A final means is determining a tactic, which can be achieved by fulfilling objectives.

Balanced scorecard perspectives
The balanced scorecard (*BSC*) can be used to attribute goals to four key focus areas (see Figure 3.6). The scorecard will be used in the first step of identifying performance indicators. The balanced scorecard is a way to link performance measures (Kaplan et al., 2005). Developed in 1984, the scorecard is often used for strategic management purposes and is applicable in many industries.

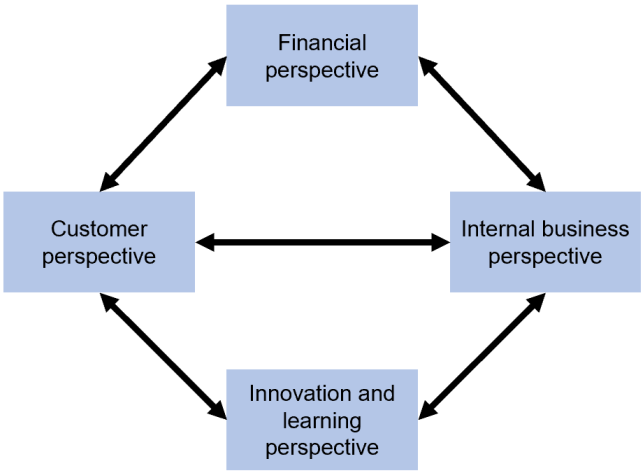


Figure 3.6: Balanced Scorecard Perspectives (Kaplan et al.,2005)

The balanced scorecard has four perspectives. These include the financial, customer, internal business and innovation and learning perspectives. To identify these areas, four questions need to be answered.

- How do we look at shareholders?
- What must we excel at?
- How do customers see us?
- Can we continue to improve and create value?

For each key focus area, the relevant question will be discussed. How do we look to stakeholders is a question regarding the financial perspective. What must we excel at, for the internal business perspective. How customers see us, refers to the customer perspective. The fourth question, how can we continuously improve and create value is focused on the innovation and learning perspective.

Composite key performance indicator (*KPI*) framework
In the study of Ganesan & Paturi, an example of a composite framework is given (see Figure 3.7). The framework indicates how the business motivation model and four key focus areas are connected. This will be used to scope and show where performance indicators can be located. Further information can be found in Appendix C.

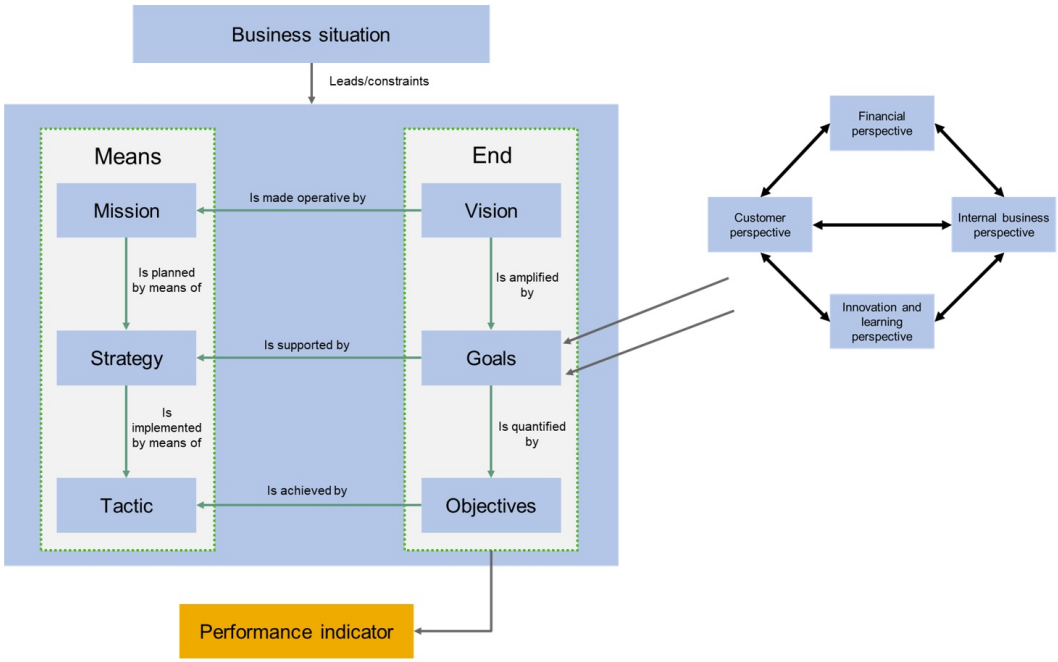


Figure 3.7: Composite KPI Framework – Fitment of *CEBA*, *BMM* and *BSC* (Ganesan & Paturi,2009)

The composite framework shows how the BMM model, the motivation, can be modelled. This amplification is an indication of where goals and objectives can be found. Not only does the BMM model pose as motivation for goals, but it can also be used to classify performance indicators (see Section 3.4.2).

Main principles for performance indicators
In a study of Rezaei et al., the main principles of a key performance indicator are listed (Rezaei et al., 2017). These principles are developed to test whether an indicator is a key performance indicator. To determine whether a performance indicator (in the list *PI*) is correct, the following principles must be taken into account.

1. The PI must be specific, realistic and representative.
2. The measurements must be consistently performed, defined and quantified.
3. The PI must be measurable in physical and financial units.
4. The PI must reflect the responsibilities of the involved departments/managers.
5. The set of PI's must make the costs elements transparent.
6. The PI must be aligned with overall organisational goals, when used by a particular department.

In this research, each performance indicator will be reviewed using these requirements. This will also serve as validation as several requirements show overlap with the Ganesan & Paturi method. This overlap can be seen in the last requirement, indicating that a PI must be aligned with the overall organisational goals. Using the Ganesan & Paturi method, which derived performance indicators from organisational goals, this requirement will always be met.

3.4.2. Theories related to the definition of performance indicators

The second section with a specific theory is related to the defining of the performance indicator, the second step in the Ganusan & Paturi framework. This section will oversee the performance indicator classification scheme. The scheme is used to determine how performance indicators can be classified.

KPI classification scheme

This framework can be used to classify the characteristics of the performance indicators (see Figure 3.8). The scheme will be used to determine how to categorize the performance indicators. This step will also affect the unit, user and data sources of a performance indicator.

Classification clusters (C)	Metrics (M) for Performance indicators			
Generic classification (C1)	Strategic (M1)	Operational (M2)		
Goal classification based (C2)	Strategic Quantitative (M1)	Strategic Qualitative (M2)	Operational Quantitative (M3)	Operational Qualitative (M4)
Regulation based (C3)	Regulated or Accounting (M1)	Non-regulated or Industry specific (M2)	Analytical or Company specific (M3)	
Balanced Scorecard based (C4)	Financial perspective (M1)	Customer perspective (M2)	Internal process perspective (M3)	Learning & growth perspective (M4)
Business Value Model based (C5)	Demand Management aspect (M1)	Supply Management aspect (M2)	Support Services aspect (M3)	

Figure 3.8: KPI Classification Framework (Ganesan & Paturi,2009)

The scheme indicates several classification clusters (C). The first classification is the generic classification, indicating whether the performance indicator is strategic or operational. A strategic performance indicator will be an indication of strategic goals while operational indicators are identified using operational goals. The operational goals are derived from activities, while strategic goals can be derived from the four key focus areas. The goal classification based cluster combines strategic and operational with qualitative and quantitative. The third regulation based cluster is a classification on type of regulation. A difference can be found in regulated and accounting, as well as company or industry-specific. The fourth cluster (C4) is a classification by the Balanced Scorecard, described previously. The fifth classification is a classification into three broad business aspects.

3.4.3. Theories related to the association of performance indicators

The third section which will be elaborated upon is the association of performance indicators. The association means the connection of performance indicator with the user and allocate responsibility. In other words, determine which performance indicator is relevant for which user and who is responsible.

Process KPI map

Ganesan & Paturi have developed a process map indicating the different associations (see Figure C.3). The framework is a visualisation of the previous frameworks. This shows the distinction between different kinds of performance indicators, operational and strategical. They can be linked to business units, functions, goals and objectives. These links will be used in the association of performance indicators in the performance indicator framework.

3.5. Proposed method

Using the background literature, a method for this research can be proposed. The study of Ganesan & Paturi will act as the traditional top-down approach to develop a performance indicator framework. As can be seen in Figure 3.9, all the steps of the study are noted. First, key focus areas are determined, which will have different focus groups. For each focus group, different performance indicators can be established. The light blue boxes indicate the specifics per performance indicator. These are the category, unit, activity, user and data source. The mechanism of Lim can be identified in the green arrows. This shows that also performance indicators can be developed by analysing the data sources.

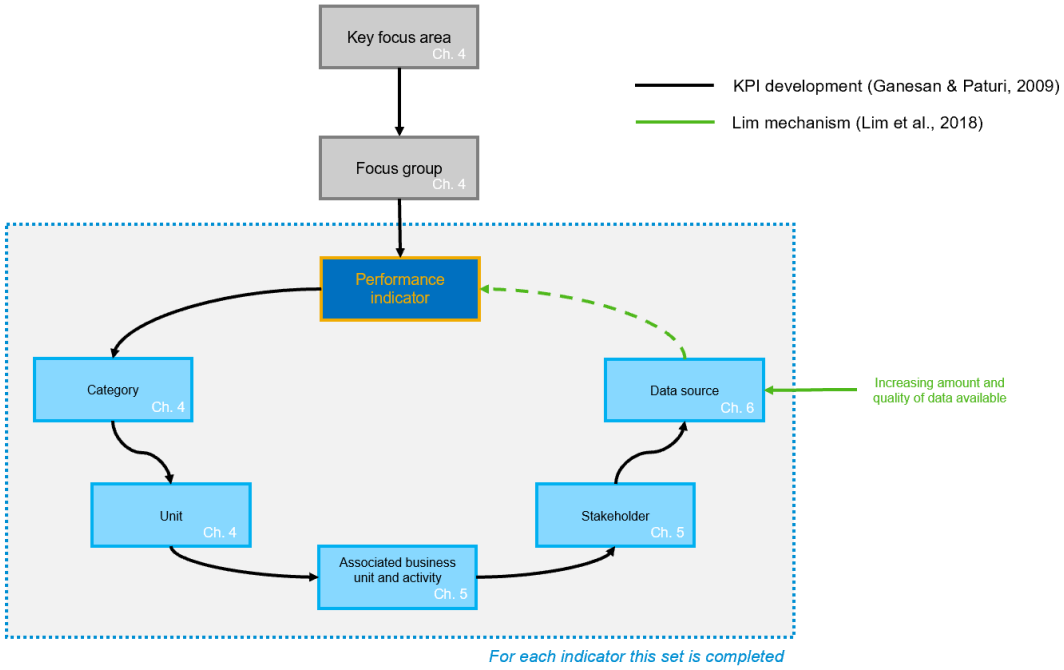


Figure 3.9: Proposed method

This figure is an overview of how performance indicators are developed. The figure consists of two ways to determine key performance indicators, the Ganesan & Paturi approach and the Lim mechanism. Using these steps, a large part of usable performance indicators can be identified. In this research, the Ganesan & Paturi method will be used to identify the first performance indicators. The Lim mechanism, and associated steps, will be taken next.

By combining the Lim mechanism, a detailed description of how performance indicators can be formed is given. The combination also provides input for a feedback loop from the data source to the performance indicators. By analysing the data sources and the relevant information they produce, performance indicators can be developed. To test this method, truckload carriers will provide a case study. A reflection on the method used is discussed in chapter 8.

Literature and interviews will give insight into different areas and a framework specific to road carriers is developed. In the next chapter (4), the key focus areas and focus groups are determined. For each focus group, several performance indicators are identified. A category description and aggregation level are also discussed in Chapter 4. Chapter 5 will identify business units and activities, including responsible employees. Chapter 6 will identify the data sources needed to produce essential information. This chapter will also identify performance indicators that can be developed using the Lim mechanism. In Chapter 7 the framework for road carriers is developed.

II

Define, associate and track performance indicators

Identification and association of performance indicators

- Chapter 4. Defining four key focus areas, focus groups and performance indicators.
- Chapter 5. Association of performance indicators with business units and stakeholder.

Additional indicators and tracking of performance indicators

- Chapter 6. Tracking of performance indicators using available data sources.

Development of a performance indicator framework

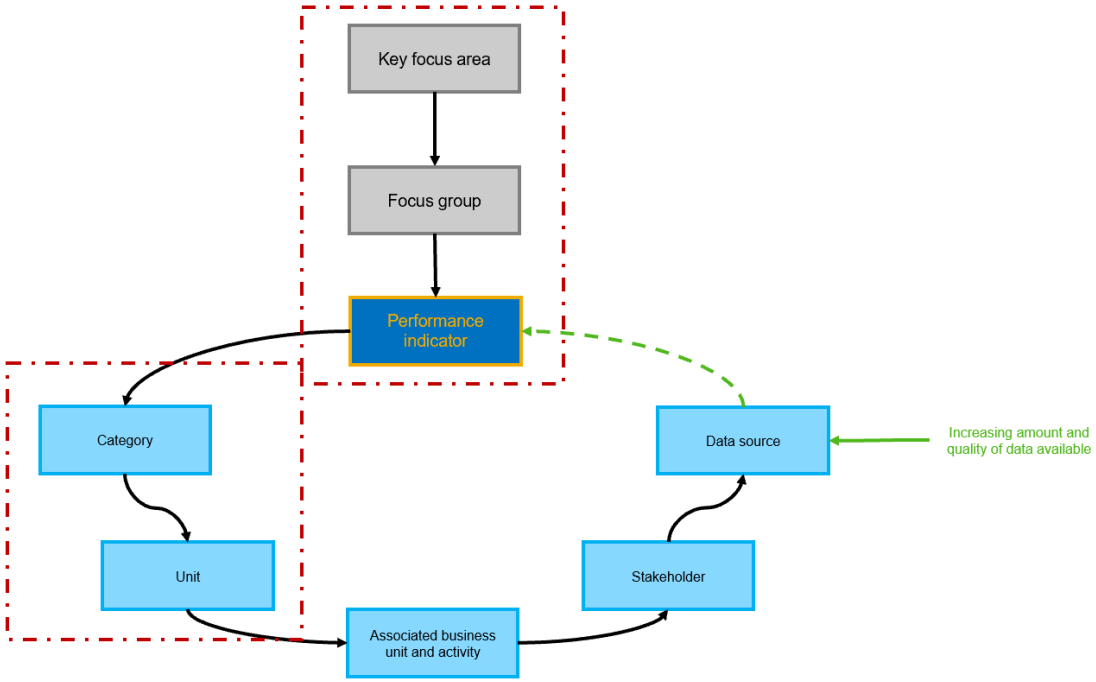
- Chapter 7. A performance indicator framework.

Part II will follow the proposed method and develop a performance indicator. In Chapter 4, the road carrier industry is evaluated and key focus areas are determined. For each area, focus groups are set. To measure the correlating goals, performance indicators are identified. In Chapter 5, the business units and activities of road carriers are described, leading to the association of performance indicators per activity and responsible user. This chapter will also indicate the units for the performance indicators. In Chapter 6, the available data sources are discussed that can be used to track performance indicators. The data sources are also analysed to determine whether additional performance indicators can be identified. Chapter 7 will combine all the information into a performance indicators framework. The framework will be usable for road carriers in identifying, associating and tracking of performance indicators.

4

From business goals to performance indicators

In this chapter, the first sections of the proposed method will be discussed (see figure below). First, the overall business goals of road carriers are determined in order to define the key focus areas. For each focus group, the goals that amplify the vision are chosen. From these goals, performance indicators are derived. A description of how the performance indicators are categorized and how units are chosen follows. The chapter will conclude with a short conclusion on the steps taken.



4.1. Overall business goals of a European road carrier

The first step to identifying performance indicators is establishing the goals of the company. To do so, key focus areas are chosen. The balanced scorecard will function as a starting point to develop the key focus areas. This model is generic and applicable to different industries. It is important to consider the areas and their association with the road carrier industry. Using the balanced scorecard, the following questions arise: *what must we excel at? How do customers see us? How do we look to shareholders? Can we continue to improve and create value?*

These questions also include overlap with some traditional logistical supply chain goals (Merchant, 2006). These traditional goals include increasing efficiency, improving customer service, increasing sales and improving relationships. When analysing supply chain, SAP analyses four areas (SAP SE, 2020a). The first area is related to customers, which is to deliver perfectly. The second area is related to employees, in which the aim is to work productively. The third area considering stakeholders covers the ability to grow profitably. The fourth area used for supply chain companies is related to the environment, where companies should act sustainably.

In this study, the key focus areas are specific to the road carrier business. In literature and interviews, the different areas and goals are discussed. The balanced scorecard, traditional areas and SAP interpretation are discussed with road carrier to indicate the most important topics. The findings from these interviews led to the following focus areas (see Figure 4.1). These key focus areas indicate the four areas in which goals should be identified. Below, a more detailed description of the focus area is discussed. For each focus area, goals are determined. These groups will combine several performance indicators that are indicators of the performance regarding the focus area.

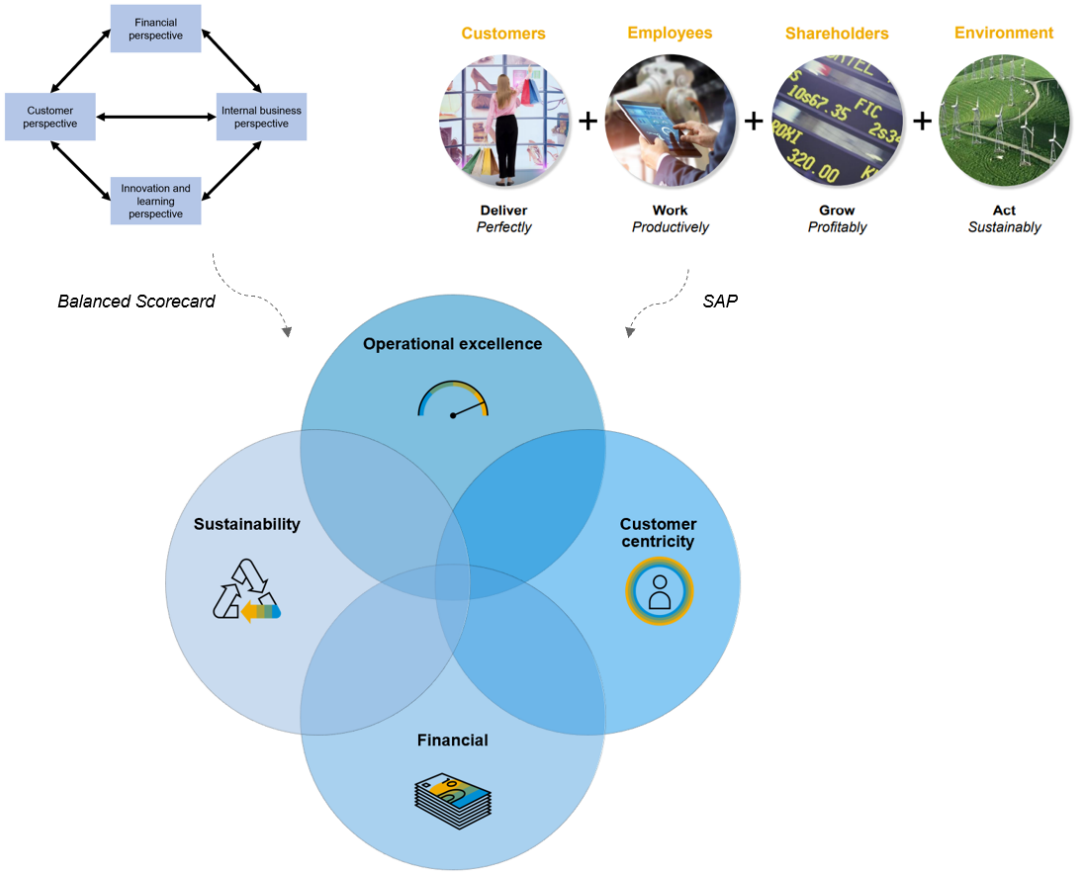


Figure 4.1: Key focus areas for road carriers

The first key focus area combines operational excellence goals. The second focus area is customer centricity, which indicates important indicators for the customer. The financial area is an indication of whether the company is healthy and growing. An increasing amount of focus lies in sustainability, which is the fourth key focus area. How can a road carrier act sustainable? What other aspects of our company should improve in order to make sure the business is still operational in years to come.

Using these key focus area, goals can be categorized. These goals will be discussed in the next sections. The goals discussed will lead to performance indicators.

Sources for performance indicators

In this research, literature and interviews are combined to indicate goals and performance indicators. A list of performance indicators will be summarized after each section. The performance indicators listed include combinations of performance indicators. For the framework development, all performance indicators are analysed.

For each mentioned performance indicator references will be noted. In Appendix A, a list of performance indicators with references is given. In the table below a summary is shown, indicating the sources.

Literature + reports		**Interviewed parties**	
a	(García-Arca et al., 2018)	k	Waberer's International I
b	(Kasilingam, 1998)	l	Waberer's International II
c	(Tjahjono et al., 2017)	m	Girteka Logistics
d	(Ploos Van Amstel & D'hert, 1996)	n	Troost Transport
e	(Bask et al., 2018)	o	Peter Appel Transport
f	(Chi, 2020)	*p*	*SAP*
g	(FreightBestPractice, 2010)	*q*	*Shudan Chi*
h	(Coyle et al., 1992)		
i	(Rushton & Oxley, 1991)		
j	(Christopher & Yallop, 1990)		

These interviewed parties speak from their own experience and can be different from other companies. To give an indication of the interviewed parties, carriers from three sizes are interviewed. Small is up to 100 trailers, medium is 100-1000 trailers and large is more than 1000 trailers. Two are large (Waberer's and Girteka), one medium (Peter Appel) and a smaller carrier (Troost Group) are interviewed. A summary of the interviews is described in Appendix D. Their different business sizes will also give insight into different priorities. The strategies of these companies also differ, which is why not all companies agree on performance indicators.

4.1.1. Operational excellence

Efficiency is important to carry out the operations without error and remove unused assets. The aim of being efficient is to reduce waste in order to achieve the best result. This lean approach is an important part of operational excellence (Found et al., 2018). There are four groups in which excellence can be measured. These are cost efficiency, processing times, use of resources and success rates. Each of these groups includes indicators of efficient operations. In the next few sections, the groups are shortly discussed and corresponding performance indicators are identified.

Resource use

The proper use of resources is a goal in line with operational excellence. Good use of resources can be considered good operational efficiency. Within this area performances can be measured of truck and trailer use, use of fuel and waiting times.

- Commercial distance/empty leg distance - *a,d,f,g,k,l,m,p*
- Utilization of drivers, trucks and trailers - *a,c,f,g,h,l,m,p*
- Energy efficiency/driver efficiency performance - *e,f,g,h,l,m,p*

- Transit speed - *l*
- Dis-balance to fleet distribution - *f,m,p*
- Waiting time - *l*

The most commonly used indicator is the empty leg distance. This is the distance that a vehicle travels, before the pick-up location or after the delivery and is an indicator of the efficiency of planning. This distance is not commercially paid for and can be regarded as waste. Another important indicator of resource use is the utilization, as unused resources are considered waste. The utilization can be calculated per truck or trailer. The utilization can either be calculated in time or in distance. The energy efficiency is another often used measurement. This is the distance that a truck travels per liter of fuel. This can be helpful in planning and order management, as tariffs can be calculated precisely.

The transit speed is an indicator of the actual travelled distance of a truck, compared to the planned distance. On average, a truck will travel a certain number of kilometers per day. The actual travelled distance can be compared to the distance it could travel. Rest times, traffic and other factors can all impact the performance. Another indicator that can be measured to determine the resource use, is the waiting time. This is the average time a vehicle is waiting.

A performance indicator that can be used to measure the efficiency is the dis-balance to the fleet. This is a measurement which could indicate future empty leg trips. The dis-balance can be measured by assessing the destinations of trucks, and comparing these with the strategically chosen 'no-go zones'. These 'no-go zones' are zones which are not desirable. In Figure 4.2, the freight flow within Europe is visualized. The map on the right is a population density map, indicating the populated areas within Europe. The map on the right indicates the main flows between areas where the transportation distance is more than 200km (Mitusch et al., 2014). *(The size of the arrow indicates the relative volume of freight.)*

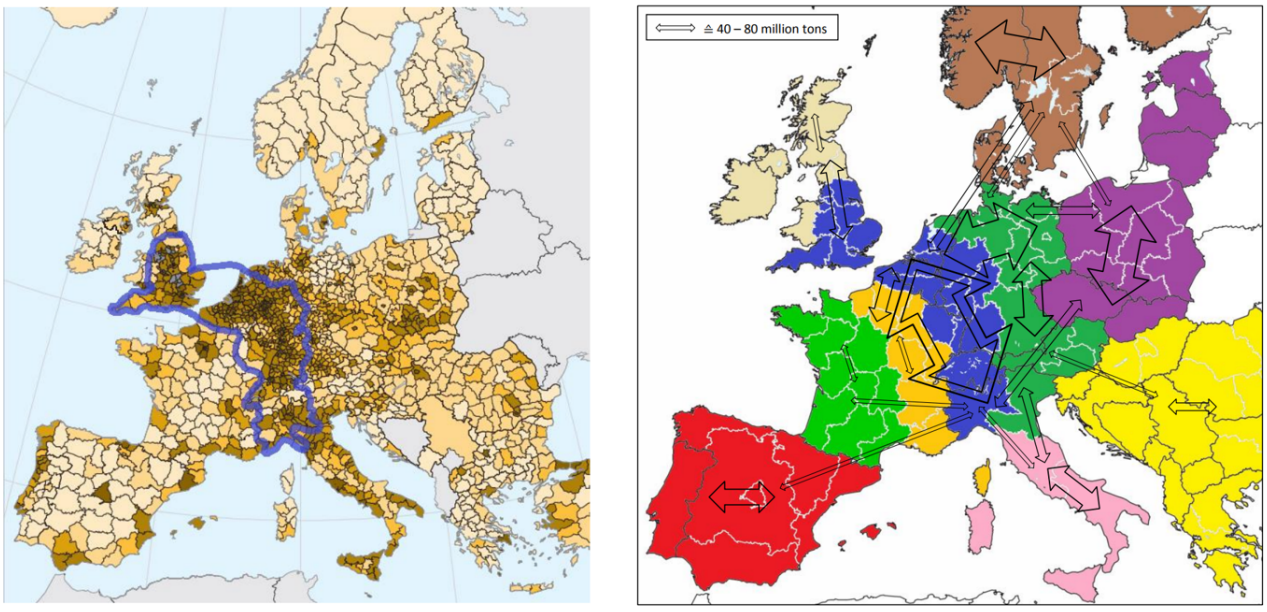


Figure 4.2: Left: population density. Right: freight flows of more than 200 km distance (Mitusch et al., 2014).

The map on the left also identifies the 'blue banana'. This is the blue area where a large part of transportation takes place. By analysing the areas, no-go zones can be identified. These no-go zones can be identified because the expected demand in that area is not sufficient, roads are unsafe or the weather is affecting the circumstances. For instance, if trucks are crowding an ocean port, or if trucks are travelling to remote locations,

these become undesirable locations. When planning an order, the goal should be to have a destination close to the next pick-up location. Using this measurement could be in indicator of a dis-balanced fleet.

Cost effective

To measure the operational excellence of a road carrier, one of the goals is to be cost-effective. How can a road carrier measure their cost efficiency? Not only is cost efficiency important to be able to provide competitive transportation quotations, but it is also important to remove costs where possible. To measure whether a road carrier is cost-effective, this research has come up with the following performance indicators.

- Cost per truck/km (running cost) - *d,g,l,m*
- Driver cost - *c,d,g,k,m*
- Maintenance cost - *c,d,g,k,m*

To shortly elaborate on these performance indicators, each is an indicator that can be measured on average. The running cost, driver cost and maintenance cost make up the largest part of operational costs. Measuring these to analyse operations such as driver and truck performances can be important indicators of cost-efficiency.

Processing times

The processing times of the carrier cover another area within operational excellence. The goal of a road carrier is to improve the processing times. This indicates the time taken for important processes within the company. These times could indicate whether processes are taking more or less time, and be used to determine whether operations are efficient. The following performance indicators can be attributed to the goal.

- Customer order cycle time - *a,b,c,d,i,j,p*
- Planning time per order - *a,d,p*
- Time to reach agreement - *a,b,c,d,i,p,m*

The first performance indicator is regarding the customer order cycle time. This is the time between an order coming in and the planning confirmation of that order. It is important to note that an order can come in, months before the executions is needed. That is why the cycle time, sometimes described as the time between demand and execution, is not usable in this context.

A second indicator is the planning time per order. This is the time between the forwarding order coming in and the planning of the order. The planning of orders is often not carried out immediately as information on future pick-up locations could result in planning changes. To reach optimal planning, a trade-off between planning quickly, and planning efficiently is made. If a planner waits for other orders, an optimization can be carried out. Interview with Waberer's and Girteka have indicated that planning can be executed by an algorithm, but it is still up to the planner to decide when to execute a planning order (see Appendix D.2 and D.3).

A third indicator is regarding the time to reach an agreement. This is a traditional indicator of efficiency, as an increasing time to reach an agreement could indicate inefficient work. It should be noted that this time will be different per customer, but an average could indicate the time, and the corresponding price, it takes to reach an agreement.

Success rate

A fourth goal that can be set is improving the success rates. The success rate of the carrier can be measured in the analysis of orders, agreements and subcontracting. The success of transportation execution is discussed in customer centricity, while financial success is addressed in Section 4.1.3.

- Freight agreement success rate - *d,m,p*
- Order RFQ acceptance rate - *b,m,p*
- Subcontracting issues - *a,d,i,m,p*

- Driver errors in system - *a,c,e*

The success rate regarding operational excellence can be measured in the handling of agreements and orders. The rate in which a quotation is accepted is an important indicator of this success. Another efficiency success measurement is the number of subcontracting issues. A lot of carrier companies have an area which is subcontracted. It is important to measure the number of issues in this area, to say something about operational efficiency. Issues in this area include damaged goods, not on time, unsafe situations and late payments.

Another indicator is the number of errors a driver makes during updating activities. These activities provide information to the back-office when loading and unloading, if a stop needs to be made or any other activity where the driver needs to update the office. Errors during these activities can include the late indication of unloading, which is considered a driver error. The success rate of these activities is another important part of operational excellence.

4.1.2. Customer centricity

The second key focus area is customer centricity. This area focuses on delivering the best experience for the customer. The relationships with customers are very important in maintaining a stable business. The performance of customer centricity can be viewed in different ways. To understand what is important to the shipper and LSP, it is important to know what is important to them. For a shipper or LSP, their customer service plays a vital role. The quality level of the customer is regarded as a very important aspect. Often, the carrier quality is analysed. These quality aspects include the condition of equipment, delays, damages and others mentioned in the Section 'Quality of service' below. When looking at those customer service indicators, several are directly linked to the performance of the carrier.

Customer centricity can be divided into four groups. The first is improving communications, which covers all performance-related activities regarding communications with customers or partners. The second achieving good customer satisfaction. The section is different from customer success. Customer success includes performance indicators that can be measured from its own operations, while customer satisfaction indicates input from the customer. The fourth goal is to optimize the quality of service.

Communications

Customer centricity performance can be measured in communications. Areas include the attitude of management, the communications with drivers and online contact. The challenge is to identify performance indicators which show how the company is performing. The performance indicators are listed below.

- Attitude of management - *b,c,h,j,m,p*
- Terms of payment - *e,h,i,m*
- Customer issues with driver - *h,k,m,p*
- Disputes regarding settlements - *a,b,c,e,h,m*

One of the most important ways to measure how well communications are going is to measure the attitude of management. Management in this case is regarded as the corporate side of the company involved with negotiating agreements. This area covers the communications in negotiating, overall information sharing and setting up agreements. It is important for customers to perceive this positively. The second performance indicator is the terms of payment. This can be measured by the number of issues regarding payments. A third performance is the communications between driver and customer. This is often the only face-to-face colleague a customer will see. Issues regarding these interactions can also be measured. These issues can occur when there is a dispute during delivery or pick-up. For example, if a driver has to wait for the customer or the other way around. A final performance indicator often used is the number of issues in settlement documents.

Customer satisfaction

Customer satisfaction is a specific area covering the satisfaction of the customers. Satisfaction can be measured using input from the client. The satisfaction is important to retain customers, while also being able to

identify unhappy customers. One performance indicator is measured, which is listed below.

- Customer satisfaction grade - *a,b,c,d,l*

The customer satisfaction grade is a grade given by the customer. This is direct input and can be an indicator of future retention. The measurement can also be used to identify unhappy clients and investigate how the carrier can improve. An example of a company involved with these measurements is Qualtrics. Qualtrics defines that there is a clear difference between the way companies measure customer satisfaction and experienced satisfaction (Qualtrics, 2020). Using surveys and direct customer input, a more reliable indication of customer satisfaction can be established.

Customer success

Customer success is similar to customer satisfaction but covers measurements on the carrier company side. These measurements can be produced from operations and give an indication of how successful the company is in the eyes of the customer.

- Perfect order rate - *a,b,e,i,m,p*
- Alignment with subcontracting party - *l,m,p*
- Customer retention rate - *m*
- Flexibility of pricing - *a,b,c,d,e,h,i,k,l,m,p*
- Freight agreements or orders with special request *e,g,h,j,m,p*

An indicator to assess customer success is the perfect order rate. This is the rate at which requests can be satisfied. All handled orders are compared to the orders that cannot be handled. Indicators related to this include the lack of drivers of trailers. As it is not uncommon for road carriers to have partners in transportation, the alignment of these partners is crucial. If a partner does not have similar values, the customer experience could be impacted. For a carrier, the alignment with subcontracting parties can be measured.

An indicator for the overall customer service can be derived from the customer retention, this is the number of customers a company retains during a period. It indicates the ratio between existing customers and new customers. The goal should be that customers do not feel the need to consider alternatives. The success of that goal can be measured in the retention rate.

One of the most recurring indicators of customer success is the flexibility of pricing. This is an indicator of the difference between the actual cost made and the price a customer pays. If a price is set no matter the execution, the price is inflexible. For many customers, it is important to have flexible prices. The final performance indicator is the number of orders or agreements with a special request. This measure shows that a carrier is able to comply with many customer needs. The performance measurement does not directly indicate whether the company is performing positive or negative, but a target can be set. It is also possible to identify issues if the number is decreasing.

Quality of service

The quality of the service is also important to measure. These indicators include how well execution is carried out. It is important to the customer and is therefore in the customer centricity focus area. There are many performance indicators that can measure the quality of the service. A summary is listed below.

- Delivery (and pick-up) on-time - *a,b,c,e,g,h,i,k,m,p*
- Consistency of transit time - *a,b,c,d,e,h,i,m,p*
- Delay - *a,b,h,i,m,p*
- Condition of trailer - *a,e,h,i,m,p*
- Number of transports with damaged goods - *a,b,c,d,e,g,i,m,p*

- Freight bill accuracy - *b,c,e,h,i,j,l,m*
- Traceability - *c,e,f,h,i,k,m,p*

One of the most important performance indicators is on-time delivery. For customers, having products on time is very important. Another aspect to measure the consistency of transit time. For customers, it is also important to receive goods at the same time if it is coming from the same location. This consistency can be measured in the difference between travelled time and the planned travel time. Delay which is the calculated delay per kilometer.

Another measurement to assess the quality of service is the condition of the trailer. This can be calculated in the satisfaction of customers. Issues with the condition of the trailer can be measured. That is also important for transportations with damaged goods. In the settlement, measurements can also be made. These include the disputes regarding settlement and the freight bill accuracy. This is the difference between the quotation expectation and the actual price that needs to be paid. A relatively new measurement is traceability. This is very important to customers. Often used if transportation is late, traceability indicates the ability for the customer to see the movements.

4.1.3. Financial

The third key focus area is improving the company as seen by investors. The area is focused on all financial aspects of the company, from booked order value to revenue. The focus of this research lies in the performance indicators relevant to road carriers. As many financial performance indicators have been identified for other cases, the next section will focus on the transportation-related financial side.

Economies of scale play an important part in transportation. The fixed costs for carrier transport is high and does not change much if more volume can be transported in the same transport. This is especially the case when transporting FTL. To give an indication of the cost side of carrier companies, two ways of distribution of costs are figured in 4.3. The relation with the volume or weight of freight is not linear to the transportation cost. The figure on the left shows that the vehicle, energy and driver take up more than 90% of the transportation cost (Berger, 2018). The figure on the right is a view on cost elements of road carriers (Persyn et al., 2020). In the study, the general transport cost that is identified also includes the distance and time in which the costs for vehicles are calculated. This calculation is made using a EURO VI heavy-duty vehicle with consumption of 45,5L per 100 km. For distance, maintenance and accommodation are considered. The time-related costs include amortization, insurance and indirect costs. An important area identified in interviews with Girteka and Troost Transport is the tolls (see Appendix D.3 and D.4). In these figures, the cost of toll or vignettes is 6%. This is very different per customer, as longer distances have more opportunities to route and therefore choose the route with least total costs. To give an example, the Mont Blanc tunnel in France costs €340 for a one way trip with a truck (Tunnel-MontBlanc, 2020). A choice to reroute can be discussed with the customer.

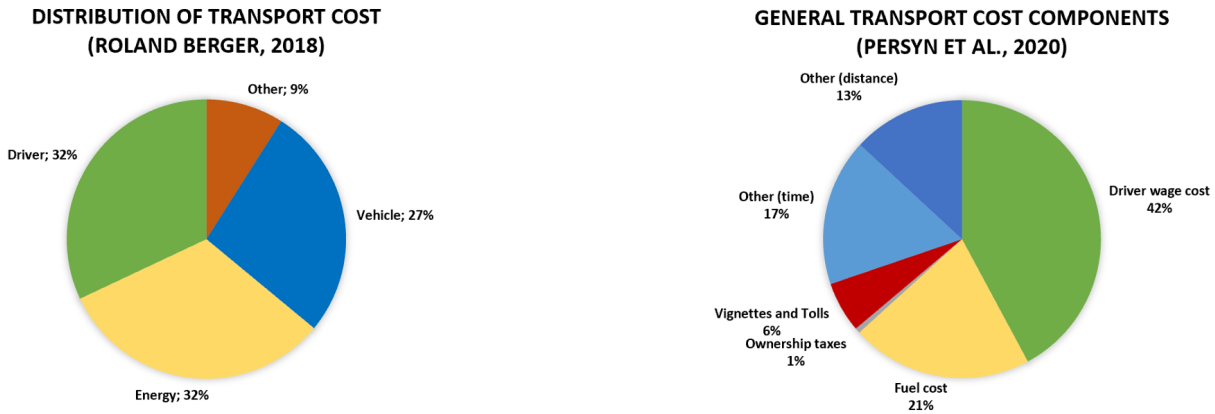


Figure 4.3: Left: Distribution of transportation cost (Roland Berger,2018). Right: General transport cost components (Persyn et al., 2020).

For carriers, the aim is to be as cost-efficient as possible. In interviews with Waberer's and Troost Transport (see Appendix D.1 and D.4), it is clear that the main focus lies on fuel and tolls. These are costs that can be influenced directly through operations. For example, in planning a choice can be made for the gas station at which the price is lowest. The way tolls and vignettes work in Europe differs per country (see Figure 4.4)(DKV-Euroservice, 2020). Some countries use distance-based charges, other time-based or a combination (Transport&Environment, 2017). Therefore, it is important for road carriers to use the toll as efficiently as possible.

The charging environment is changing due to national and international regulations. The chart below is a recent indication, showing the difference between different types of charging. For carriers, keeping up to date with these prices is crucial. At the moment, the electronic toll system is used most over Europe. This on-board-device uses criteria to calculate the tax. The criteria include the number of axles, weight, size, distance travelled and CO_2 emission (Easytrip, 2020). To make the situation more complex, each country can implement these criteria differently.

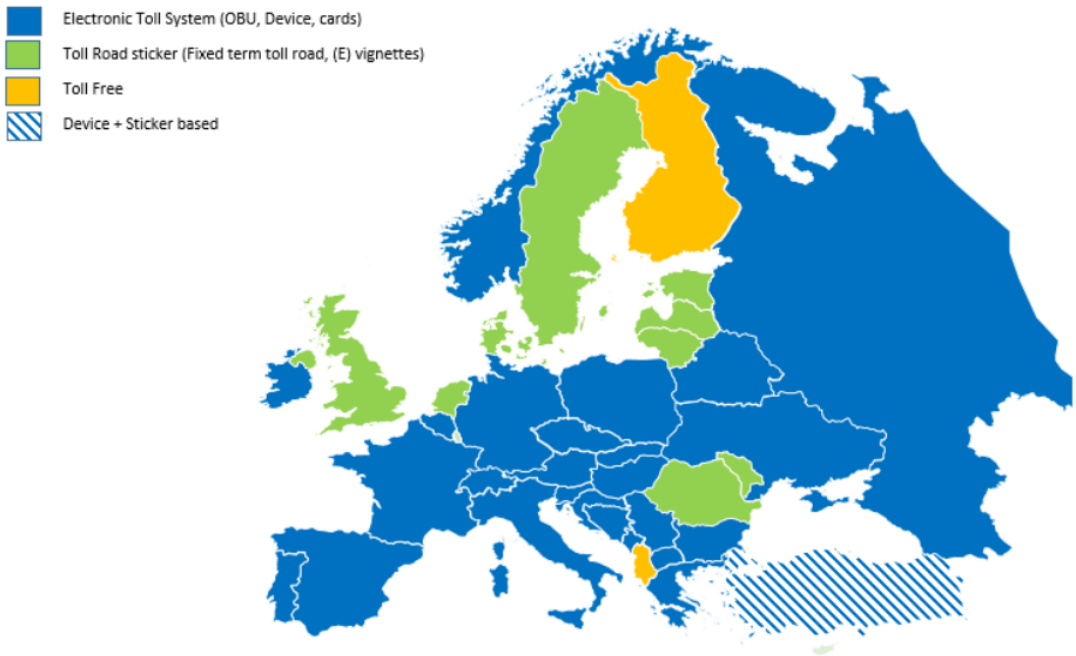


Figure 4.4: Charging of heavy goods vehicles in Europe (Easytrip, 2020)

To understand how to measure this area, three goals are identified. The first indicates the performance considering customer orders. The customer orders are an important indicator for investors. The same can be said for the second group. The second group covers the financial side of the agreements set up. The third group is revenue related and indicates measurements related to the revenue.

Customer orders

The number of customer orders is often an indicator of overall performance measurement for carriers. When analysing the customer orders there are several aspects to look at. The performance indicators are listed below.

- Forwarding order forecast - *l,m,p*
- Number of order *RFQ* received - *k,m,p*

To assess how financially healthy a company is, the number of orders plays an important role. The forecast of orders can be calculated using the previous orders, current agreements and the number of requests received.

When a customer demands an order, the customer will first receive a quotation. The number of requests can also be measured.

Agreements

Similar to the number of orders, the number of agreements is another indicator of financial success. Carriers often set up agreements in which a certain number of transports or period are discussed. In these agreements, the number of orders can be determined (see Section 'strategic freight selling' in Chapter 5 for more detailed description). The following performance indicators are set up to measure the financial focus area.

- Number of active agreements - *h,k,l,m,p*
- Expected growth in freight agreements - *k,m,p*
- Number of agreement requests received - *h,k,m,p*

The most important indicator is the number of active freight agreements. These are agreements which almost directly indicate that orders will come in. The expected growth can be calculated in order to determine where the company is heading financially. A performance indicator which can be used first is the number of requests received. This number will likely lead to a number of agreements set up.

Revenue

The revenue is another important area for investors to look at. When assessing the financial side of the company the revenue is one of the things to look at. The financial side is often calculated when making up financial reports, but several transportation-related indicators include the following list.

- Booked order value - *h,m,p*
- Planned freight cost - *a,b,d,e,g,h,k,l,m*
- Business share per customer - *h,m,l*
- Profitability per order - *b,h,k,l*

The revenue is affected by many factors. Some of these factors can be measured, to ensure a healthy financial situation is maintained. Two of these measurements include the booked order value and the planned freight cost. The first is the indication of the income that confirmed orders will achieve. The second is the planned cost of these orders.

A third important factor is to determine the business share per customer. In customer acquisition, customers who have the ability to generate more profit, are more attractive. Therefore, it is important to understand which financial share customers have in the business. For example, a customer with a large share should be managed extra carefully, as they generate a lot of business. A final performance indicator is the profitability per order. This can be calculated and indicates if an order is financially attractive. If the profitability is not as desired, changes can be made.

4.1.4. Sustainability

The fourth key focus area is improving sustainability. Sustainability is a topic which is discussed on the national and international level and is an important aspect, as road carrier company operations often cross borders. In different countries, different laws may apply. Many of the countries within Europe have agreed policies to ensure the environmental impact is controlled. This objective may currently not rank high up in the agenda of road carriers, but will ultimately lead to a better business if handled properly.

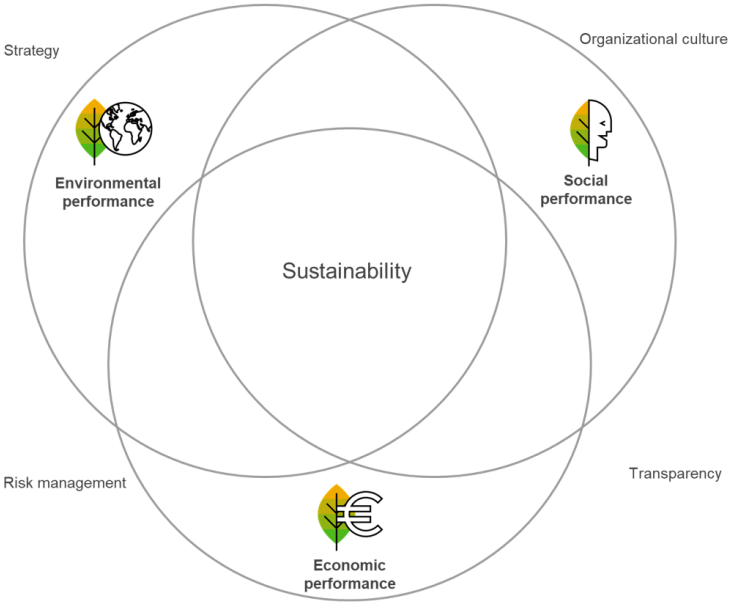


Figure 4.5: Sustainable Supply Chain Management (Carter & Rogers,2008)

Sustainability is a term used that can apply in different areas (Carter & Rogers, 2008). To clarify, it is often referring to the environmental aspect, looking to impact on the environment. When looking at the sustainable supply chain management framework of Carter, sustainability can be found by combing several areas. The first is environmental performance. One aspect in the environment area is safety. This aspect has yet come to light in earlier focus areas. A second aspect is social performance. Values and ethics play a role in this. For road carriers, it is important to also assess employee satisfaction. A third aspect is the economic performance. These performances are largely handled in the financial focus area. The sustainability goals for road carriers can be classified in three areas. First, the environmental aspect is discussed. Followed by safety and employee satisfaction. These three aspects cover most of the sustainability-related goals for a road carrier.

Environmental

In the study of (Bask et al., 2018), it is concluded that environmental sustainability is interesting to large and international carriers, mainly due to external pressure and the belief that greening transportation will become a competitive advantage. The study also concludes that sustainability can be free if combined with efficiency. There are several approaches to do so; effective shipment consolidation, route optimization, reduction and recycling of packaging waste, and intermodal transport.

This study also aligns with the interviews held, as smaller road carriers indicate the prices and quality are the main focus. For larger road carriers, the carrier has more abilities to improve the environmental performance. The most important performance indicator purely related to the environmental aspect is the emission. Other studies have indicated solutions for reducing carbon emissions. The main aspects include reducing overall freight transport demand, optimizing transport modes, increasing asset utilization, improving energy efficiency and reducing the carbon content of energy (McKinnon, 2018). In the FTL carrier industry asset utilization and improving fleet energy efficiency play a role in other focus areas.

Smart Freight Centre has developed a framework for calculating emissions (see Figure 4.6). Important information for calculating emissions are identified. A distinction is made between total emission and intensity.

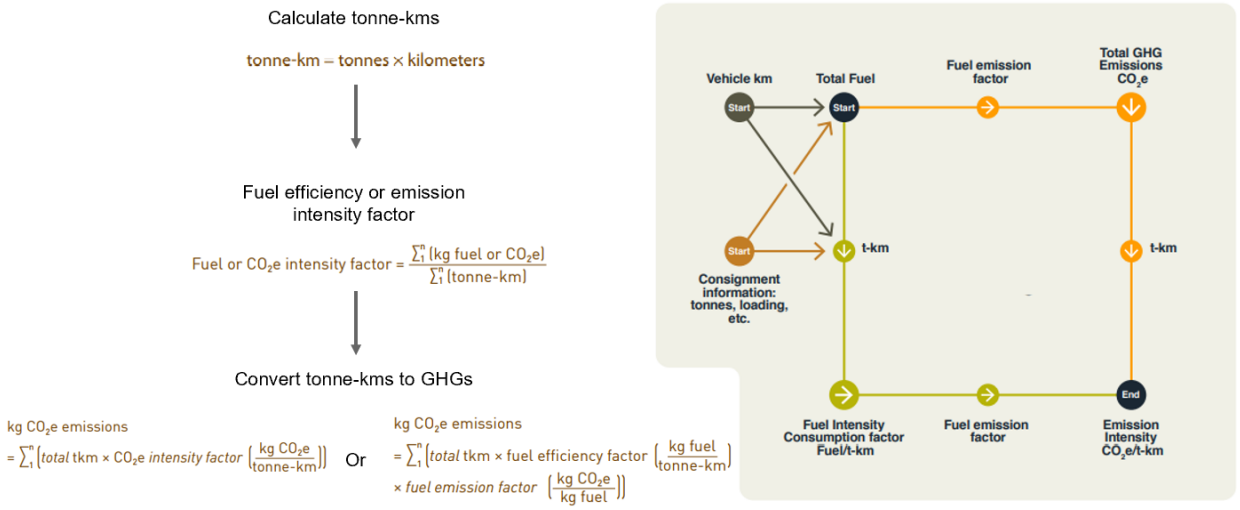


Figure 4.6: Emission calculation (Smart Freight Centre, 2019)

For calculating emissions, weight class, engine class, volume, year and fuel type play a role. Activity information such as topography, road type, distance, traffic and other deviations impact the emission (SmartFreightCentre, 2019). Using the steps mentioned in Figure 4.6, the total emission and intensity can be calculated.

- Total emissions - *e,f,m,p*
- Carbon intensity - *e,f,m,p*
- Truck label - *e,f,m,p*

An indicator of the emission is also the truck label. The label of the truck is an important indicator of fuel use and CO_2 emission. For many countries, the NO_x emission is also important. The label of the truck is another important aspect to take into account. In 2019 over 250 European cities had Low-Emission Zones (Transport&Environment, 2019). The expectation is also to phase out internal combustion engines. The impact on road transport is likely to be significant and the carriers will need to adapt their trucks.

Safety

Safety is another very important part that should be measured to indicate the sustainability performance. As mentioned by Carter & Rogers, risk management is also part of sustainability. There are many aspects to measure safety. Safety categories include those indicating driver safety, as well as truck safety. A study on accidents involving trucks (commercial vehicle with gross weight >3.5 ton) indicated that of the accidents involving a truck, only 7,4% involved a single truck. Of all the accidents, 78,4% was an accident at either: an intersection, queue, lane departure or overtaking manoeuvre (IRU, 2016). When analysing the accidents the following causes were found (see Figure 4.7).

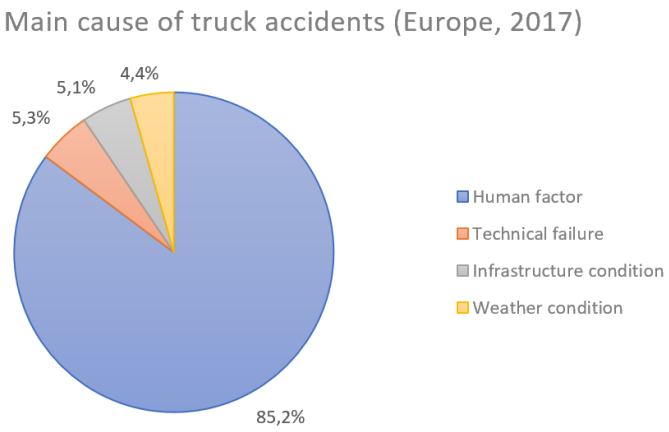


Figure 4.7: Truck accident causes (IRU, 2017)

For the carrier industry, these safety issues play an important role. Performance indicators identifying potential issues should be monitored to prevent unsafe situations. The study also concludes that most accidents are caused by non-adapted speed or failure to observe intersection rules. In the future, smart trucks will likely provide better assistance to prevent these situations. At the moment, there are measurements that can be made to indicate the safety performance. A summary of performance indicators is listed below.

- Safety disputes with driver - *d,h,m,k,p*
- Traffic infringements - *a,b,c,d,e,g,m,k,p*
- Breakdowns - *c,d,g,k,m,p*
- Failed/overdue safety inspections - *g,m,k,p*
- Truck exploitation - *d,h,m,p*
- Close call safety situations

In safety, one of the first things to measure is the number of issues. Unfortunately, driver safety issues are a recurring problem for carriers and is mentioned by different companies. Safety issues can relate to drivers not stopping when a rest period is needed, unsafe driving and driving under the influence of alcohol or drugs. A more specific measurement is the number of traffic infringements. As the truck is monitored, the stops that need to be taken by a driver can be checked. Traffic infringements focus on road safety. Infringements include speeding, neglecting signs and many other instances where government entities may intervene.

The truck safety is another important factor, as unsafe trucks lead to unsafe situations for employees and people on the road. The number of breakdowns should be carefully monitored. There are some measurements that could indicate issues beforehand. These measurements are the number of failed or overdue safety inspections and truck exploitation. Understanding the state of the truck is very important in preventing unsafe situations.

Employee satisfaction

The final goal related to sustainability is employee satisfaction. This cannot be directly derived from other focus areas. The employee satisfaction does however impact the sustainability of employees. For road carriers, the drivers are important assets. Their performances directly impact the execution and often changing carriers is not desirable. There are measurement available to indicate the performance.

- Driver satisfaction - *l*
- Late dispatch or return - *l*

- Number of orders import - *I*

Although these performance indicators are not described in much literature, they are an indication of what could, and possibly should be measured. The overall performance can be measured in driver satisfaction. This could be a grade given by the driver to indicate satisfaction.

In an interview with Waberer's, it was also mentioned that there are measurements that can indicate driver satisfaction. An important factor for drivers is arriving home on time. Likely important in many industries, coming home on time or even on the day you are scheduled is important. In the carrier business, it does occur that driver arrive home very late or even the day after. To measure this, the number of late dispatches and returns can be measured. Another indicator is the number of import orders. This measures the percentage of orders that have a destination in the area where the driver lives. If orders are mostly export (outgoing), issues around late dispatches or returns could arise.

Reflection on identified performance indicators

Using the input of literature focused on transportation, as well as business management, many performance indicators are defined. Literature a-g is mostly used to determine the transportation related performance indicators. Literature sources h-j are used to determine performance indicators useful to the logistics and supply chain industry. By reflecting on the performance areas, interviews conducted are focused on specific areas.

Interviews with Waberer's are used to identify goals regarding planning, the human factor, safety, sales, pricing, utilization and subcontracting. In the interview with Girteka, a focus was on the customers, efficiency, safety, planning, profitability, fleet management, sales, optimization areas, complaints and traceability. With Troost Transport, the added value of carriers, quality level and emissions are discussed. Peter Appel Transport contributed in determining views on subcontracting, pricing and sustainability.

These interviews also indicated the different views carriers have on the future. The challenges differ for large carriers from safety to the driver and customer satisfaction, while smaller carriers see pricing and congestion as critical issues. As only a handful of carriers is interviewed, no conclusions are made regarding the strategy of challenges.

4.2. Categories

In Chapter 3, several categories for performance indicators are discussed. In the previous sections, many performance indicators are established from their respective key focus area. The next step is categorizing them into either strategical or operational groups. The performance indicators show that there are different levels of measurement. There are measurements which can directly impact an action, while others need to be analysed before actions are taken. The goal of these categories is to deliver performance indicators to the right group.

The performance indicators are also analysed and allocated to the type of stakeholder in three levels. The first level is the executive level, second is management and third is role-specific. The chosen levels are used to identify a selection of users. The road carrier activities cover a large amount of operations, and by analysing the users, a selection is made. The executive level is determined to answer the top level question: what are the ten most important performance indicators? (see Appendix D.3) The management and operational side are split to divide performance indicators per focus group, or activity. The management level include performance indicators that can be analysed by managers who are not directly acting in the activity. Role specific performance indicators include performance indicators directly related to the activity.

Conducted interviews and literature are used to determine the 10 most important performance indicators. These performance indicators cover all four key focus areas. A choice is made per focus group and the overall importance. This is determined by looking at the area which the performance indicator covers.

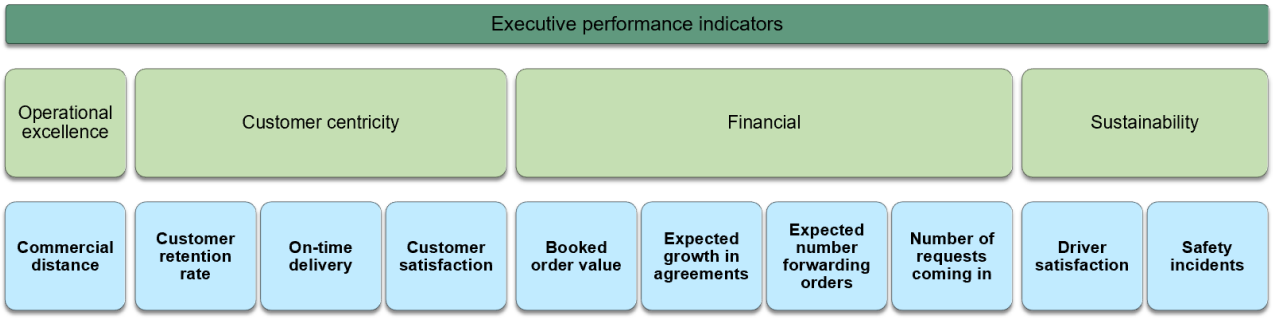


Figure 4.8: Executive performance indicators

The commercial distance is the distance travelled that is paid by the customer. This is an indicator of both utilities and customer success. The customer centric success can be identified in four indicators. These are the customer retention rate, the satisfaction grade, the net promoter score and on-time delivery. The customer retention rate is an indicator of whether customers are staying. the satisfaction grade could be an indicator to identify unsatisfied customers. The on-time delivery is for many customers an important aspect when choosing a carrier. The net promoter score is an indication of whether the customers would promote the carrier company, and could be an indication of future growth. The financial area also has four performance indicators. The booked order value indicated the total value of forwarding orders and can be regarded as the expected income from customers. The expected growth in freight agreements is an indication of business growth. The forwarding order forecast is focused more on the day to day activities, as these are used for planning. The performance on the spot market can also be measured using the incoming orders. The performance indicator to track is the number of order RFQ coming in. The driver satisfaction is the most important sustainability performance indicator. This indicator can be used to determine whether drivers are happy and likely to stay at the carrier company. The large number of performance indicators identified can either apply to a management or role-specific employee. These performance indicators are focused more on a specific area, business unit or activity.

These levels also play a role in determining whether an indicator is operational or strategical. The second aspect to take into account is the time interval. For strategical indicators, the time interval is often longer. For operational indicators, the time interval should be short, as role-specific employees will be able to adjust their actions using the measurements. It should be noted that for management roles, both long term and day to day performance indicators are relevant. The key to these performance indicators lies in determining the measurement unit.

In practice, some performance indicators are regarded as strategical and operational, as they can be important for different stakeholders. These performance indicators will differ in aggregation level, and possibly data sources. Looking at the method, the first steps have been taken, key focus areas are identified, goals and groups are chosen. Performance indicators are the result of this. Now the categories are known, the next step is to determine the correlating aggregation level.

4.3. Aggregation level

Mentioned in the previous section, performance indicators can be used in operational and strategical form. The stakeholder, unit, business activity and data source can be different. The next step in establishing performance indicators is the choice for a unit.

For example, the empty leg distance is an important performance indicator. This indicator can be used by both strategical and operational stakeholders. The difference for this indicator is the unit. For strategical purposes, it is important to look at a longer period of time. A strategical unit would be the average empty leg distance per month compared to the previous months (and years). In that way, strategical stakeholders can use the information to determine strategies. Operational stakeholders will likely be more interested in the empty leg distance of the past week, the target and the expected empty leg distance.

The unit will likely not be the same for each carrier. Data is stored per different periods, some carriers wish to see more up-to-date data, while other demand a long term data insight. Therefore, this research proposes several units that can be used. These units can be derived from Figure 4.9.

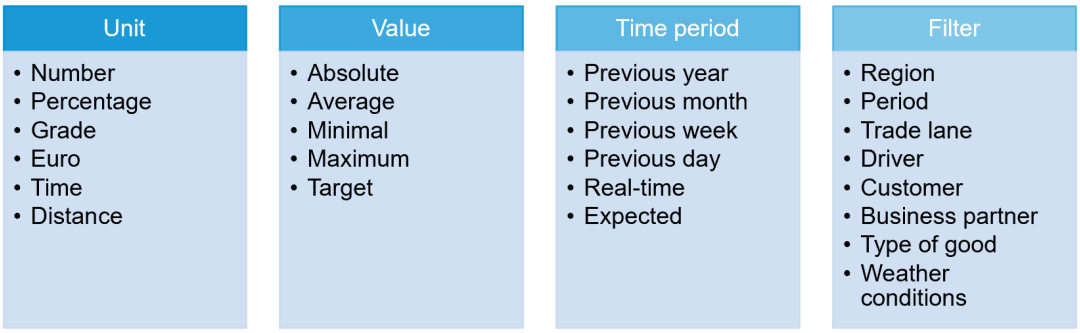


Figure 4.9: Aggregation level

The aggregation level is divided up into four sections (see Figure 4.9). The first column can be derived from the performance indicator. For the other three columns, a choice has to be made. The second column is chosen to determine the value, and the third the time level. In analytics, it can also be interesting to look to different filters, for instance per region, period or type of good. These filters are not obligatory but can be used to analyse certain situations.

4.4. Conclusion on identification of performance indicators

This chapter has described how a road carrier business can be assessed using four key focus areas. For each focus area, a group in which goals can be identified is discussed. This has led to the following key focus areas, including the groups which are correlated (see Figure 4.10).

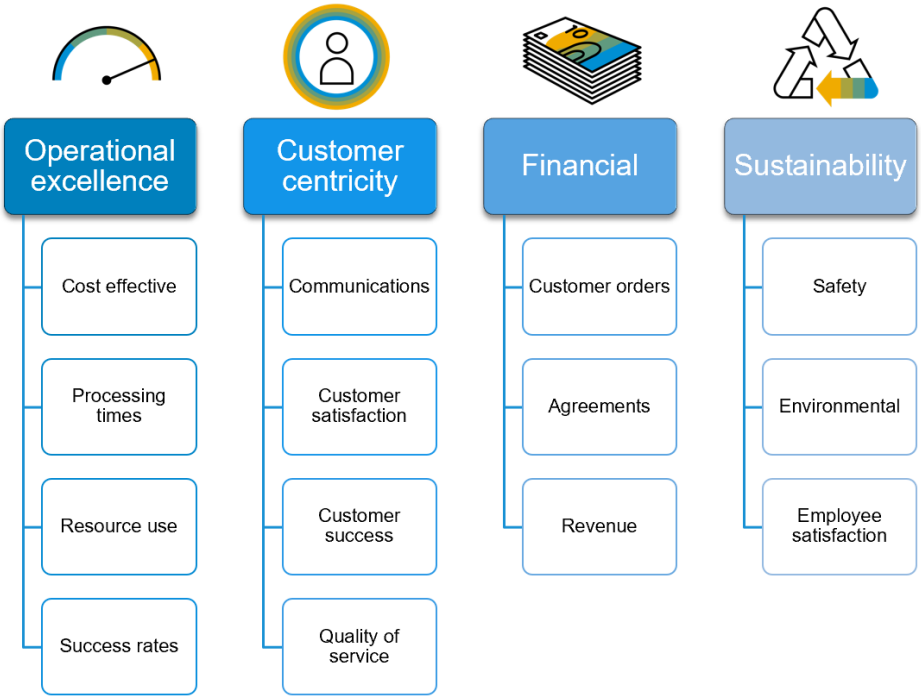


Figure 4.10: Focus groups per key area

Using these key focus areas and groups, performance indicators can be chosen. Using literature about performance indicators, specific to supply chain, transportation and general management, a set of 63 performance indicators is identified. These are divided into 20 customer centricity, 9 financial, 23 operational excellence and 11 sustainability. These are also allocated to the 14 focus groups.

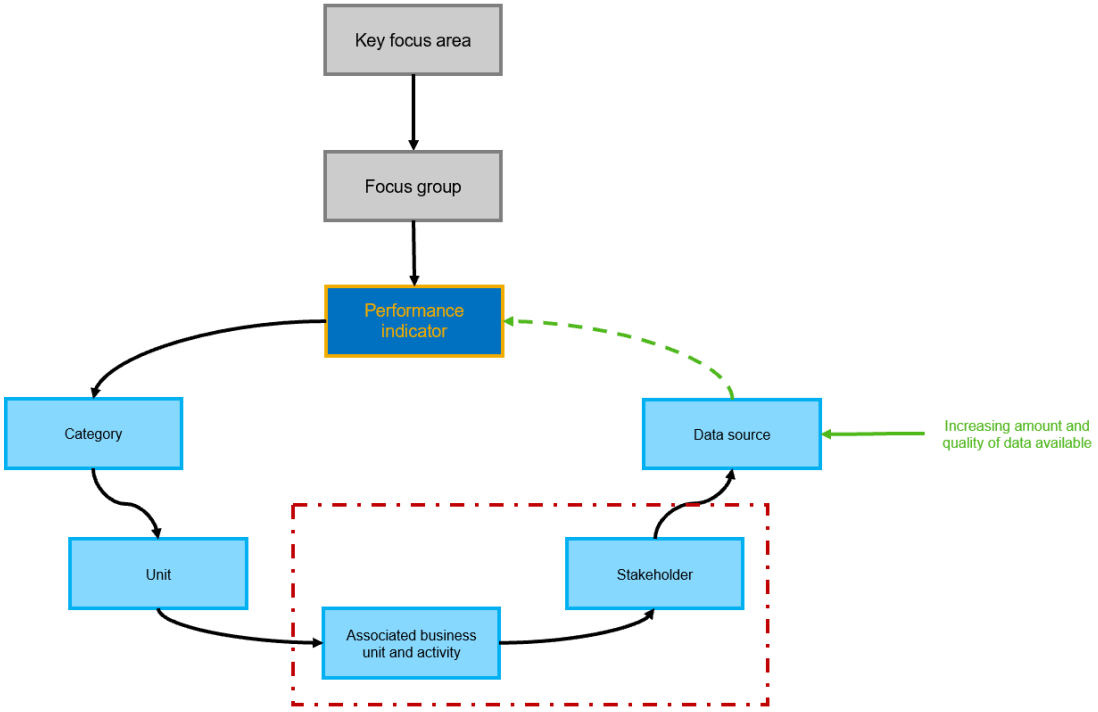
Interviews with road carriers are used to validate and added performance measures to improve the list. Categories are described to indicate the difference between strategical and operational performance indicators. Next, the performance indicators are further defined by the aggregation level. Several levels indicate what exactly needs to be measured per performance indicator.

Now the performance indicators are identified, the next step is to associate them to a business unit and activity. The association will also answer who is responsible and who can use the performance indicator.

5

Association of performance indicators

In Chapter 5, a fictional road carrier company will be analyzed to determine the business units. The business units consist of specific activities (see Chapter 2). Using the corresponding responsible employees the association of performance indicators can be made. As each activity has a responsible employee, the stakeholder of the performance indicators can be identified. The figure below indicates the method overview and the steps taken in this chapter.

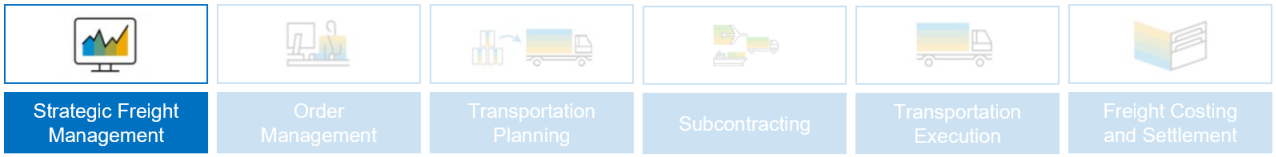


5.1. Business units and related activities

This chapter will describe the business units and activities of a road carrier. The activities are generic and not derived from a single company. The business units can be divided into six areas (see Chapter 2). In these areas, several key activities are identified.

For each section, a short introduction is given, explaining the related activities. Using information about the activity, responsible employees can be identified. Using the information gathered in this research, an association of performance indicators with the business unit, activity and responsible stakeholder can be made.

5.1.1. Strategic Freight Management



The strategic freight management (*SFM*) unit covers the procurement and selling of transportation services. As a road carrier is selling freight, strategic freight selling is an important part of the business. Activities related to the procurement of freight are discussed in the business unit subcontracting. The employees involved strategic freight selling are mainly freight contract specialists.

Strategic Freight Selling (*SFS*)

Strategic freight selling is the process of setting up long term contracts with clients to deliver transportation services. The contract is called a forwarding agreement (*FWA*). The first step in SFS is customer onboarding, which is the function of customer acquisition. This function should indicate which customers to focus on, and what market they come from. Road carriers can focus customer acquisition on certain areas where there are strong and reliable transportation lanes. Acquiring the right customers can help to better performances of different activities. The data needed will come from analyzing the customers and assessing the network at the moment. This will help understand which customers contribute to a healthy business and which are not profitable. Areas which have an imbalance in delivery of pick-up locations can be interesting to find new customers.

After customer acquisition, pricing management will determine flat rates and set up rules for margin and discounts. These are included in the quotation and are discussed until an accord is made. The rates can be calculated automatically or manually. In the bid preparation service products and costs are described. The workflow and revenue projection is calculated and an agreement is validated. Once an agreement is made, the contract is prepared. It is important to understand customer demand and create specific quotes (SAP SE, 2020b). It is also important to monitor contracts and make sure they adhere. In Figure 5.1, the collaboration between LSP/shipper and carrier is visualized.

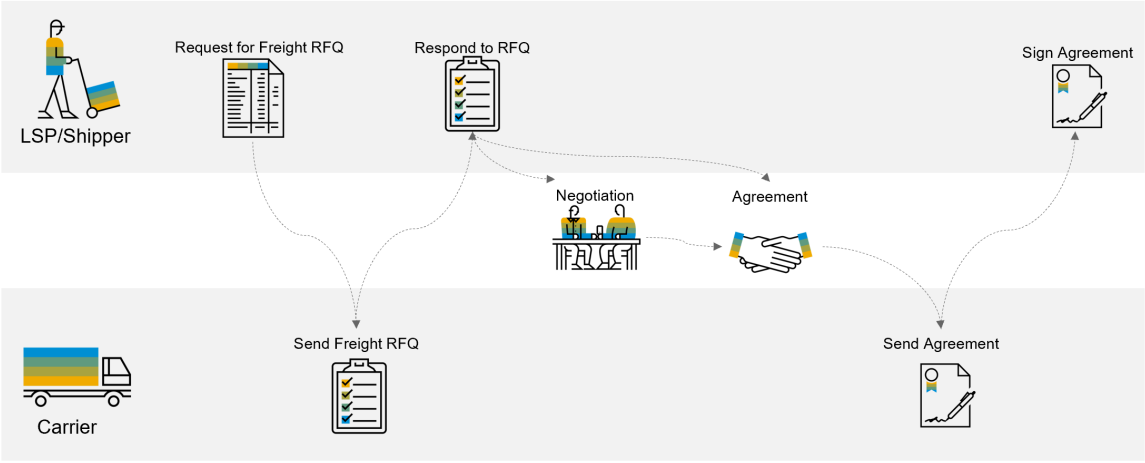


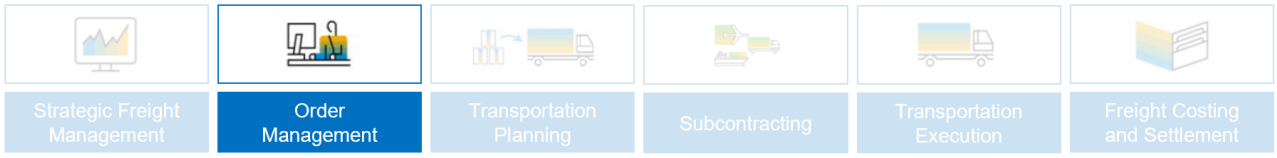
Figure 5.1: Strategic Freight Selling

The contractual relationship will include the service levels, commodity & capacity, rating, transportation requirements and trade lanes. A carrier can use performance indicators, analytics & simulation and fact sheets to produce the best agreement. In SFS, shippers and LSP are seen as customers. From their perspective, there are several important questions which they consider. These questions can be asked to the carrier and will determine whether an agreement is reached.

The objective is to have a streamlined quote to contract process. This includes automated creation of 'request for quotation' document, excel up-and download, automated rate building, revenue analytics, multiple users on 'forwarding agreement quotation', multiple quotation rounds and on-click contract creation. It is also important to keep customers satisfied, which can be achieved with a good request to agreement rate.

This important activity can be monitored by freight agreement specialists but is equally important for managers. A number of performance indicators will be associated to this activity.

5.1.2. Order Management



The second business unit is order management. Order management includes the managing of orders, the order quotation process and the creation of a forwarding order. These activities are widely used in carrier companies. The employees involved include customer service agents. These agents are responsible for the handling of customer orders.

Manage Orders

This activity consists of receiving and identifying orders. All booking information regarding customer, locations, insurance and transportation modes is handled. The handling of the information can be done using email, phone, collaboration portal of *EDI* (electronic data interchange) messages. These technologies pose possibilities of acquiring new orders. In the future, orders could also be received through mobile applications.

The objective is to receive orders in a way that all information is clear and the process is easy for the customer.

Orders should also be able to be handled easily within the business. An important objective is to be able to quickly comply with the customer. For example, the reaction time to requests and the ability to tell if an order can be accepted can be measured.

Forwarding Quotation

This activity consists of the creation of a forwarding quotation. Once an order is received, a quotation can be made. The quotation is set up differently for new customers and existing customers. New customers receive a new quotation, which is to be discussed while existing customers often have agreed on tariffs, discussed in the FWA. The offer contains information about the price and other conditions related to transportation services. Starting from the order and the information in it, a quotation is made. The quotation includes the distance, times and other specific demands. A shipper or LSP can request quotations at different carriers so a quotation must be competitive. In the case of a new customer request, a RFQ which is not competitive will likely lead to the loss of the customer.

An important function of this activity is the pricing mechanism. The price is one of the most important factors for shippers and LSP in choosing a carrier. The cost of the trip the important factor which eventually impacts the price. External impacts such as oil price, toll tariffs and delays can impact the price for the customer.

The objective of this activity is to attain a forwarding order, while also being profitable for the company. It is important to keep a profitable business, but also grow. This is due to the positive impact from economies of scale for road carriers. Examples include collective maintenance, information about truck performance and fuel efficiency. From a customer service perspective, it is also important to keep profitability per order in balance. As mentioned in Chapter 4, the flexibility of pricing is important, and this activity could play a role.

Forwarding Order

Order managements third activity is the forming of a forwarding order. In Figure 5.2, the levels are depicted with icons. These levels indicate the type of information that is gathered. The levels include the locations, date and times, unit and type of goods, partners and type of documents that will be used. The logistical function correlated with this process is order processing. That indicates how an order is optimally put into in the system. This activity can be different for each carrier, as different carriers have different systems. The difference between this activity and the managing of orders, is that in managing orders the relation with the customer is covered. In this activity, the creation of the forwarding order is discussed.

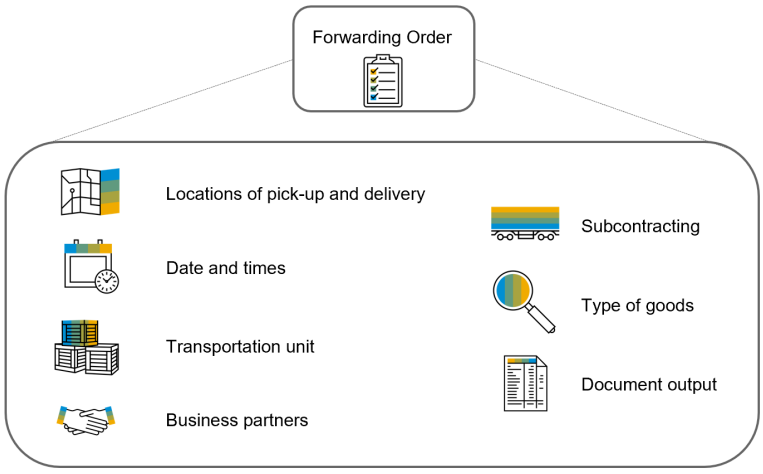


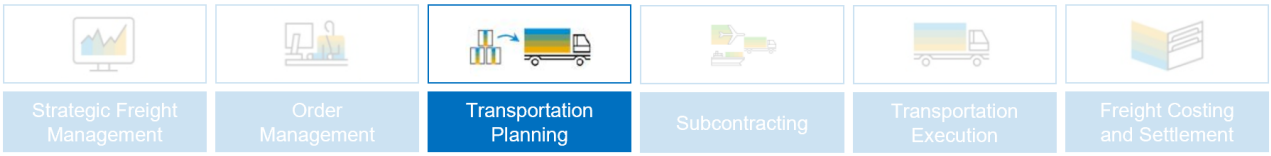
Figure 5.2: Forwarding Order levels of information

The objective is to have all this information as easily and quickly as possible in the system, so it can be used by planning. The information should be clear and complete and correct. The forwarding order should be able to

provide all the information necessary for planning operations. If an order is accepted and cannot be handled, it leads to issues with the customer.

The performance indicators that can be associated with order management include the forecasting of orders, acceptance rates and cycle times. The role-specific employees can use these performance indicators to measure their performance.

5.1.3. Transportation Planning



Transportation planning covers the steps from a forwarding order to a planned freight order and the dispatching. This includes the management of fleet and drivers, and the planning and dispatching. The first two activities are used to help in the planning of orders. First, the fleet management will be discussed. Next, the driver management is described. The third section covers the activity of planning and dispatching. In the transportation planning business unit, the capacity planner and transportation planners play an important role.

Fleet Management

The activity of managing the fleet is important. Tasks include having an up-to-date availability of trailers, their locations and status. The more detailed the status, the more detailed the planning can take place. For road carriers, their main assets include the trucks and trailers. Resolving issues such as damages and theft can impact fleet management. It is also important to have assets maintained so they do not break down during the transportation of goods. The maintenance can use information from this activity. The communication between the driver, maintenance and planning is key.

There can be several logistical functions that correlate to this activity. The first is network design. Where should maintenance take place, which locations are important? For road carriers, it is important to place warehouses at intelligent locations. This is a traditional function of transportation. The goal is to use the network as efficiently as possible, in a way that the empty leg is minimized. This function is similar to fleet positioning, which focuses on where the fleet should move, mainly applicable for the moments a trailer is empty. How many vehicles should be located in which zone to be able to comply with the highest number of orders? Understanding the demand and where pick-up locations will be, can help with optimizing the fleet positioning. For planners, the dis-balance in the fleet is an important performance indicator.

Another important function for fleet managers is maintenance planning. Predictive maintenance is one of the more technical aspects of logistical functions. In predicting maintenance, the exploitation of trucks and their performances play a vital role. It is different per business, as there is a point a choice has to be made between using a truck longer and more chances of truck failure. To optimally predict maintenance, it is important to gather data on performances of used trucks. For many large carriers, their own fleet can provide information.

Using the data available from these functions, it is possible to analyse vehicle performance. The performance of the vehicle can indicate how a vehicle is performing. This can provide information on fuel consumption, maintenance, tyres and damages to the vehicle. A calculation can be made on how much the vehicle costs per kilometer. If costs increase, the carrier can choose to invest in new trucks. Using the maintenance schedule and status of trucks, the objective is creating a real-time status of the fleet, and receive updates when necessary. It is important to optimize the functions regarding predictive maintenance and network positioning. That will help in achieving the overall objectives of having correct up-to-date information for planners.

It can be concluded that the fleet management activity includes a lot of logistical functions and has the potential

to produce important data. The information gathered can be important to both the fleet management employees, as well as higher management.

Driver Management

The second capacity management is driver management. It is important to have up-to-date information on the availability of drivers, their locations and status. The driver is often also important to tracktrace, where the driver can share information on the transport. Driver management considers non-working times and absences (e.g. vacation, sickness), driver qualifications and validity period. Regulations considering drivers are also updates in this area. These are important for planning and make more complex planning possible (for instance, driver swapping).

A logistical function related to this area is the evaluation of drivers. Information from this evaluation can be useful to driver management. The fuel consumption, damages, and contact with the customer can be analyzed and lead to a driver performance indicator. The evaluation of this can help identify drivers who are performing poorly and which are doing above average. A reward system could be an option.

When driver management is properly updated, planning will be able to easily combine the optimal driver and trailer combinations. The objective is also to improve driver utilization to reduce overall costs. Working experience for drivers is also important to understand. The aim is to have automatic updates between headquarters and drivers. The information about drivers should be correct and useful in decision making. This activity also indicates the data that can be used, as well as produced.

Planning and Dispatching

Planning and dispatching is one of the most dynamic aspects of a road carrier business. Forwarding order can be regarded as the starting point. The freight unit is known as this study focuses on FTL. An order is used to combine with vehicle and driver resources. The maximum transportation quantity per unit and the compatibilities are known. The resources and subcontracting information is used in planning.

If handled by software, an optimizer will suggest the best planning options. The optimizer has a certain algorithm, which can be derived from a strategy and transportation proposal settings. There is a list of constraints for this optimizer (see Figure 5.3). These constraints are some of the topics that need to be covered to optimize planning operations.

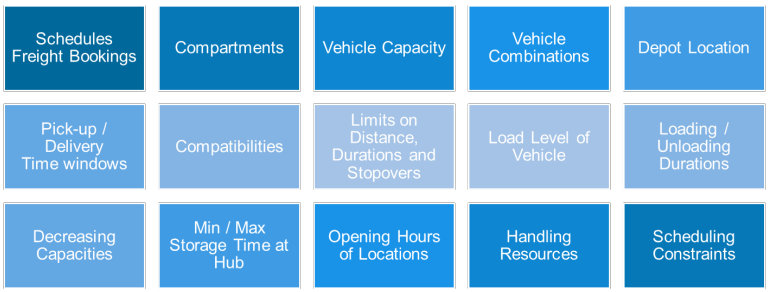


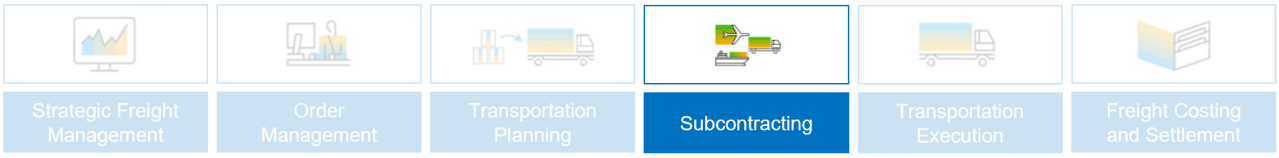
Figure 5.3: Planning optimizer constraints

The final planning can take place automatically or manually. A transportation planner can confirm or deny proposed planning. Default driver assignment to a truck, assign drivers to road freight order, facilitate planning via warnings are some of the actions taken by the planner. The planner order will be a freight order ready for execution or subcontracting.

Another function of this area is routing. Routing is a traditional problem in logistics. Goals can include the best pick-up time, to the cheapest route, which is not to be confused with the shortest route. A choice can be made per carrier and many different tools can be used to optimize the routing. Constrains for route optimizing can include the driver working times, traffic, no-go zones, fuel prices.

When looking at the technical aspect of these activities, it is important to be able to plan dynamically. For instance, dynamic routing could lead to better routing. Important objectives of this activity include the improvement of resource utilization to reduce transportation costs. Select the most cost-effective easily. Achieve on-time delivery and ability to adjust planning on real-time events.

5.1.4. Subcontracting



Subcontracting is more important to some road carriers than others. Subcontracting covers the activity of contracting third parties to cover part of the transportation or logistics. There as several players in the company who play a role in subcontracting. These include the transportation planner, the booking specialist and the carrier settlement specialist.

Subcontracting

Subcontracting is done when the own fleet is unable to transport all of the demand or if other parties are needed to transport goods. For example, if a customer demands part of the freight to be transported in special trucks, the carrier can subcontract the special type of truck. The process of subcontracting also applies to parts of the transport. 'Huckepack' is an example, this is when a trailer is lifted onto a rail car to be travelled over a longer distance. Toll and ferry's are also part of subcontracting, as they need to be planned and paid appropriately.

Subcontracting is close related to the planning and is executed with a freight order as a starting point. All areas within the freight orders need to be accounted for, and if this is not possible with the own fleet, parts are subcontracted. As subcontractors handle goods for a period, documents need to be in place, and handling must be with as little issues as possible.

An important part of subcontracting consists of tendering. This is the process of choosing a subcontracting party. Successful tendering leads to better performances of the road carrier and a choice is often made based on performance and costs. In these processes, it is important to have a clear definition of what needs to be subcontracted. The goal is also to have a clear overview of the schedules, availability and prices of subcontractors. This is needed to find the subcontractor with the best performance for the lowest possible price.

5.1.5. Transportation Execution

The transportation execution area covers the execution of transport. The activities included are track & trace and execution. This covers the monitoring, notifying, analyzing and adjusting of transportations. The dispatchers of the company are most involved with this process. The execution is carried out by the drivers.

Track & Trace

Once a freight order is created, the drivers are notified of the steps that need to be taken. The next step it tracking the goods. Tracking of goods can be important for customers and carriers. With up-to-date information, arrival times can be as specific as possible.

The activities and steps taken can be monitored. This monitoring is done by tracktracing. An example of this process is SAP Event Management. An overview of event management is shown in Figure 5.4. For road carriers, a lot of information can be used. For example, the time stamps for each event are known, as well as the number and types of events reported.

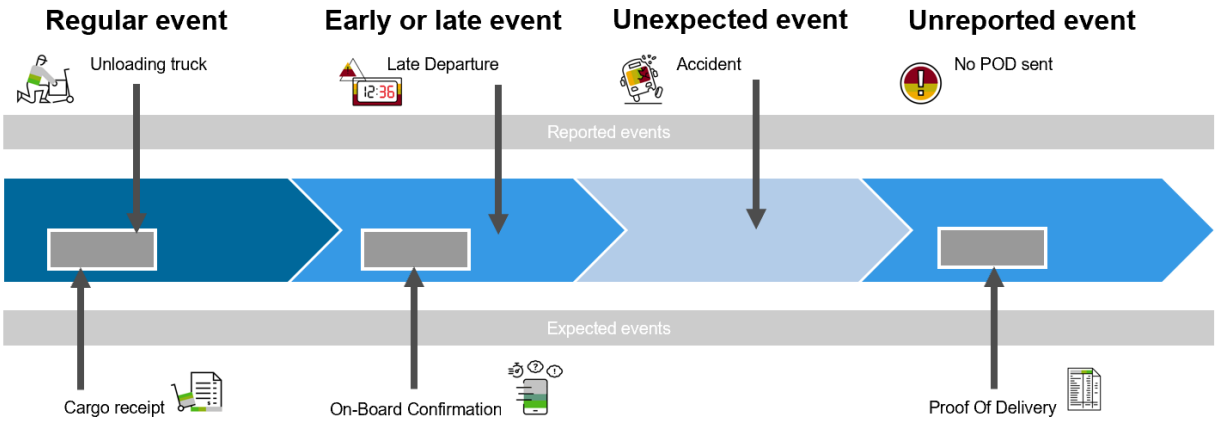


Figure 5.4: SAP Event Management

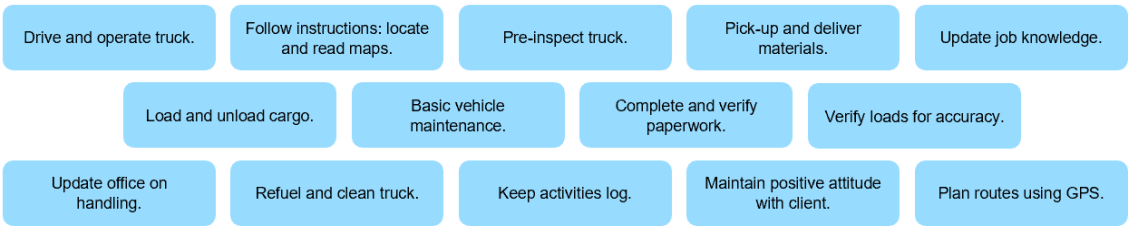
For road carriers, the first step is determining the milestones and how they are reported. As can be seen in the figure, events carry actions with them. A cargo receipt is created when transport is finished. Late events need to be used to adjust the expected time of arrival. Unexpected events can be used to inform the freight owner. This means there are four types of events (see Figure 5.4), either a regular event, a late or early event, unexpected event or unreported event. How events are communicated to managers can differ. Geocoding can help determine the location of the truck where there is no tolerance for errors by drivers. As tariffs are calculated knowing delays, the events must be closely monitored. For the customer, it will be important to be kept in the loop on events. Informing and discussing issues will lead to a better experience.

There can be two objectives identified. The first is to keep informed on the execution for own activity purposes. The second is to inform product owners on the progress of the operations. The goal is to have a quick and clear information exchange between the truck and the fleet managers. This is crucial in the ability to act when events occur. The ability to adjust to customer preferences can be a result of this. The correctness of this tracing and consistency play a role in keeping customers satisfied.

Execution

The execution final execution responsibility lies with the driver. A driver receives a location and time at which transport has to take place. Information can be given through a mobile device, on-board computer or email. Once started the driver uses the tachograph aboard the truck to monitor the state of the truck. Interviews have also indicated the importance of keeping the number of interactions with the driver to a minimum. This is to decrease the number of issues or miscommunications that can arise. Many carriers are instructed to indicate the time they arrive and depart. These times are important for further settlement.

There are many indicators to measure driver performance. The number of issues can be monitored, to determine whether a driver is unsafe. The fuel use can be monitored, as fuel efficiency plays an important role. The driver is also the face of the company to customers, and these communications also need to be carried out well.



The responsibilities can be different per carrier. Some drivers may be responsible for preventive maintenance, recording logs, the loading and unloading and reporting. The items shown above give an indication of the different activities of a driver. The execution relies for an important part on the driver and 14 role-specific performance indicators are identified. Although these performance indicators are regarded as part of the execution, the responsibility can also be found in other areas.

5.1.6. Freight Costing and Settlement

Freight costing and settlement cover the topics of charge and tariff management, as well as the settlement documents. Both use information from previous actions. This is the sixth area, in which an activity is directly connected to the transport of goods. The customer settlement specialist is one of the key employees active in this area.

Charge and Tariff Management

Charge and tariff management is carried out after the transport is completed. For the settlement documents, it is important to have a clear calculation of all costs. The shipper will receive an invoice once information from drivers, fuel and other costs are accounted for. Due to events, the rates described in the RFQ may change. This activity takes place in charge and tariff management. The freight charge is calculated using various origin/destination point classifications. The main costs are driver and fuel charges, the rest of the rates are based on; equipment, weight, volume, distance, discounts, tolls and taxes. A fuel surcharge is also calculated. For the carrier, it is important to collect revenue as quickly as possible.

The main objective of charge and tariff management is to generate clear tariffs which are based on accurate events. The objective is to automatically combine information from orders and event management to determine charges. For shippers and LSP's, it is important to have a transparent view of charges. The invoice must comply with country special requirements.

Settlement Document

Once the final event is passed and the charge is calculated, settlement documents are sent to involved parties. The documents are a freight settlement document and a forwarding settlement document. A forwarding settlement document is used to request the sending of an invoice to the shipper of LSP. A freight settlement document is used to check the data of an invoice of a subcontracting party. The documents are both created using the information described in the order. The faster the settlement documents are created, the faster an invoice can be sent. It is favourable for all parties to settle as quickly as possible, as disputes after time will become more difficult.

A number of performance indicators can be associated to freight costing and settlement. Measurements from the activities can lead to a clear view of disputes, payment and pricing. Several key focus areas have performance indicators that can be associated.

5.2. Conclusion on the association of performance indicators

Using the information from the activities, the performance indicators can be associated with the responsible employee and activity. The six business units and relating activities are generic and identify the most common activities of a road carrier. By analysing the activities and looking at the specific objectives, a distinction can be made between responsible stakeholders. Performance indicators which align directly with the objectives of the activity can function as operational performance indicators. The role-specific stakeholder will be able to measure their performance using these indicators.

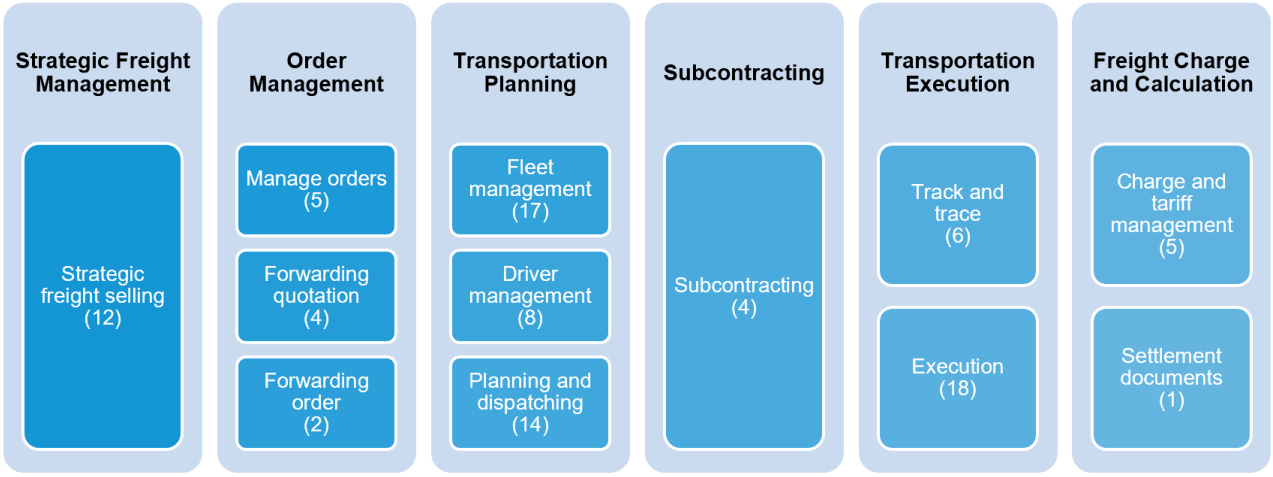


Figure 5.5: Business units and related activities (number of performance indicators)

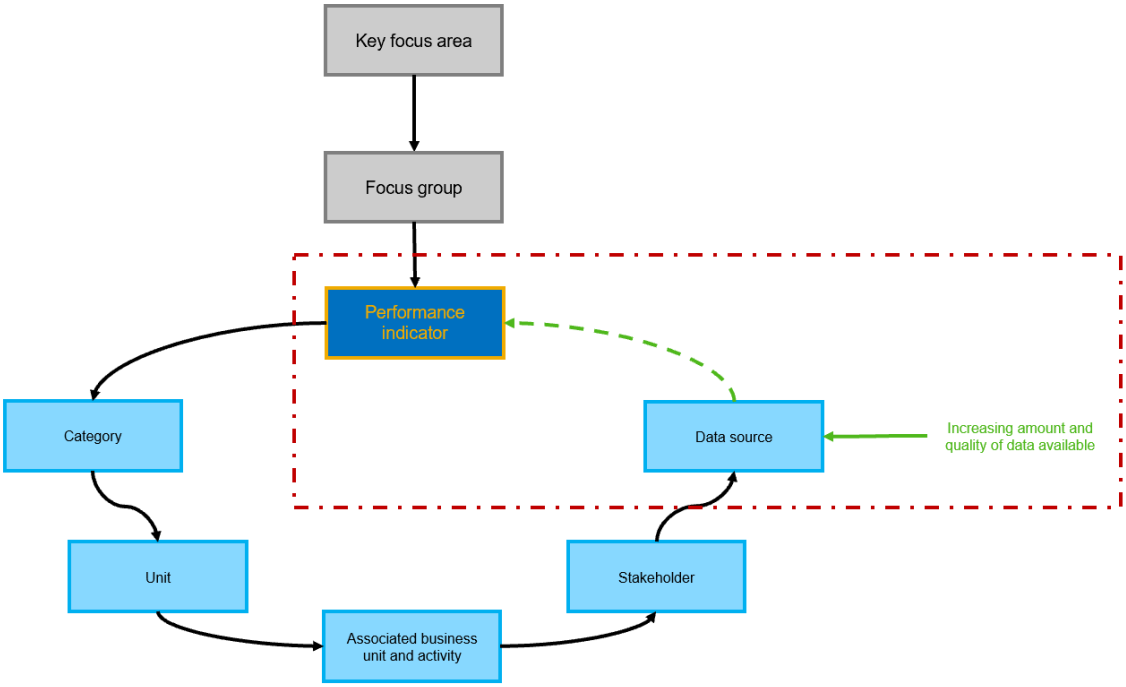
An activity which covers the operations is analytics and reporting. Carriers often identify analytics and reporting as a separate area. The activities discussed in this chapter do not mention this as a separate area, as performance indicators are a means for analytics and reporting. Therefore, analytics and reporting are not used for the association of performance indicators.

In this chapter two steps in the method have been taken. First, the activities and relevant business units are discussed and associated to the performance indicator. The relevant stakeholder of the performance indicator is also identified. For each business unit, several functions are described. These functions also describe the information needed for them to perform. These sources will be taken into account in the next step, tracking of the performance indicators.

6

Connecting data sources to performance indicators

This chapter will discuss what data sources are available and can produce information to measure performance indicators. First, an overview of the data sources is given. Next, a more detailed description of the data sources, indicating how the data is collected and stored is given. The data sources can be used to track performance indicators. The proposed method also includes a link between additional data sources. These are improvements and new data sources. By analysing the data source and the information that can be gathered, new performance indicators, related to business goals or activities can be developed.



6.1. Tracking performance indicators

For each performance indicator, data needs to be collected. Information can be retrieved from many different data sources, from IT to IoT devices and external sources. In this section, each data source will be analysed and potentially connected with a performance indicator. As mentioned in Chapter 3, there are several steps that need to be taken to identify data sources (see Figure 6.1). The first question that is asked is, *what needs to be known to measure the performance indicators?*. The next step is to identify a data source for each part of essential information.

By analysing the data sources, new insights into performance indicator tracking are gained. These insights also have the possibility to introduce new measurements. Therefore, for each indicator, the possibilities of improving tracking are described. The information is tested to determine whether the performance indicator is relevant to one of the focus groups and associated activities.

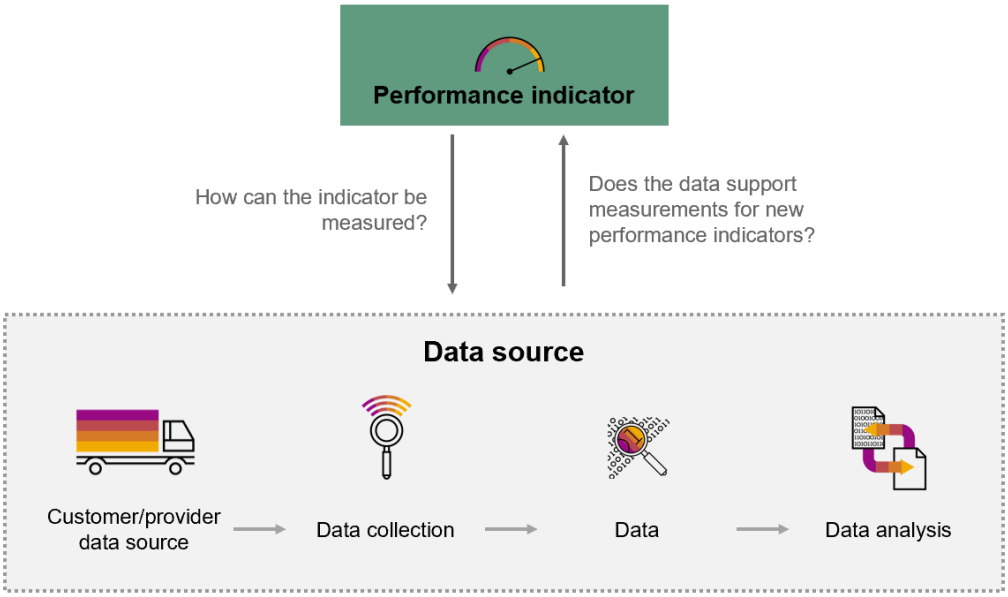
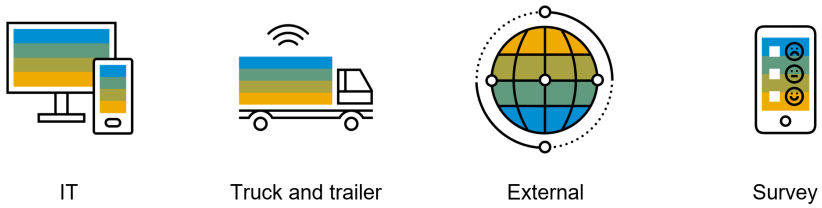


Figure 6.1: Tracking performance indicators

The following sections will identify ways in which data can be collected and analysed. The sections are split up into four sections. The sections are based on the data source (see Figure 6.1), in which the customer and data provider sources are analysed. These are the four principal areas in which data can be produced. For each area, the specific source or collection equipment is identified. A description of how data is analysed is given. The first area includes IT data sources. These sources include information that can be retrieved from different software programs that a carrier can use. The second area includes data sources in the truck and trailer. External areas form the third group that includes information about weather, road conditions and traffic. Surveys are another type of data source which will be discussed before a note about future data sources is given.



6.2. Information Technology (*IT*)

For road carriers, there are many different areas that produce data. In this section, an overview of the most important areas is given. To give an idea of how IT can be a data source, Figure 6.2 shows how an IT data source can be used to acquire information.

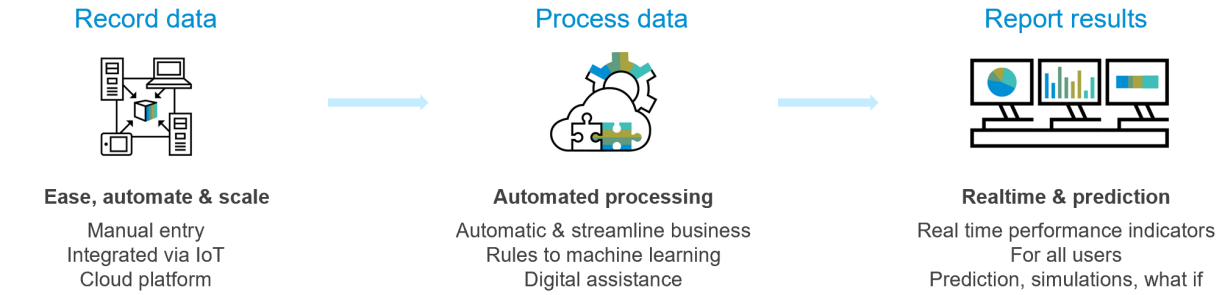


Figure 6.2: Explanation of information technology sources

In this figure, the IT module represents business software that can be used. These can include customer software, where orders and customer information is handled, to HR software, where HR can account for information about employees. A software system will record data, process it and report results.

The mechanism of Lim can be used to describe how information can be produced from IT software. The data source can be seen as the first step of the mechanism (see Figure 6.1). The raw data can be analyzed to find relevant information. To relate this mechanism to IT sources, in each of the IT modules, the data source can be different and can be seen as different software. In the next steps of this study, the insights on these data sources will indicate the software needed for producing information essential to performance measurement.

IT - Customer Management

Customer management software is used to handle orders and freight agreements. Information about customers can be handled and stored. Information includes details about freight agreements, customer orders or disputes with customers. This software could provide a lot of information on measuring the performance of these activities. Acceptance rates for quotations, cycle times, ability to handle special requests, processing times and retention rate are some of the performance indicators that can be measured using information from the customer management software.

By looking at the data sources and the information that can be gathered, additional performance indicators can be identified.

- Contact times
- Orders and agreement details per customer characteristics

Using customer management software, information on contact times can be calculated. Performance measurements related to the cycle time are previously mentioned. Information on the time between contact from

customers can also be measured. Details related to the customer can also give insight into acquiring a new customer in the future.

IT - Planning

The second section in IT is the planning software. Carriers use software to conduct planning of their fleet, drivers and orders. The software can differ from automatic planning to manual input and output. In the software, all details concerning planning are kept. This information is very valuable to carriers and is used for measurements in many performance indicators. This IT section also covers all the information regarding assets. Information about trucks and trailers, including technical aspects, are found in this section. This is very useful for certain units and filters. For example, to analyse the condition of the trailer, the specifications and age of the trailer can give valuable insight into the situation.

A few examples of performance indicators that can be measured using the information are; the direction of the orders (away or towards desirable zones), the utilization rates, fleet distribution, consistency of transit times, safety inspections, emission labels, maintenance planning and traffic issues. Other areas that can be measured using this data include the following.

- Asset usage (trucks and trailers)
- Optimal planning time
- Downtime information
- Vehicle replacement

Planning software can produce a lot of information. The use of the assets is required to determine utilization. The software can also include information about the assets. This can indicate whether certain trucks deliver better performances than others. For example, this information can be used to determine the downtime in relation to the age of the truck. Other information regarding the optimal planning time can be produced. Different planning times can be tested and the relation to operational excellence can determine the optimal planning time. Similar is the calculation of downtime. Downtime can be calculated and combined with characteristics of use and technical specifications. This information can be used for vehicle replacements.

IT - Finance

The finance software is the software that is being used for accounting and financial reporting. Information on costs coming in and expenses can be found. Overall financial information on revenue, customers and agreements can be derived from this data source. Performance indicators that can be measured using finance software include the cost per truck, maintenance costs, driver costs, flexibility of pricing, profitability per order and business shares.

- Costs of assets over time
- Revenue fluctuations

A lot of performance can be measured using the financial key focus area. As mentioned in the scope, financial performance indicators are already studied and can be used in this research. The cost of assets could provide measurements regarding the maintenance. Revenue fluctuations are another performance measurement that can be used to determine the impact of different scenarios on the revenue.

IT - Supplier Management

Supplier management is used to handle information of suppliers and subcontractors. Information on the subcontractor, the relation and quality can be produced in this module. Software reporting this data can be used to produce several performance indicators, including issues with subcontractors and alignment with the subcontracting party.

- Changes in suppliers

By monitoring the supplier management software, information regarding the changes in supplier approach can be determined. These changes can be measured and used to determine future suppliers.

IT - Human Resources (*HR*)

HR software can produce information regarding the employees in the carrier company. All driver information and salaries can be found in this area. The availability of drivers used in planning software can be connected to the availability of the driver by HR software.

- Employee availability
- Salary information

Employee availability can be measured. Understanding when there is lack of drivers of management personnel can be valuable. Information about salaries can be monitored. Understanding salaries can determine future costs.

IT - Quality Issue Management (*QIM*)

The IT area that monitors all quality issues is 'Quality issue management' software. This is software that is used to identify and track all issues in the carrier business. This can include late deliveries, traffic infringements, safety issues and damages. The way that this information is acquired can differ per company. Some issues might be automatically connected to the issue management, while other issues may be manually put into the system. Information can be used for several performance indicators, including issues with the condition of the trailer, traffic accidents, traffic infringements and other safety disputes.

- Issue characteristics

Important information regarding issue characteristics can be calculated using the quality issue management software. For example, the reason for the issues can be determined.

IT - Forecasting

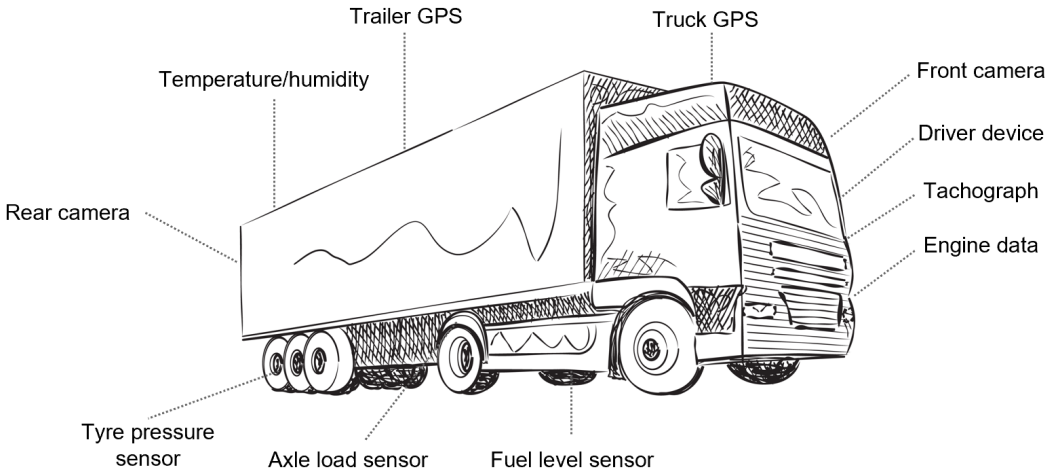
A final software component that is used is forecasting. The activity of forecasting is present in many carrier companies and is instrumental to successful performances. The output of this activity can be used in different activities, but it can also be used to measure performance indicators. Some of these indicators include the number of expected orders or agreements or planned costs.

- Forecasting time and reliability

Forecasting information is used to determine several expected numbers. The software can also be used to determine the forecasting time and the reliability of the forecasts. For improving forecasting but also warn for unreliable forecasts.

6.3. Truck and trailer

A recent study at Scania is used as a starting point to identify the important data sensors aboard a truck (Chi, 2020). These sources are discussed in the next sections. The first to be described is the tachograph. The tachograph is an essential part of all trucks and has many meters. The second section will elaborate on the GPS systems carriers use. Camera use is also increasing and will be discussed in the third section. Another area is the sensors aboard a truck and trailer, these may include the tyre pressure, temperature or humidity.



6.3.1. Tachograph

The tachograph is a device found aboard a truck that records many aspects of the truck. The driver activity and vehicle usage can be monitored which can help with potential legal activities. The device can be used after a driver inserts his or her pass and is confirmed. The truck will be able to produce information on the truck state and driver actions. Analysing the tachograph using the Lim mechanism, the data source is the truck, the data is collected using the tachograph. The data can be updated and uploaded to the carrier every few minutes, so as an almost real-time state can be determined. The data is also stored in the tachograph chip on board. In the Lim mechanism, what can be considered the data is different for each aspect. These will be elaborated on in the next sections.

One of the most used attributes of the tachograph is that is monitors the actions of the driver. The states that the truck can be in include the driving, other work, rest and period of availability. These four states can indicate whether a driver is resting when necessary, or the total time a truck is used. Considering the driver activity, this also indicates gear changes, speed, acceleration and slowing down.

The tachograph can be used to determine several performance indicators. The state of the truck can be used to determine the utility, by comparing different states. The monitored driver activity can also be used to determine the performance of the driver. An example includes the way the truck is used for acceleration, braking, cruise control, shifting, which all impact fuel efficiency. The speed can be used to determine possible traffic infringements and traffic delays. The tachograph also measures information from the engine, which can be used in predictive maintenance.

- Drive time analysis
- Driver infringements

The information of the tachograph can also be used to determine the left over driving time of drivers. The efficiency of driving time can be optimized using the information. Another aspect that has possibilities to measure is driver infringements. These can be measured using the Qim software, but can also be measured using own equipment. The tachograph has the possibility to measure close call infringements.

6.3.2. Global Positioning System (*GPS*)

Track and trace data is an important data source for road carriers. Using GPS aboard a truck, the location of the truck can be tracked. Using the Lim mechanism, the four steps in producing the relevant location information can be are as follows. The data source is the truck, the data is collected using a GPS tracker. The data is collected in the form of coordinates, which are analysed and lead to the required locations.

- Improved track and tracing

The location is an important factor when measuring performance indicators. For many indicators, it is interesting to know the performance per region. This filter is only possible using GPS. An important activity uses GPS, which is track&trace. New use of the GPS is geo-fencing, which is a way of specifying coordinates to send a signal if the truck in a certain area. That means that events can be monitored using GPS and no longer rely on input from the driver or customer.

6.3.3. Cameras

The dashboard camera is a camera located inside the cabin. The camera is pointed at the road ahead and is used mainly for dispute management. Issues regarding settlements, fines can be checked using the camera evidence. Other cameras can be located inside the trailer or on the back of the truck.

- Close call accidents
- State of goods in truck
- Loading and unloading details

The cameras can also be used to identify close call safety situations. For example, the number of late brake responses can be measured. Another way the camera is used is to report incidents when away from the truck. The cameras can also be used to discipline and coach drivers. Using data from cameras requires software able to analyse the recording. The state of the goods in the truck can also be monitored for safety reasons. The loading and unloading of trucks can be analysed and clear loading times can be determined. Using the camera data, there is less chance for disputes.

6.3.4. Sensors

Onboard of the truck, there can be several sensors. These include the sensors that monitor the fuel level, tyre pressure, axle, temperature, humidity and emission. Each of these sensors poses as data collectors in the Lim mechanism. The data retrieved is analysed in different ways.

Fuel level

The fuel level is monitored and using a fuel level sensor. This is used to have an up-to-date view of fuel use. This is useful to determine the average fuel use, but the information can also be used for planning the refuelling locations. Due to the large amount of fuel, it can be financially interesting to find the cheapest location. To do so, the actual fuel levels need to be monitored. Another use of the data can be to monitor whether fuel is stolen.

- Fuel efficiency
- Stealing

The level of fuel can also be used to improve fuel efficiency. By analysing the level of fuel and the type of fuel, efficiency can be compared. Stealing of fuel can also be monitored to warn of fuel stealing.

Tyre pressure

The tyre pressure is an important indicator when assessing safety. The sensor aboard can measure the pressure of the tyres. Tyres with underflat tyres result in more fuel use. Underflat tyres also pose safety issues, because tyres are also more prone to blowouts, loss of grip and increased response times. These situations become more unsafe in bad weather conditions. High pressure can also increase wear of the tyre, which may result in faster replacements. The performance indicators that use information from the tyre pressure include the number of issues with tyre pressure and a number of possible safety issues.

- Unsafe situations

The tyre pressure is an important factor in safety. Therefore, the pressure can be analysed and information about the pressure can be used in predictive maintenance.

Axle sensor
The axle sensor is a sensor which is located underneath the trailer and can calculate the load on top. The sensor produces information on the current load, but can also be used to determine changes in the load.

- Loading and unloading
- Stealing

This means that the information can also be used to determine loading times. This is because the change in load indicates loading or unloading. Another use can be theft prevention. A connected sensor could pose as detection of theft.

Trailer temperature
The temperature within the trailer is important to the client when handling goods which need to be monitored. The temperature can be measured using a thermometer inside the trailer. For many customers, the ability to provide the right temperature during transport is very important. The temperature can play a role in the quality success and related performance indicators.

- Temperature issues
- Energy use for temperature management

The trailer temperature can be used to determine issues regarding freight. In case of an increasing temperature, actions can be undertaken. Another important aspect is the energy use per temperature. Temperature control uses energy and the usage differs per area. For example, more energy for cooling is needed in Italy in the summer compared to Latvia in winter.

Trailer humidity
The humidity in the trailer can be measured using a sensor. The sensor is often combined with the temperature sensor. Similar to the temperature, the humidity plays a role for some customers. The ability to show that the goods have been monitored can be used to show the trailer conditions.

- Humidity issues
- Energy use for humidity management

Similar to the temperature measurement, the humidity can be monitored and energy use can be measured. The issues can be analysed and indicators related to these issues can measure the performance.

Emission sensors
Exhaust gas sensors can be used to monitor different aspects of emission. The air-fuel ratio NO_x can be calculated to determine faults in the system. Other gas sensors can also be installed to monitor misfire and greenhouse gas in the exhaust. These include the CO_2, CH_4 and N_2O.

- Difference emission per area

The sensors can be used to determine the emission of gasses. Using this information, conclusions regarding high emission criteria can be gathered. The information can also be used to determine charges for the customers. Using emission factors to calculate emission does not take into account what the actual emission is.

6.4. External
External data sources include sources that can be accessed using an external provider. The providers can give information about weather, road conditions, traffic information and other external factors. The data sources can be accessed using subscriptions and are analysed by the external company.

Weather information

The weather plays an important role in transportation. The weather conditions impact the planning of transport. For example, planning around snow conditions. The weather is also used to determine the estimated time of arrival and can be used to determine the possibility of traffic. Weather information can be used as a filter in performance indicators, as the weather could indicate the safety and condition of the truck. The exploitation of the truck may be different in different weather conditions.

- Possible traffic areas
- Critical weather areas

The weather information can also be used to determine where possible traffic occurs. Another indicator is the impact on the road. Snow can lead to roads unable to use.

Road conditions

The road conditions play a role in planning. Knowing when to plan around road works can be an important part of on-time delivery. As road carriers work in many different countries, some research is needed to identify important information sources regarding road conditions.

- Reliability roads used

The road conditions also function as a data source for performance indicators. The road conditions can be assessed to determine the reliability of a route.

Traffic information

For daily road users, traffic information plays an important role. Data can be collected using radio, applications or television. For road carrier companies, reliable and accurate forecasting is important. The traffic conditions are often taken into account for tracktrace and could play a role in charge calculations.

- Critical traffic areas
- Driver performance in traffic

Areas with a lot of traffic can be taken into account by transportation planning. The performance of drivers in traffic can also indicate fuel efficiency. Changing gears at the right time can lead to less fuel change. Choosing to stop could also provide a solution.

Toll information

For carriers, toll plays a large part in the cost of transport. To be as cost-effective as possible, up to date information on road charges need to be known. A choice for avoiding toll can be used to determine the route. Data can be collected using different websites. Planning and order management can use this information to determine optimal routes.

- Route prices

The prices of toll play an important role. Using the toll information, the cost of a rout can be calculated. The cost of driving toll during the weekend may be different from weekdays.

Pricing information

Information regarding pricing and cost for the carrier can also be acquired. Truck and trailer maintenance prices play an important role in the overall cost.

- Prices of maintenance parts
- Cost of maintenance

Using this information, the prices of parts can be monitored. The cost of maintenance in different periods can also be analysed.

6.5. Surveys

Data which gives insight into customer and client experience can be found using surveys. One of the largest survey companies in the world is Qualtrics. This company uses surveys to determine the experience of customers and clients, in a way that is it perceived. Recent studies have shown that there is a significant difference between how companies think their clients and customers rate their products and service and how they actually perceive this. This is called the experience gap, which indicates that 80% of CEO's believe they deliver a superior experience, and only 8% of their customers agree (Qualtrics, 2017). With a large amount of operational data available, companies are often performing well in this area. Using surveys, the experienced data can also be analysed. This is the human factor that can be an important indicator of what is really happening.

Figure 6.3: O-data and X-data

Another way surveys are used is in the NPS (Net Promoter Score). This score is an indication of whether a customer would promote the service. Besides customer insights, surveys can also be used to determine the experience of employees and brand perceptions (Qualtrics, 2020).

- Brand experience
- Experience of customer regarding equipment

The experienced data also leads to information about the brand experience and the equipment. This data can be analysed and compared to operational data to determine the correct decisions.

6.6. Future data sources

Not all of the data can be acquired at the moment of this research. In the future, it might become easier to identify the following data. New devices such as driver wearables might also play a role.

In the future, drivers could be wearing new devices which could give information on the state of the driver, the actions of the driver and possibly also instruct the driver. Privacy is an important issue in the introduction of possible devices.

6.7. Conclusion on the tracking of performance indicators

In four areas, a total of 22 data sources is analysed and categorized in four areas. In the IT area, 7 separate sources are identified. Truck and trailers sources are split into four areas, in which sensors are split into 6 usable sensors. External data sources include sources available from 4 sources. Surveys can be used for NPS and to determine experienced data from customers.

For each performance indicator, one or more data sources can be analysed. The data sources are all inspected from data source to how the data is collected and analysed. The result of the data sources can be seen in Figure 6.4. This indicates the four areas of data sources. IT is an important part of the sources that are needed to produce essential information. The truck and trailer sources can be categorized into the tachograph, GPS, cameras and sensors. External data sources analysed include weather, road conditions and traffic information.

The survey category is used to indicate two sources that can be collected through the customer. The customer is able to give a grade using these surveys.

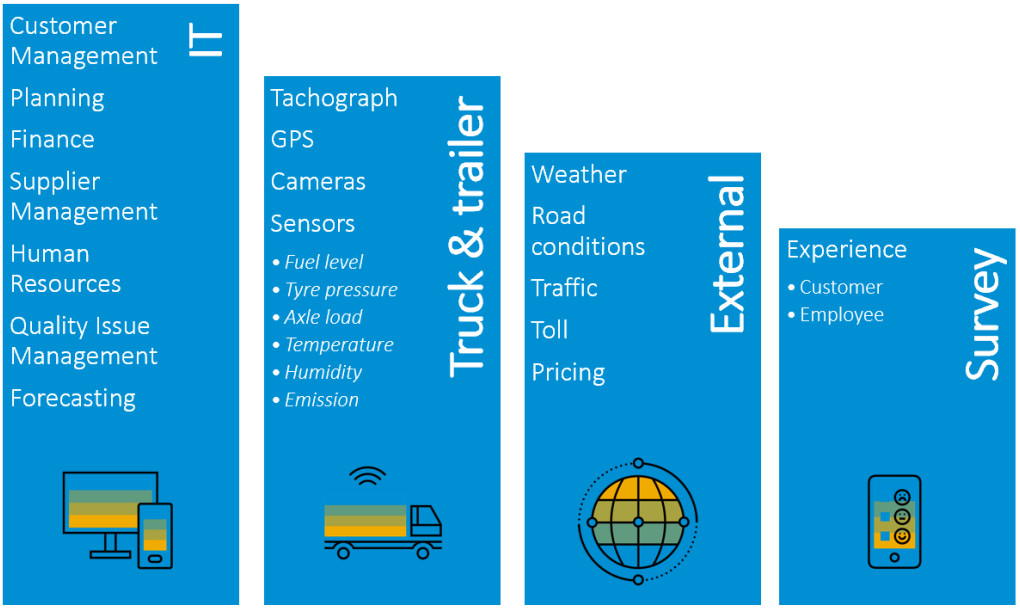


Figure 6.4: Overview data sources

By analysing the data sources, new insights are given to identify performance indicators. Per data sources, several information areas are described. Using this information, performance indicators are improved and added. For the added performance indicators, the key focus area and correct association are chosen. An important note regarding the performance indicators added is that these are derived from a single data sources. This means that there is little combination of data sources to create new performance indicators. The contribution of this insight is further discussed in Chapter 8.

7

A performance indicator framework

In this chapter, the development of the performance indicator is described. The in-and outputs of the model are discussed and a description for stakeholders is given. The framework is verified and a description on how the results can be interpreted is given. A scenario analysis will indicate the impact of scenarios on the framework and identified performance indicators.

7.1. Framework development

Mentioned in the research objective, the goal is to develop a framework that a) gives insight into performance indicators for road carriers and b) indicates how to track indicators using data sources. In the previous chapters, performance indicators are identified and associated in a way that a road carrier can use the performance indicator. Using Excel, the performance indicators are stored. A pivot table functions as the core of the framework. An input tab is used to store all the information regarding performance indicators. To show the level of detail for each performance indicator, performance indicators have the indicators seen in Figure 7.1. The pivot table will use the information and visualize this in a way best usable.

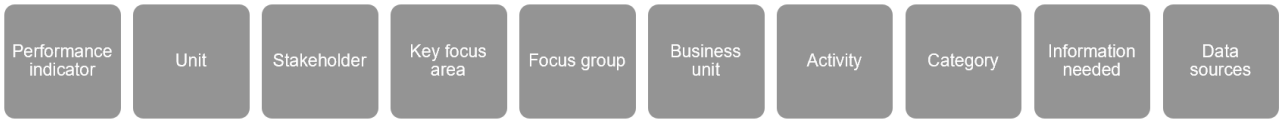


Figure 7.1: Performance indicator information

The requirements for the framework indicate that the framework should be able to identify performance indicators per relevant stakeholder. There are several stakeholders that can use such a framework. In Figure 7.2, the five options are shown. For each option, a set of performance indicators can be identified.

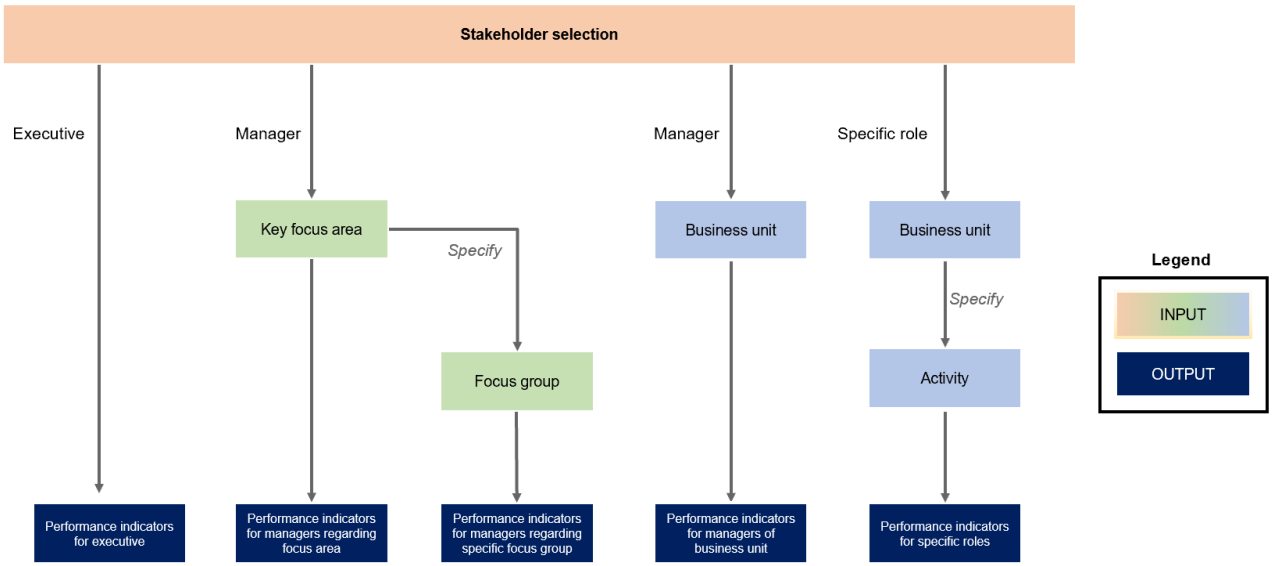


Figure 7.2: Framework blueprint (colors indicate input areas)

This overview can also be read from the bottom up. For a carrier who is interested in how the performance of their fleet management department, the framework can be used. For this example, looking to the bottom right corner, the performance indicators for role-specific employees are needed. To achieve this, the framework is used by selecting the specific role. Next, the business unit (transportation planning) and next, the related activity, which would be fleet management. For a management function, there are two options. A management stakeholder can be used to identify performance indicators specific to focus groups or business units.

The output will also indicate the data sources per performance indicator. In that way, a carrier or service provider will be able to use the information to develop new solutions. The output is developed using a pivot table and relevant filters. The choices made by a stakeholder function as filters. The output is displayed next to the input and consists of the performance indicators, the definition, unit and relevant data source(s).

7.2. Overview of framework: input and output

The framework consists of two areas, the input and output. The first step in using the framework is determining the stakeholder. Executive, management or a specific role. If the stakeholder is executive, a second choice can be made per focus area, and a set of most important performance indicators in that area are shown. For a management stakeholder, the important indicators are chosen by selecting a certain group. The last option is selecting specific role performance indicators. For example: for a customer settlement specialist, choose a specific role. Next, choose freight charge and calculation, and the activity charge and tariff management. The output will be calculated and shown on the right-hand side.

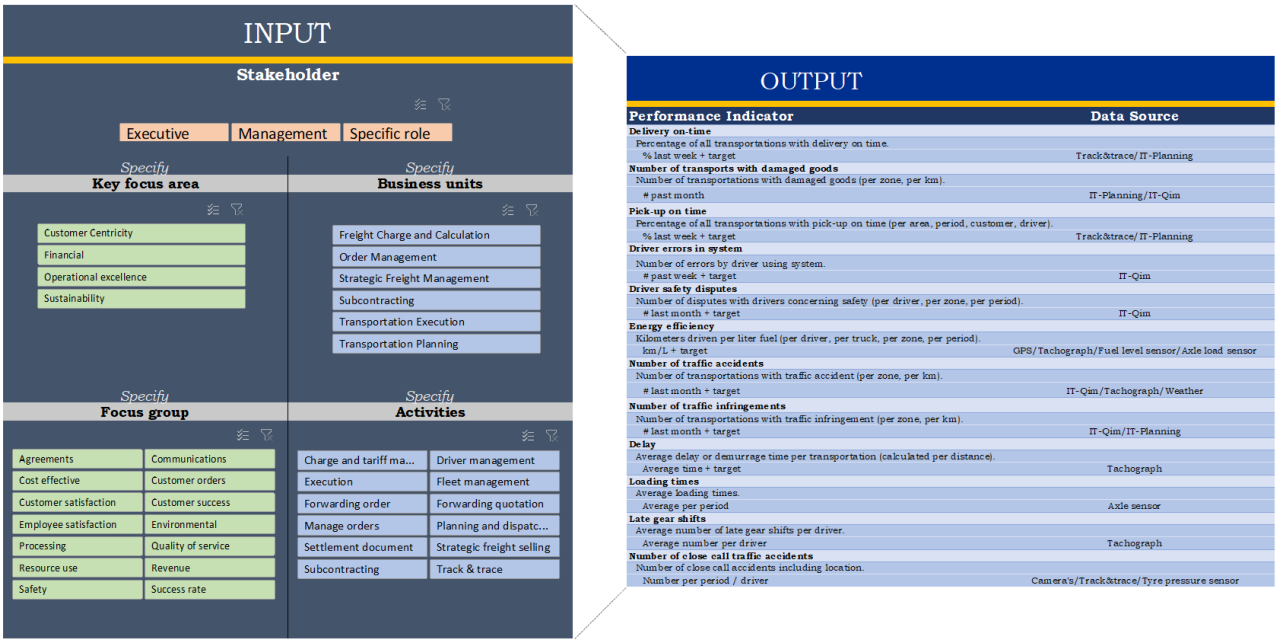


Figure 7.3: Framework overview

7.3. Instruction for stakeholders

The framework can be used in several ways. This section will elaborate on the routes within the framework. For each step, a screenshot of the input is given. The instruction consists of step 1 and step 2a or step 2b. A detailed description of how the output can be read will conclude this section.

The first step is to identify the stakeholder for which performance indicators need to be identified. A choice between executive, management and the specific role is given. In Figure 7.4 the selection buttons are shown. The different stakeholders indicate the level of performance indicators that can be chosen. Performance indicators for executives differ in management and role-specific employees. If a choice is made for executive, the performance indicators will be shown in the output. A choice for management will result in a choice for step 2 a or b. A specific role stakeholder will progress to step 2b.

The choice for management to progress to step 2a or 2b may differ per company. This depends on whether a management function covers a certain business unit or a focus group. If a management function is responsible for a focus group, the next step is 2a. A management function related to a business unit or certain activities can progress to step 2b.

Each screenshot also shows two icons on the top right. These two icons also function as a choice in the framework. The left icon with three ticks can be clicked if multiple stakeholders are to be chosen. The same applies to step 2a and 2b. The filter icon with a cross is used to clear all. This 'unclicks' all the choices made. Once the framework is used each of these clear all icons needs to be clicked. Once this is done, the framework

can once again be used.

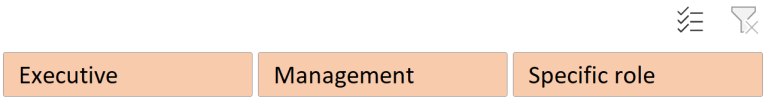


Figure 7.4: Input step 1: stakeholder choice

The second step is split into two sections. Step 2a functions for management or executive stakeholders who want to specify performance indicators per key focus area. Once a choice is made for a key focus area, the performance indicators are shown in the output. A management function related to a certain focus group has the possibility to define more performance indicators per focus group. The input is shown in Figure 7.5.

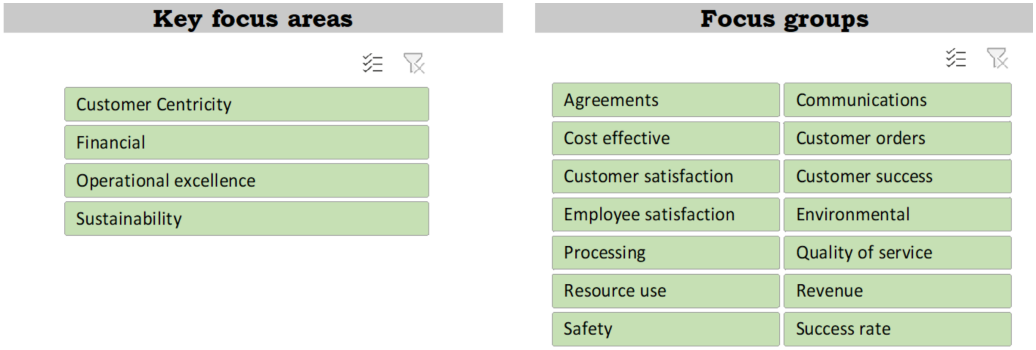


Figure 7.5: Input step 2a: specification per key focus area and group

Figure 7.6 shows the choices that can be made in step 2b. A management or specific role stakeholder will progress to this step. A management stakeholder can specify performance indicators per business unit. For specific role stakeholders, the relevant activities can be chosen.

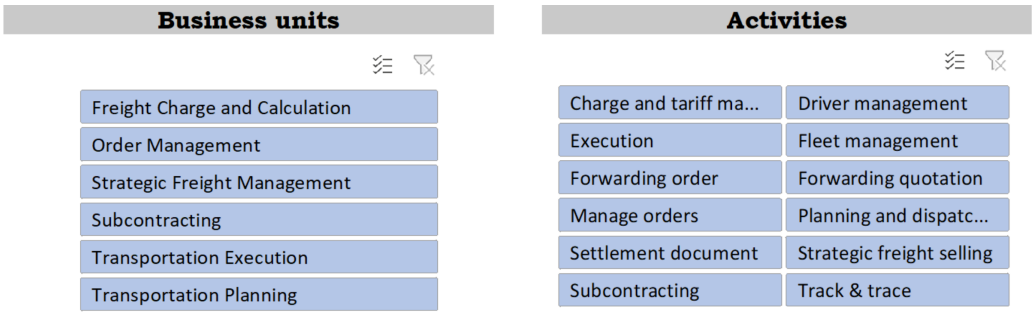


Figure 7.6: Input step 2b: specification per business unit and activity

the output is described in Figure 7.7. This figure shows a schematic overview of how the performance indicators can be read. After completing step 1 and 2, the relevant performance indicators are shown in the output. The output can be divided into two columns. The left column shows the performance indicator, the aggregation level and a detailed definition. On the right-hand side, the relevant data sources are shown.

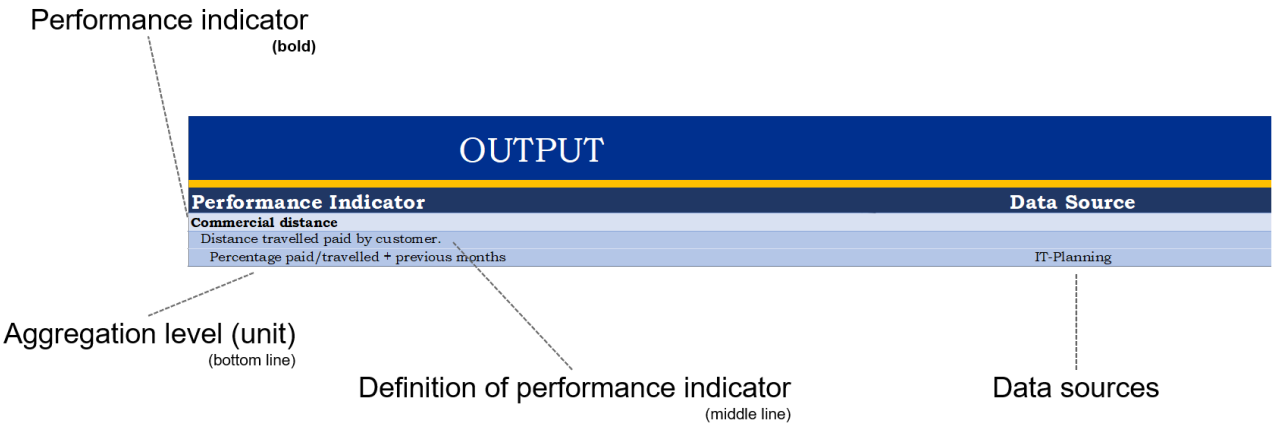


Figure 7.7: Output of framework

These instructions give an indication of the possibilities that lie in the framework. The chapters 4, 5 and 6 in this research can function as an appendix to the framework. For example, a stakeholder interested in a data source can look into Chapter 6 for a detailed description of how the data source is used to produce essential information.

Reporting performance indicators

The framework can be used for road carriers to identify performance indicators and data sources the need to measure these. The framework also indicates the unit in which the performance indicator can be measured. The measurement can be shown in different ways. A dashboard can be made, measurements can be shows in activities or onboard for the driver to use. The Lim mechanism also indicates this as the delivery of information. Examples used in the study include emails, onboard display, control center, smartphone, web page and applications.

For each road carrier, the delivery must be designed. In this research, the input has been identified. Using the unit and description of the performance indicator, in combination with the stakeholder, the best way of information delivery can be decided. For performance indicators relevant for corporate management, a dashboard of real-time or up-to-date information can be relevant. Operational indicators requiring quick response can be best provided using phone or email. The transportation execution also has the possibility to have onboard displays or smart wearables for drivers. These are some examples, in future research the next step may be to design the way information is delivered. This design would be the next step to a controlled performance management system where the stakeholder uses data to make decisions.

7.4. Results

The results of the framework include all the possible options. A selection of results is visualized in Appendix E. In the appendix, the results for executive, management per focus group and specific role per activity are given.

For each stakeholder, the performance indicators and respective data sources needed to produce the information can be reported. A total of 96 performance indicators is connected to 22 data sources. As a result, to measure operational excellence, 38 performance indicators are identified, customer centricity 31, for financial 12 and for sustainability 16. An important note to the number of performance indicators related to sustainability is that there are few for environmental aspects. Emission and truck labels can be identified. The environmental aspects are also closely aligned with the efficiency, but the number of performance indicators to improve the environmental aspect can be increased in the future.

When analysing the performance indicators per business unit, the strategic freight management unit associates 12 performance indicators, mostly focused on agreements and customer satisfaction. In order management, there are 11 performance indicators related to the orders, costs and cycle times. In transportation planning, there are 39 performance indicators focused on the fleet and drivers. There is 4 performance indicators related to subcontracting, as these are focused on the alignment and issues. The transportation execution is measured using 24 performance indicators, focused on transit times, safety, efficiency, on-time and issues. For managing freight charge and settlement activities, the performance indicators apply to the pricing, response times and disputes.

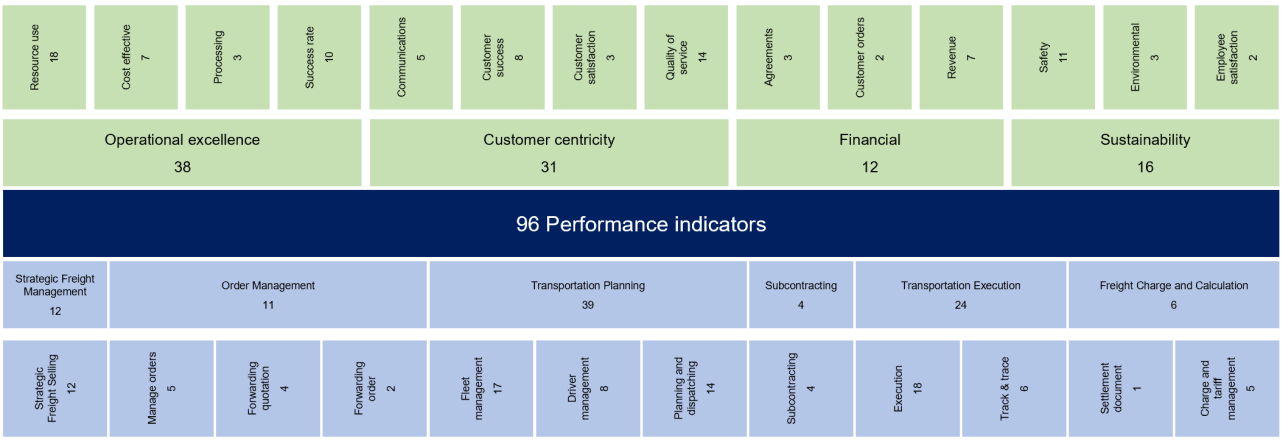


Figure 7.8: Results

A total of 22 data sources in four areas are identified to produce essential information. The first area considers the IT sources, indicating the data that can be produced using IT tools. The second is the data sources in and around the trailer and vehicle. The tachograph and GPS tracking systems are most used. The different sensors and cameras aboard the truck monitor data that can be used for specific performance indicators. External and surveys respectively complete the third and fourth areas. In the future, there might be more data sources available. An example is a driver wearable to monitor the driver's heart rate. By analysing the rate, an estimation of the fitness (and alertness) of the driver can be made. The implementation of these wearables could lead to prevention of unsafe situations, but privacy is another aspect that cannot be left out of scope.

The majority of performance indicators can be produced using IT applications, while sensors also produce large amounts of valuable information. The external data sources can be mostly applied in certain aggregation levels, while they also have the potential for future activities. Surveys are focused on the satisfaction of the customers and driver. Relating these data sources to the performance indicator framework results in an overview of important data sources. For operational excellence, the IT-planning, IT-customer, IT-finance and tachograph are most important. These data sources are most used for respective performance indicators. To measure customer centric performance indicators, a lot of data sources are needed The IT-customer, IT-planning, IT-

finance, track& trace and surveys are among the most used data sources. For financial performance indicators, the IT-customer, IT-finance and IT-forecasting are used. Sustainability performance indicators have different data sources. The IT-Qim, surveys, IT-planning and track&trace are among the most important.

Verification

The framework is also verified by walking through the different possible outputs of the model. For example, when selecting specific role performance indicators for fleet management, the selection will show the designated performance indicators. To verify, these will be checked and adjusted or added to the data input.

1. Executive performance indicators (executive). *Results in 1 output.*
2. Management performance indicators (management, per focus group). *Results in 14 outputs.*
3. Specific role performance indicators (specific role, per activity). *Results in 12 outputs.*

The resulting outputs are shown in Appendix F. The results of these outputs are in line with earlier described information. Each output consists of a performance indicator, a definition and unit. Each performance indicator also indicates the data sources needed. The performance indicators used in the framework can be extended using more information from road carriers. Therefore, this framework can be viewed as the starting version of a framework that can be expended further in the future.

An important result that can be concluded from this framework is that there are several important indicators for executives. It has yet been defined what the most important performance indicators are for road carriers. Using the framework, a shortlist of performance indicators is given. As the framework is able to give the most important performance indicators and relating data sources, it can be used to answer sub-research questions 1 and 2 (see Section 1.3).

The results show that there are several performance indicators relevant to executive stakeholders. To measure operational excellence, the commercial distance and acceptance rate of quotations are important. Customer centricity performance indicators include the retention rate, satisfaction grade, net promoter score and on-time delivery. For the financial focus area, the booked order value, expected growth in orders and agreements, active agreements and the current number of requests are important. For executives, the direct environmental aspect is not existing. The sustainability aspect taken into account is the driver satisfaction.

7.5. Implementation of the developed framework

The framework is developed using generic information and is not limited to a specific carrier. A carrier has the opportunity to adjust the framework in order to fit the company better. The key focus areas identified are used to group the goals of a carrier company. The areas may be different per carrier and can be adjusted in the framework. This also applies to business units and activities. The stakeholders can combine activities or responsibilities that may be distributed differently. That means that the framework can be adjusted in a way applicable to the carrier.

The framework can be used by software providers in the development of IT solutions. The framework identifies the different aspects, performance indicators and data sources for road carriers. A software provider interested in developing software for the carrier can use the framework. Using the information and connections, software can be produced to give insight into the performance indicators. In the form of a dashboard or other reporting, the measurements can be used. This research has focused on identifying a set of performance indicators that cover all the important aspects of the carrier company activities. This also means that not all usable performance indicators are identified. The list is not infinite and can be extended by stakeholders in the future.

An important aspect of the framework is the data sources. The data sources identified are currently able to produce the information needed. In the future, data sources may change, new information might become more relevant and data sources may disappear. When analysing the IT area, it can be noted that the type of software used is of high importance. A large number of performance indicators rely on information using IT, if these sources were to change, the information should still remain producible. As the external data sources are

producing information outside the company, it is important to keep up to date in changes. The way weather, road and traffic is monitored can be used for measuring performance indicators and planning. The way surveys are used can differ per company. The way questions are asked, ratings and grades are given, impact the output of these sources.

Scenario analysis

An important aspect of the framework is the impact of different scenarios on the framework and identified performance indicators. In this section, a scenario analysis is conducted. Three scenarios are discussed and their impact on both the framework as well as the performance indicators is discussed. The impact of scenarios on the framework is described. Overall notes, the impact on focus areas, business units and data sources are analysed. Next, the impact on different performance indicators is discussed. Per indicator, the impact of a scenario can be given. In that way, a choice for positive or negative areas can be reported. It is important to understand that the impact can be different per carrier. The location of the carrier, the activities, the goods they move, the customers. All have an impact on the way these scenarios change the situation. Each performance indicator receives either a neutral, positive or negative impact of the scenario. Using the expected impact, a new function is added to the framework. The impact of a scenario can be positive, neutral or negative. A positive impact indicates that the performance indicator could improve due to the scenario. A negative impact indicates a performance indicator negatively impacted by the scenario. These impacts can be used to identify areas that could change in certain situations. These insights can be used to determine targets and forecasting.

1. Impact of scenarios on the use of the framework (discussed per paragraph)
2. Expected impact of scenarios on identified performance indicators (add-on for framework)

Using the framework, a selection for stakeholder is made first. By clicking on an 'impact button' seen in Figure 7.9, the performance indicators are identified. For example, by selecting the negative button for the pandemic scenario, performance indicators are reported which could be impacted negatively due to the scenario. A negative impact indicates that the activities related to the measurement are likely to be negatively impacted. An example is the waiting time. Increased regulations can lead to an increase in waiting times at customs. Therefore, the impact of increased regulations on the waiting time is negative.

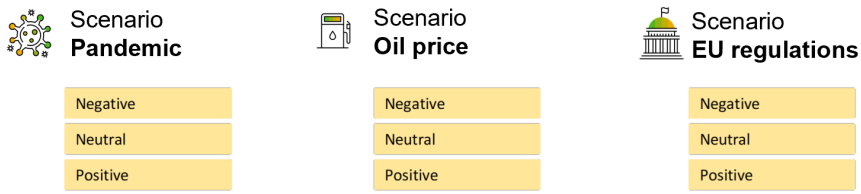


Figure 7.9: Scenario analysis input for framework (add-on)

To performance indicators are all analysed and the results are put into the framework. In Figure 7.9, the input area is shown. Using these inputs, the following scenarios are analysed. First, the impact of a pandemic is discussed. An example of this is the Covid-19 pandemic. A second scenario will indicate the impact of changing oil prices. A third scenario indicates changing regulations within the EU. The example used in this analysis is the Brexit.

Pandemic

A scenario which is current at the time of writing is the Covid-19 crisis, also known as the coronavirus pandemic. During the research, each interviewed company elaborated on the changes they have seen during the crisis. Looking at the key focus areas and groups, the importance of several aspects increases. As the reliability of shipments decreases and more focus lies on the customer centricity. Operational excellence becomes more complex. There are no changes in business units and data sources.

These changes also mean a change in performance measurement. The performance measurements that are likely to be affected are discussed. Negative impacts include that orders are changing and loads are coming

in late from other continents. The demand is changing. As a result, the cycle times and handling times will change. On-time delivery will become more difficult as transit times become less reliable. Late payments will lead to more issues. A positive impact could exist as there will be more possibility to handle orders with special requests. The ability to become more useful to customers will improve. That indicates that a carrier can distinguish itself from other carriers.

Changing oil price

A recurring external factor for many companies is the change in oil prices. Influenced by politics, large companies and many other factors, the oil price is important to many transportation companies. The impact of this scenario of the framework lies mainly in the performance indicators. Looking at the focus areas, operational efficiency could become more important. Changing oil prices could be measured using external data sources (pricing information). Fuel pricing and routing would become more important as the financial impact of fuel prices increases.

As road carriers see much of the transportation cost being used for fuel, the price of the fuel, and related to that also oil, is important. Changes in the oil price can influence orders and costs. The oil price is an indicator of fuel prices. These are still heavily taxed but the trends show that a lower oil price leads to lower fuel prices. The scenarios which are tested is an increase in the oil price and with that an increase in the fuel prices.

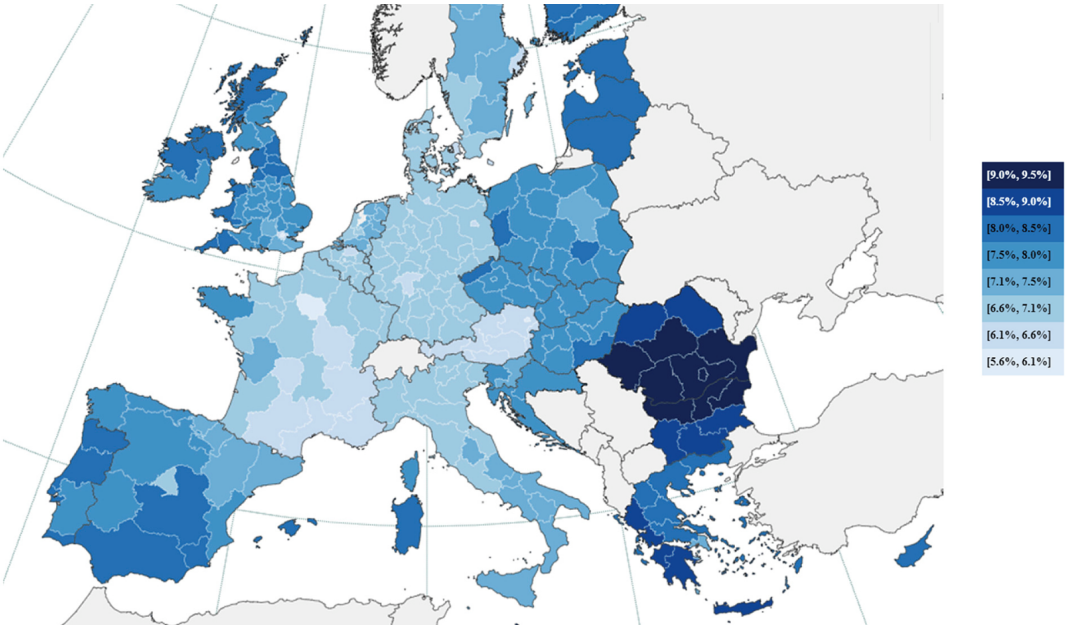


Figure 7.10: Change in weighed transport cost due to 20% increase in fuel prices. (Persyn et al., 2020)

The increase of fuel price relatively high effect on transport cost in eastern Europe (Persyn et al., 2020)(see Figure 7.10). This is due to the relative share of fuel cost in these regions. In eastern Europe, the wages and tax to infrastructure are lower, leading to a larger share of fuel cost. The regions where the population is lower and there are fewer highways, the fuel prices also have a larger effect.

Increasing prices can lead to less business as customers look for cheaper other alternatives. Time to reach agreements may be longer as negotiating is important. A positive impact could be that the waiting time could decrease as the road become less crowded. Less congestion also results in less traffic and accidents.

Changing regulations within European Union

A third scenario which is also playing a role at the time of this research is the regulations in the EU. Many factors play a role in the European Union. Each country has its own toll system, fuel prices and between countries the

details about transport are agreed upon. These agreements could also change in the future, and the certainty of transportation within the EU may change. A challenge many carriers are facing at the moment is the Brexit. The Brexit has been announced but no concrete deals about trade have been made. This means that from January 1st 2021, there will be customs between Britain and the other EU countries. The impact on logistics may be very high, as all trucks will need to be checked. A study indicates that the impact will last for six months, while the first quarter will be affected most (Deloitte, 2019). These regulations have an enormous impact and some carriers with customers in Ireland are now looking for ways to travel around Britain. The situation has a different impact on the performance and can be seen in negative and positive impacts.

This scenario also poses a potential impact on charge and tariff management, as well as transportation planning. Additional information on how tariff calculation changes due to new regulations need to be analysed. An impact could also take place in planning. Extra steps may need to be taken to ensure correct transportation.

Negative impacts on performance indicators include that the consistency of transit time will decrease, the delays (especially at transshipment locations) will increase, the satisfaction of customers will decrease as delivery success will decrease. More issues arise in settlements. Subcontracting becomes more complicated. The only positive impact could be the number of special requests in orders.

The scenarios in the framework indicate the impact on the different performance indicators. It can be concluded that the pandemic, an increased oil price and increased regulations lead to more negative impacts than positive impacts. Positive impacts include that changing situations can be used to improve the company reputation and expand the activities. This can make a company stand out among other carriers. The performance indicators identified for negative impacts can be used to determine which activities to focus on in changing scenarios.

Use of framework for other carrier specialities

The framework is developed focusing on truckload carriers in Europe. This means that several special industries are left out. These include the LTL, bulk, LSP, dangerous and high-value goods. The framework consists of a lot of logistic generic aspects. These aspects can be used for future frameworks. In this section, some changes in the framework are identified. A suggestion on areas to improve or change is given. First, the key focus areas are analysed to determine if these are similar to the FTL framework. Changes in the business units and data sources are also noted.

	Overall	Operational excellence	Customer centricity	Financial	Sustainability	Business units	Data sources
Less than truckload	Transportation per freight unit.	Utilization per truck. Consolidation performance.	More focus on service options, less on OTD.	Pay per portion, new aspect to tariffs.	Efficiency of trailer, possible more within city (emission zones).	Planning per unit, scheduling, and more complex charging.	More data from planning. Schuduling information.
LSP	More logistical aspects.	Efficiency in warehousing and inventory.	More responsibility of overall process.	Costing of warehousing and inventory.	Warehousing employees, emissions of other logistic areas.	Include planning with warehousing and inventory. More activities.	More data from warehousing, inventory, customers.
Bulk	Transport per weight or volume.	Change in efficiency. Loading unloading different.	Different customers.	Costing per weight or volume.	Safety during loading and unloading.	Planning changes for loading and unloading. Quality assurance.	Weight and volume measurements.
Dangerous goods	FTL movement of dangerous goods. Safety aspect increases.	Operations focus on safety aspects.	Customer importance of safety.	Possibly more focus on quality of transport than pricing.	Include safety aspects.	Quality assurance and safety activities.	Information on safety issues and improvements.
High value goods	FTL movement of high value goods.	Efficiency aspects on planning and security.	Focus on security and reliability.	Insurance aspects.	Possibly include damages and stealing.	More complex settlements and quotations.	More focus on location, safety and security.

Figure 7.11: Implementing framework for other transport specialties (indication of areas to focus on).

The main differences between LTL and FTL industries lie in the type of service. A truckload carrier is responsible

for leasing the trailer to a customer. For LTL goods have to be combined, often leading to more efficient use of the trailer, but not the flexibility in delivery times. The majority of the framework can therefore be used for LTL carriers. The activities of planning freight units, instead of orders should be taken into account.

The differences for LSP lie in the addition of extra logistic processes. Bulk is the transport of unpacked goods (for example sand). Loading and unloading changes but the overall process is similar to the FTL business. Transportation of dangerous and high-value goods demand more focus on certain aspects. Safety, security and tariff management would need to be reviewed. Another important aspect is subcontracting. For each speciality, subcontracting can be different from the FTL business.

7.6. Conclusion on framework development

This chapter discussed the development of a performance indicator framework. The framework can be used to determine performance indicators for executives, managers and role-specific employees. The performance indicators reported per stakeholder are determined using the key focus areas and business units. The output shows the performance indicator, the definition, unit and data source. A total of 22 data sources is connected to performance indicators per stakeholder. This results in data sources connected to performance indicators. All data sources and performance indicators can be adjusted. Performance indicators and data sources can be added to the framework. The framework can also be used to identify the impact of different scenarios. A pandemic, changing oil prices and EU regulations are all discussed. For each scenario, the performance indicators are analysed and results are added to the framework. Therefore, the framework can be used to identify the effect of these scenarios on performance indicators.

III

Discussion, conclusions and recommendations

- Chapter 8: Discussion
- Chapter 9: Conclusions
- Chapter 10: Recommendations

Part III reflects on the research objectives and conclusions. First, the developed framework is discussed. Possible improvements are identified and the results are discussed. The proposed method used will also be analysed and shortcomings are identified. In the conclusion, the research questions are answered. The academical and practical contribution is described in Chapter 9. Recommendations are given for road carriers, software providers and further research.

8

Discussion

In this chapter, the developed framework and method used are discussed. A focus will lie on the method used, the literature reviewed and conducted interviews.

Reflection on the proposed method

The proposed method combines the top-down approach by Ganesan & Paturi with the Lim mechanism from a nine-factor framework. The combination results in a more complete approach to tracking performance indicators and the addition of performance indicators due to data source analysis. The combination also results in a more structured way of tracking performance indicators.

Following the steps results in a good association of the framework. Reflecting on the steps taken, the result is a useful performance indicator framework. The identification of performance indicators is conducted by analysing the key focus areas and related goals. For each performance indicator, an assessment is done to determine whether an indicator can be used operational or strategical. Once the unit is determined, associating the indicator with an activity takes place. All of the performance indicators can be connected to one of the activities. There are performance indicators which can be useful to multiple activities or stakeholders. These indicators are placed to the activity which it is most closely related to. By determining the level of performance indicator the responsible user is identified.

These steps have indicated the possibility to identify, define and associate performance indicators. The next step is identifying the data sources. An analysis of all available data sources is done and performance indicators are connected. By determining what information is needed per performance indicator, the correct data sources can be identified. In some cases, multiple sources can be identified. The data sources also contribute to new insights. Information that can be produced also shows what can be measured. By combing the information with the focus areas, performance indicators are determined. The new performance indicators also follow the cycle from category to responsible user. Reflecting on this process, the newly identified performance indicators often only indicate information gather using the single data source. Future research should indicate how the combination of data sources can be used to identify new performance indicators.

The method can also be improved in some areas. When a performance indicator is identified, the next step is to categorize and determine a unit. As the responsible unit and stakeholder have not been associated, this is not always directly possible. From the business activities and stakeholders, new performance indicators can be identified. Therefore, a feedback loop between activity and unit could improve the method. This would introduce a step in which the activities are analysed and the aggregation level could be improved.

The data sources are changing and as a result, the possibilities to produce information from the data sources increase. The relation between new or additional data sources and performance indicators is identified in the proposed method. A next step would be to identify how these data sources can be used to improve certain activities of the carrier. The possibility could arise that using data for these activities would result in data-driven decision making. It will require extra research to indicate what the direct connection between new data and performance indicators is. In this research, the new data sources are connected to performance indicators. The next step could be to analyse the value of each data source.

Reflection on considered literature

During this study, literature is used as input to determine performance indicators and identify important areas. A first observation is that there is no clear literature on a set of performance indicators for road carriers. Several studies indicate some important areas. A report by Freight Best Practice identifies a structure in performance indicators but is not extensive. Another observation is that a large number of performance indicators are identified using logistic management views. For many transportation and logistic companies, the important areas have remained similar to some years ago. The main addition to these performance indicators is sustainability. Little research identifies clear performance indicators on sustainability aspects. The GLEC framework (see figure 4.6) is used to determine a way to calculate emissions. The focus lies on the total amount of emissions and the intensity. An important consideration for transportation companies is the overlap between efficiency and sustainability. The literature reviewed often defined efficiency under sustainability, as it can have a positive effect on sustainability aspects. It is also often considered an operational aspect. The differences are divided into this research by determining what indicators are related to efficiency first. All indicators directly related to a sustainability aspect remain in the sustainability focus area.

Reflection on conducted interviews

During this study, multiple interviews are carried out. In the first stages often informal to determine the scope of the study. The formal interviews are carried out with people from four different carriers. Two large carriers (Girteka and Waberer's) are able to give insight into the activities of large carriers. The important performance areas are similar. Peter Appel, which can be considered one of the largest carriers in The Netherlands (merging in 2021 to Simon Loos) also produced information on important areas. An important difference is the customers. The type of customer is very important to the activities of a carrier. Carriers focused on transport between distribution centers and retail shops have different routes than long-distance carriers. The importance of the customer is also discussed with Troost Transport, a relatively small carrier.

During these interviews (see appendix D), a large number of topics is discussed. This means that not all areas are covered in each interview. A note regarding this aspect as well as the validation using experts is given in Chapter 10. The interviews have provided valuable insights into many topics. An interesting observation during the interviews is the carrier's vision. Strategies differ from focusing on only truckload transport to expanding operations to warehousing and distribution. This trend to becoming more of a LSP is mentioned in more carriers. There is no clear evidence on which strategy is the best.

9

Conclusions

In this chapter conclusions will be described. First, sub research questions will be answered. Conclusions regarding the academic and practical contribution of this research are also discussed.

Answers to research questions

The answers to the research questions are used to conclude the findings of this research. The main research question will be answered using conclusions from the previous sub research questions.

What are the important performance indicators to assess future road carrier operations?

The developed framework has given insights into the most important performance indicators to assess future road carrier operations. The performance indicators are defined using key focus areas and groups. For each group, goals are identified and performance indicators are defined. The performance indicators are further analysed per category, aggregation level, stakeholder and activity. The goal to identify the important indicators had led to three levels of performance indicators.

The first level is identified for executive stakeholders. As mentioned in interviews, carriers are interested in the most important performance indicators and want to know which are needed at the top level. The executive performance indicators are the 10 most important indicators for executives. These indicators are commonly mentioned indicators in literature and interviews and cover all four focus areas. By analysing which performance indicators are most mentioned and selecting different areas, an indication of the overall carrier performance can be established. The importance of performance indicators may change in different situations through time. However, these ten performance indicators are likely to stay important.

The commercial distance is the distance travelled that is paid by the customer. This is an indicator of both utilities and customer success. The customer centric success can be measured using the customer retention rate, the satisfaction grade, the net promoter score and on-time delivery. The customer retention rate is an indicator of whether customers are staying. the satisfaction grade could be an indicator to identify unsatisfied customers. The on-time delivery is for many customers an important aspect when choosing a carrier. The net promoter score is an indication of whether the customers would promote the carrier company, and could be an indication of future growth. The financial area can be measured using the booked order value indicated the total value of forwarding orders, and can be regarded as the expected income from customers. The expected growth in freight agreements is an indication of business growth. The forwarding order forecast is focused more on the day to day activities, as these are used for planning. The performance on the spot market can also be measured using the incoming orders. The performance indicator to track is the number of order request for quotations coming in. The driver satisfaction is an important sustainability performance indicator. This indicator can be used to determine whether drivers are happy and likely to stay at the carrier company. A final area is safety. By measuring the total number of safety incidents, an indication of the safety performance is measured.

What data sources are required to produce the information needed for performance measurements?

The performance indicator framework is also able to provide insights into the possible data sources needed to track the performance indicators. A total of 22 data sources is analysed using the Lim mechanism. The mechanism is used to define the data source, the data collection method, a description of the data and how the data is analysed. In the developed framework, a summary of the data sources is indicated. A selection is made

between IT, sensors, external and survey data sources. It can be concluded that the majority of performance indicators can be measured using the appropriate IT software. The software categories include customer, finance, supplier, HR, quality issue management, planning and forecasting. These units are very important to measure the financial and operational excellence areas.

The truck and trailer also include data sources that can be used to track performance indicators. The tachograph is an important data source and able to monitor actions onboard the truck. The tachograph monitors the state of the truck and measures this with the driver and timeline. Almost all trucks are fitted with a GPS tracker which is able to track the location of the truck. This is helpful to prevent theft but can also be used in geofencing. This is the activity of monitoring the truck location. For example, a truck located within 100 meters of the location can be considered to have reached its destination. In that way, the delivery time can be calculated more reliably. This is also an example that multiple data sources can be used for one performance indicator. A carrier can decide which data source to use. External information sources are mainly used for performance indicators with the desired aggregation level. For example, the delay time can be measured more reliably if information about weather, road conditions and traffic is known. External information can also be used as a measurement for other activities. An example is measuring maintenance prices. These measurements could be useful in maintenance planning.

A fourth data source is a survey. During this research, it has been indicated that there is a structural difference between measuring customer satisfaction using own performance indicators, and the response of the customer. The difference can lie in the value customers have for different aspects. To identify the true customer satisfaction, surveys can be used. This data is different as it is considered experienced data, whereas IT, truck and trailer sources offer operational data. Surveys use the customer as input and their overall experience can be measured.

Looking at the business units and the performance indicators needed per unit, an indication of important data sources can be found. In strategic freight management, the IT data sources are able to track five out of seven performance indicators. For order management, only IT data sources are identified. In transportation planning, a more diverse list of data sources is needed. A combination of IT, surveys and on-board equipment are needed. External data sources are used mainly for analysing certain performance indicators within planning. For subcontracting, solely IT-supplier software is needed. Performance indicators related to the transportation execution need a combination of all of the data sources. IT-customer and IT-finance modules can be used to track the performance of freight charge and calculation.

It can be concluded that there is a diverse list of data sources that are applicable to track performance indicators. The data sources are analysed in a way that they can be used in the road carrier business. Data sources show the importance of data within performance measurement. Performance indicators can sometimes be tracked in different ways and a stakeholder can determine which combination is best suitable.

How can road carriers use the framework to improve their operations?

The developed framework can be used by carriers to identify performance indicators and data sources. The framework is used in two steps. The first step is identifying the stakeholder for whom performance indicators need to be identified. Performance indicators can be identified for an executive, management or role-specific employee. For executives, the performance indicator framework only consists of a single step, as the performance indicators are directly shown when selecting executive stakeholder. For a management function, a choice can be made between a management performance indicators per focus group or business unit. The second step for role-specific employees is determining the specific activity. Using these steps 37 different stakeholders are able to identify specified performance indicators.

In this research, a generic framework is developed. This means that the focus areas, stakeholders, business units and activities may differ per carrier. The carrier is able to modify the framework easily and can also add performance indicators. For future operations, the data sources can be adjusted. Therefore, the framework is widely applicable to carriers in Europe. Using the framework will provide insights into how performance indicators can be measured, and this can be used to improve their operations. Understanding which areas are performing well and which under can help to allocate focus onto the right areas. If customer centricity is

decreasing, investigating the source of issues can help improve operations. When assessing the business, the framework can also be used to determine several scenarios. In this research, three scenarios are discussed. The impact of a pandemic, a changing oil price and changing EU regulations are three scenarios analysed. A carrier can adjust the scenarios and add new scenarios. The framework is used to determine which performance indicators might be impacted positively and negatively by the scenario. The framework can be used in different ways to improve the operations of carriers.

How can a framework be developed that links important performance indicators with relevant data sources for European truckload carriers?

Understanding how to measure a system can lead to analytics and is the first step to a data-driven system. This research proposed a method to develop a framework. Using the truckload carrier industry, the method is tested. The method had resulted in a useful framework, but improvements can be made. However, this study performed a single iteration of the method cycle. New iterations can provide information to improve the method used.

For road carriers, the indicators have been identified and relevant data sources are defined. A carrier can use the framework to measure and analyse the information. This research has given a clear insight into the performance indicators and the relevant data sources. Each performance indicator is used to measure carrier performance. Data sources are analysed and the key sources are connected to performance indicators. The framework is useful for carriers and can be personalised per carrier.

Academic contribution of research

The academic contribution of this research lies in the proposed method. By reviewing the literature, no clear method for developing a performance indicator framework is found. Different studies focus on different aspects, from the identification of performance indicators to how to analyze data. By combining two studies, two approaches are combined to develop a method. The method used by Ganesan & Paturi is a clear top-down approach indicating several steps to developing performance indicators. Their approach does not include a clear indication of how to track performance indicators. A mechanism developed by Lim et al. in 2018 indicates how data can be of value. The mechanism consists of a bottom-up approach. By analysing the data sources, information can be identified that can be valuable to a user. The study also introduced a structural approach to defining data sources. The Lim mechanism is also used to add a flow from data to performance indicators. In this study, the two approaches are combined in a single method.

The method is conducted using the truckload carrier industry. The method has resulted in usable performance indicator framework. Therefore, the result is used to reflect on the method used. Possible improvements of the method are discussed and can be used in future studies. This approach can be improved by introducing a feedback loop between the activities and performance indicators. This research has shown that understanding the activities is important for establishing performance indicators. Another improvement is determining the additional value of data sources. This research has shown what data sources are used for performance measurements. These data sources often posses the information for operations within a carrier. Using the information, new performance indicators are identified. Using these insights, the method can be used for the development of frameworks in other industries.

Practical contribution of research

The practical contribution focuses on the use of the framework by a carrier and a software provider. The main contribution for a road carrier lies in identifying relevant performance indicators. Data sources needed to produce the essential information are described and can be used by carriers to measure performance indicators. Using the indicators to measure the performance can be useful for many. Operational stakeholders can use it to determine how well a certain activity is operating. Stakeholders interested in the performance of certain areas can measure the performance to determine which areas are performing well and which need to improve.

Currently, there are not many carriers who have resources to develop these indicators and produce the necessary information. A solution is software for a model company. A model company is software developed for a

generic company, and in which the majority of the software can be produced without special knowledge from the customer. This model company can be developed using general information about road carriers. The model company can function as a template for relevant software solutions. An add-on in the form of a performance indicator dashboard can also be developed.

To describe how the framework is received by software developers the innovation cycle is used. The innovation cycle describes the steps in which software is produced. First, a setup and plan are determined to plan the software environment. This step describes what software is already available and to what extent it can be connected to current software solutions. The next step is the development and building of the software. This is where the framework can be of use. During development, the needs of a customer are determined. For example, a carrier will likely demand order management, planning and settlement software. These areas are combined to produce the model company software. An addition to this software is a KPI dashboard. For developers, there is no clear insight into what should be in a KPI dashboard for road carriers. Therefore, the software provider can use the framework to determine the important performance indicators, what needs to be measured and where the data can be produced. After development, the software can be deployed, integrated and tested. The next step is determining the use and making sure the software is available for the right users. This study has also briefly identified the users of activities, which can be used as a starting point. The final step in software development is operating and monitoring. The efficiency and reliability are analysed and it is made sure the software is used properly.

10

Recommendations

In this chapter recommendations for involved parties will be given. In addition, a list of recommendations for further research is listed and shortly elaborated on.

Recommendations for further research

Connecting performance indicator to decision making.
This research also introduces areas in which further research can be carried out. The performance measurement cycle consists of a controlled system, analytics, an action and controller. The research has identified the relations between analytics and the controlled system. Using the identified data sources and performance indicators, the information can be used to determine how to use the data. Performance indicators are valuable to determine the performance but they can also be used to drive decisions. Further research into the activities and the data they use can lead to insight into how data can be used in decision making.

Expert validation of framework.
The developed framework is verified by analysing the possible input and output and comparing this with the expected outcome. During interviews, performance indicators, activities and data sources are discussed. The framework is not validated by experts. This is due to the fact that no clear way to validate the framework is defined. The framework is new and future research into a usable validation could provide a valuable addition to the framework. The size of the framework is too large and needs instruction for experts to validate. This research indicates how the framework can be used. A future study could provide information on how these and similar frameworks can be validated.

Investigate the value of future data sources.
A generic overview of data sources is given in this research. Further research detailed on the data sources and how the development of new data sources can give insight into new value for carriers. A large number of different data sources exist and the number is likely to keep increasing. Changing, combining and removing data sources should be investigated in the future to improve the reliability of the framework.

Research into different carrier strategies.
Further research can also be carried out to identify the way the transportation sector is changing. Literature and interviews have indicated the changing environment. Research into the different types of logistics providers, from third-party logistics to freight forwarding can be valuable. The value would lie in associating performance indicators to the right companies. Companies focused on full truckload likely have different performance indicators to freight forwarders. Research into the changing industry and responsibility per activity can be carried out.

Approach to sustainability by road carrier industry.
This research also identifies the importance of sustainability and mainly environmental sustainability. In this research, environmental performance is focused on emission and truck labels. Further research can be conducted to determine how environmental performances can be measured better. A method developed as the GLEC framework by Smart Freight Centre indicates how some emissions can be measured. Many carriers are aware of emission goals and the EURO label their truck should have. Not many have a clear vision of how to comply by emission goals set for the future. The main concern is the financial aspect. In combination with the changing politics in Europe, the challenge lies in where and how to invest. Further research on how

this will develop and the way carriers can improve their performance on environmental sustainability should be carried out. Research can include the changing emission goals, the current financial stimulation, the changing technical equipment and the demand for road carrier transport.

Recommendations for road carriers

Use and personalize framework.
The information on performance indicators, data sources and the developed framework is valuable for carriers. This research gives insight into the relevant performance indicators in a generic way. A road carrier can adjust the way performance indicators are associated. A road carrier can also use the framework to identify the important data sources. A carrier could use this information to develop their own performance measurement dashboard. The performance indicators form an important contribution to this research. A carrier can add, remove and adjust performance indicators in the framework to apply this to their own business.

Analysis of different strategies.
During the research different strategies by carriers are identified. The rise of logistic service providers indicates the growing towards a more complete service of the supply chain. This is in contrast with carriers who specialize and focus solely on transportation. These strategies can be different due to location, company size, customers, type of equipment and other factors. The road carrier industry is also very fluid and companies grow and decrease in size very easily. These factors play an important role in choosing a strategy and the important performance indicators that can be applied.

Recommendations for software providers

Development of usable software solutions.
The connection between data sources and performance indicators has shown the possibilities that lie in performance measurement for road carriers. For software providers, this knowledge can be used to investigate the use of data sources further. The analysis of data sources in this research has identified sources, collection equipment and ways to analyse. By analysing the implementation of these data sources in practice, a more detailed description can be established. The combination of data sources can lead to better use of the information. For example, the implementation of multiple IT data sources could lead to a more efficient database. Combining data correctly in a single system could prevent issues between sources.

Reporting of information.
An addition of this research can be applied in the development of key performance indicator dashboards. For many carriers, the knowledge of performance indicators is valuable, and the reporting of these performance indicators is not yet clear. A software provider can investigate how the information should be reported. Information delivery can be in the form of a dashboard, but it also includes information to drivers and other equipment. The use of information can also be used to drive decisions. These data-driven decisions need to be determined first.

References

Appelbaum, D., Kogan, A., Vasarhelyi, M., & Yan, Z. (2017). Impact of business analytics and enterprise systems on managerial accounting. *International Journal of Accounting Information Systems*, *25*, 29–44.

Bask, A., Rajahonka, M., Laari, S., Solakivi, T., Töyli, J., & Ojala, L. (2018). Environmental sustainability in shipper-lsp relationships. *Journal of Cleaner Production*, *172*, 2986–2998.

Bello-Orgaz, G., Jung, J. J., & Camacho, D. (2016). Social big data: Recent achievements and new challenges. *Information Fusion*, *28*, 45–59.

Berger, R. (2018). Automation , electrification and digitalization in the trucking industry Management summary. (September).

BusinessRulesGroup. (2010). The business motivation model - business governance in a volatile world.

Carter, C. R., & Rogers, D. S. (2008). A framework of sustainable supply chain management: moving toward new theory. *International journal of physical distribution & logistics management*.

Chi, S. (2020). *Data-driven service innovation strategy for Scania Data fuelling Scania's future business* (Tech. Rep.).

Christopher, M. (2016). *Logistics & supply chain management*. Pearson UK.

Christopher, M., & Yallop, R. (1990). Audit your customer service quality. *Focus*, *9*(5), 1–6.

Coyle, J., Bardi, E., & Langley, J. (1992). *The management of business logistics* (5th ed.). 610 Opperman Drive: West Publishing Company.

Curry, E. (2016). The big data value chain: definitions, concepts, and theoretical approaches. In *New horizons for a data-driven economy* (pp. 29–37). Springer, Cham.

Deloitte. (2019). *Brexit Industry Insights: Logistics.* Retrieved 2020-12-1, from https://www2.deloitte.com/content/dam/Deloitte/uk/Documents/international-markets/deloitte-uk-brexit-industry-insights-logistics.pdf

DKV-Euroservice. (2020). *Toll services per country.* Retrieved 2020-12-1, from https://www.dkv-euroservice.com/gb/services/toll/toll-services-by-country/

Easytrip. (2020). The optimal solution for heavy goods vehicles passing through european toll networks. *Easytrip Transport Services*.

ECTA. (2020). *The European Clean Trucking Alliance calls for the rapid decarbonisation of the road freight sector.* Retrieved 2020-11-07, from https://clean-trucking.eu/

Effigy-Consulting. (2017). *2017 Road Freight Market Study On 2014, 2015 and 2016 Data Europe and Country-Level Market Overview.* Retrieved 2020-11-24, from https://www.effigy-consulting.com/road-freight-market-report/

Eurostat. (2020a). *Freight transport statistics - modal split.* Retrieved 2020-11-07, from https://ec.europa.eu/eurostat/statistics-explained/index.php/Freight_transport_statistics_-_modal_split

Eurostat. (2020b). *Summary of annual road freight transport by type of operation and type of transport.* Retrieved 2020-06-03, from http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do

Found, P., Lahy, A., Williams, S., Hu, Q., & Mason, R. (2018). Towards a theory of operational excellence. *Total Quality Management & Business Excellence*, *29*(9-10), 1012–1024.

FreightBestPractice. (2010). *Performance Management for Efficient Road Freight Operations*. Department of Transport.

Ganesan, E., & Paturi, R. (2009). Key performance indicators framework-a method to track business objectives, link business strategy to processes and detail importance of key performance indicators in enterprise business architecture. *AMCIS 2009 Proceedings*, 736.

García-Arca, J., Prado-Prado, J. C., & Fernández-González, A. J. (2018, oct). Integrating KPIs for improving efficiency in road transport. *International Journal of Physical Distribution and Logistics Management*, *48*(9), 931–951. doi: 10.1108/IJPDLM-05-2017-0199

Girteka. (2020, Aug). *Interview: Performance indicators with girteka chief information executive.*

Girteka-Logistics. (2020). Eighteen european companies and organisations launch the european clean trucking alliance to call for zero-emission trucks.

Harris, J. G., & Davenport, T. H. (2017). *Competing on analytics: The new science of winning*. Harvard Business Review.

Heeks, R., & Shekhar, S. (2019). Datafication, development and marginalised urban communities: an applied data justice framework. *Information Communication and Society*, *22*(7), 992–1011. doi: 10.1080/1369118X .2019.1599039

IRU, I. R. T. U. (2016). A scientific study ”etac” european truck accident causation. *International Road Transport Union*.

Jony, R. I., Rony, R. I., Rahat, A., & Rahman, M. (2016). Big Data Characteristics , Value Chain and Challenges. *1st International Conference on Advanced Information and Communication Technology 2016, At Chittagong Independent University, Bangladesh.*(May), 1–6.

Kaplan, R. S., Norton, D. P., et al. (2005). The balanced scorecard: measures that drive performance. *Harvard business review*, *83*(7), 172.

Kasilingam, R. G. (1998). *Logistics and Transportation*. Springer US. doi: 10.1007/978-1-4615-5277-2

Koh, L., Dolgui, A., & Sarkis, J. (2020). *Blockchain in transport and logistics–paradigms and transitions.* Taylor & Francis.

Kundinger, T., Yalavarthi, P. K., Riener, A., Wintersberger, P., & Schartmüller, C. (2020). Feasibility of smart wearables for driver drowsiness detection and its potential among different age groups. *International Journal of Pervasive Computing and Communications*.

Lim, C., Kim, K. H., Kim, M. J., Heo, J. Y., Kim, K. J., & Maglio, P. P. (2018). From data to value: A nine-factor framework for data-based value creation in information-intensive services. *International Journal of Information Management*, *39*(December 2017), 121–135. Retrieved from https://doi.org/10.1016/j.ijinfomgt.2017.12.007 doi: 10.1016/j.ijinfomgt.2017.12.007

McKinnon, A. (2018). *Decarbonizing logistics: Distributing goods in a low carbon world*. Kogan Page Publishers.

Merchant, M. (2006). *Using Logistics to Win in a Multichannel World.* Retrieved 2020-06-30, from https://multichannelmerchant.com/news/using-logistics-to-win-in-a-multichannel-world/

Mitusch, K., Liedtke, G., Guihery, L., & Bälz, D. (2014). *The structure of freight flows in europe and its implications for eu railway freight policy*. Nomos Verlagsgesellschaft mbH & Co. KG.

Persyn, D., Díaz-Lanchas, J., & Barbero, J. (2020). Estimating road transport costs between and within european union regions. *Transport Policy*.

Ploos Van Amstel, R., & D'hert, G. (1996, jan). Performance Indicators in Distribution. *The International Journal of Logistics Management*, *7*(1), 73–82. doi: 10.1108/09574099610805458

Punte, S., Wang, B., Li, S., Goedhart, B., & Douglas, C. (2017). *Smart truck fleet management: A holistic and systematic approach for truck fleet energy efficiency*. Smart Freight Centre.

Qualtrics. (2017). *Manage every experience that matters: Why X-data is the new imperative.* Retrieved 2020-11-30, from https://www.qualtrics.com/blog/manage-every-experience-that-matters/

Qualtrics. (2020). *Qualtrics for customer experience: optimize every moment along the customer journey.* Retrieved 2020-11-25, from https://www.qualtrics.com/uk/customer-experience-management/

Rado Kotorov. (2017). *The Data Value Chain: Steps for Monetizing Your Data.* Retrieved 2020-06-24, from https://www.idevnews.com/stories/6998/The-Data-Value-Chain-Steps-for-Monetizing-Your-Data

Rezaei, J., Hemmes, A., & Tavasszy, L. (2017). Multi-criteria decision-making for complex bundling configurations in surface transportation of air freight. *Journal of Air Transport Management*, *61*, 95–105.

Rushton, A., & Oxley, J. (1991). *Handbook of Logistics and Distribution Management*. Kogan Page.

SAP SE. (2019). Processes in Transportation Management. *TM100*.

SAP SE. (2020a). Making your Supply Chain Resilient to Times of Disruption. *VNSG*.

SAP SE. (2020b). SAP for Cargo Transportation Driving Success for Third Party Logistics. *Travel and Transportation IBU*.

SmartFreightCentre. (2019). Global logistics emissions council framework for logistics emissions accounting and reporting.

Statista. (2018). *Netherlands: consumer interest in sustainability 2018 | Statista.* Retrieved 2020-06-03, from https://www.statista.com/statistics/922567/consumer-interest-in-sustainability-in-the-netherlands/

Tavasszy, L. (2020). *Assignment Engineering - Performance measurement for the trucking industry.* Retrieved 2020-10-25, from https://brightspace.tudelft.nl/d2l/le/content/127826/viewContent/976549/View

Tjahjono, B., Esplugues, C., Ares, E., & Pelaez, G. (2017, jan). What does Industry 4.0 mean to Supply Chain? *Procedia Manufacturing*, *13*, 1175–1182. doi: 10.1016/j.promfg.2017.09.191

Transport&Environment. (2017). *Roadmap to climate-friendly land freight and buses in Europe*. Transport & Environment.

Transport&Environment. (2019). *Low-Emission Zones are a success - but they must now move to zero-emission mobility*. Transport & Environment.

TroostGroup. (2020, Nov). *Interview: Performance indicators with troost group logistics.*

Tsugawa, S., Jeschke, S., & Shladover, S. E. (2016). A review of truck platooning projects for energy savings. *IEEE Transactions on Intelligent Vehicles*, *1*(1), 68–77.

Tunnel-MontBlanc. (2020). *Vehicles classification and tolls.* Retrieved 2020-12-1, from https://www.tunnelmb.net/en-US/vehicles-classification-and-tolls

Waberer's. (2020, Sep). *Interview: Performance indicators with waberer's business intelligence and iot specialist.*

Wang, Y., Feng, L., Chang, H., & Wu, M. (2017). Research on the impact of big data on logistics. In *Matec web of conferences* (Vol. 100, p. 02015).

A

Scientific paper

This appendix will add a scientific paper based on this research. A summary of the research focused on method, results and academical contribution will form the base for the paper.

Developing a performance indicator framework for European truckload carriers

A method to identify, define, associate and track performance indicators

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***Abstract*—The past decade has seen a rise in ability to collect, store and manage large amounts of data. With data becoming increasingly available to businesses, organizations are looking to new ways to gain insight into their activities. Acquired information can help transportation companies to cope with industry trends of expanded competition, the increasing pressure for lower transportation costs and higher service levels. The challenge for truckload carrier companies lies in determining which data is of value to the business. Understanding performance indicators and how to measure these is an important aspect of using data. To propose a solution, a framework is developed, in which clear performance indicators are reported, as well as how these can be measured.**

***Approach* - A combination of two studies is used to propose this method. The top-down approach of Ganesan & Paturi and new insights from Lim et al. are used to establish the method. The method is used to develop a framework for European truckload carriers. Literature and conducted interviews have provided relevant information.**

***Findings* - A performance indicator framework is developed. Important performance indicators are identified, defined, associated with activities and relevant data sources are analysed. The analysis of data sources has added new insight into performance indicators.**

***Implications* - This study reveals the results of the proposed method. During the research, the method steps are followed and reflected upon. The information available in the framework is of practical use to road carriers and software providers. The main academic contribution lies in the newly developed method that acts as a solution for performance indicator measurement challenges.**

Keywords: truckload, carriers, performance, measurement, framework, identification, association, tracking, indicators.

I. Introduction

A challenge for companies is determining which data can be of value to the business [1]. Data has the potential to be used in making data-driven decisions. Measuring the performance of a company can be regarded as a first step to making these data-driven decisions [2]. Understanding what to measure and how to measure is an addition to current studies. In literature, there is no clear method of determining relevant performance indicators and how to measure these. Therefore, this study proposes a method which can be used to identify performance indicators and relevant data sources.

For the truckload carrier industry, little is known about the possibilities that lie in data-driven decision making. Some examples in which data has the possibility to be of added value include optimizing operations, increasing efficiency and improving forecasting. To achieve this added value in the future, relevant information and data sources need to be identified. Therefore, the proposed method will be used to describe how to identify and produce the information relevant to European road carriers. At the moment, few carriers measure their operations in a way they are able to use the information gathered. To provide solutions to these problems, a framework is developed, in which clear performance indicators are defined, as well as how these can be measured.

As there is no clear method described in the literature to develop this framework, a proposal for a method is made. First, background information on usable methods is discussed. Next, the proposed method is described. European truckload carriers will act as a stakeholder to test the proposed method. In Section III, the steps and results of the method are discussed. In Section IV, the resulting performance indicator framework is described. Section V will conclude by reflecting on the proposed method and the improvements that can be made for future research.

II. Background

This section provides relevant background information on studies used to develop a method. Two approaches are analysed. First, the approach by Ganesan and Paturi is discussed. The shortcomings of this approach are described. A study by Lim et al. is interpreted to indicate a second approach. The addition of the Lim et al. mechanism will produce steps that are not described by Ganesan & Paturi.

A. Ganesan & Paturi

In the study 'Key Performance Indicators Framework - A Method to Track Business Objectives, Link Business Strategy to Processes and Detail Importance of Key Performance Indicators in Enterprise Business Architecture', structured steps are identified. These steps are: a) identify the performance indicator, b) define the characteristics of the indicator, c) associate and tie-up performance indicator to stakeholder and d) track and monitor the performance indicator [3].

This study can be considered a top-down approach, where first the key focus areas of the organization are determined.

The framework developed in 2009 is generic, as it does not focus on a certain business or industry. By analyzing the method of Ganesan & Paturi, the following specified steps are identified.

Identify: "identify what to measure".
a Define goals through goal modelling techniques
b Define performance measures for goals
c Define objectives - quantify goals.
Define: "classify and define characteristics of performance indicator".
a Classify the performance indicator using performance indicator classification scheme.
b Define characteristics of performance indicator - metrics, targets and benchmark levels.
Associate: "tie-up performance indicator and allocate responsibility".
a Identify key business process affecting objectives of performance indicator
b List business participants.
c Associate performance indicator to processes and business participants
Track: "monitor performance indicator over a period of time and report results".
a Collect data related to performance indicator.
b Analyze data.
c Report performance indicator.

Fig. 1: Ganesan & Paturi method

The approach can be considered a top-down approach. The steps are followed by first understanding what the most important areas for the company are. The first steps of this method pose as a good starting point. However, the approach is not clear on how to track performance indicators. A second study, by Lim et al. will provide information to fulfil this gap.

B. Lim et al.

A study by Lim et al. in 2018, proposes a framework to identify value from data sources. The approach by Lim is bottom-up and indicates how different data sources produce data that can become valuable information for stakeholders [4]. The nine-factor framework indicating data-based value creation for information-intensive services is shown in Figure 2.

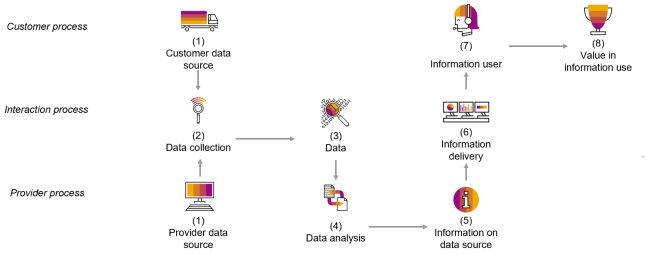

Fig. 2: Lim et al. mechanism

Looking at the trends and the increasing amount of data and data sources used in the road carrier industry, this factor framework identifies that value can be created from data. The goal of the study was to contribute to indicate how data management can lead to service value creation. Using several empirical studies, the nine factors are identified. This factor framework can be used to describe and analyse different services. It is not specifically used to determine performance indicators or measure business performances. Using the framework as an addition to the Ganesan & Paturi method, a more complete method can be proposed.

The Lim et al. mechanism will provide steps to analyse data sources. Steps in the Lim mechanism will also be used to determine whether new performance indicators can be identified by analysing data sources.

III. Proposed Method

Using the background information on the two studies, a method for this research can be proposed. The study of Ganesan & Paturi will pose as the traditional top-down approach to develop a performance indicator framework. First, key focus areas are determined, which will have different focus groups. For each focus group, the goals and corresponding performance indicators are identified. The next step also follows the definition and association steps of the Ganesan & Paturi method. For each performance indicator, a category is determined, and the best unit is chosen. Next, the indicator is associated with a related activity in which the performance indicator measures the performance. The stakeholders of the performance indicator are determined. Once the indicator is defined and associated, the data sources are determined.

In the Ganesan & Paturi method, the last step indicates that data needs to be collected, analysed and reported. The method does not go into detail on how these steps can be carried out. These steps also cover the steps taken by Lim et al. These steps are described in more detail by Lim et al. Therefore, the steps taken by Lim et al. are used in the proposed method. The Lim et al. method also indicates that by analysing the data sources, value can be created. The value in the study of Lim et al. does not describe performance indicators. Therefore, this study will try to identify performance indicators using the method. This last step describes a relation which completes the loop in the method. A new performance indicator will need to complete the other steps in the cycle to be successful.

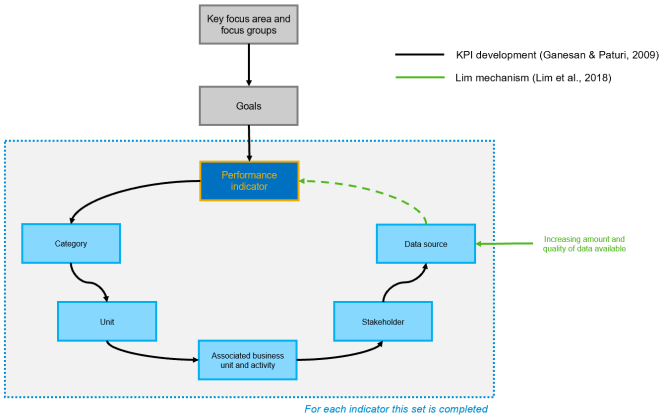

Fig. 3: Proposed method

The proposed method is demonstrated in Figure 3. The overall steps are shown and the feedback loop is visualized. The method is tested using the European truckload carrier industry. In the next section, the steps of the method are discussed and the results are shown.

The steps of the proposed method can be described in three sections. First, the identification of the performance indicators is discussed. Next, the association of performance indicator is described. The final step consists of tracking the performance

indicator. The analysis of the data sources and possible added performance indicators conclude this section.

A. *Identification of performance indicators*

The first step to identifying performance indicators is establishing the goals of the company. To do so, key focus areas are established. Using the Business Motivation Model and Balanced Scorecard, the relation between the business situation, goals and performance indicators is described (see Figure 4).

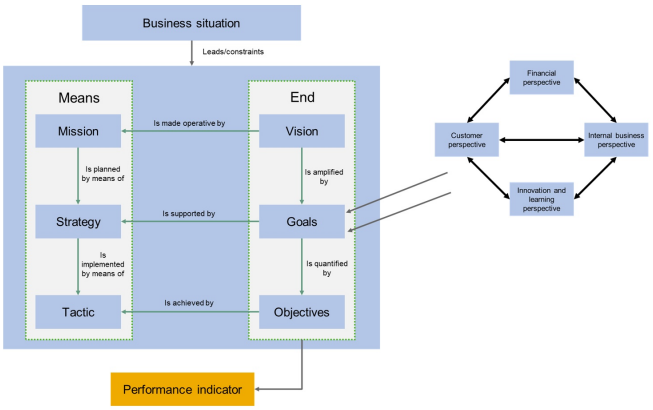

Fig. 4: Business Motivation Model and Balanced scorecard

The balanced scorecard will function as a starting point to develop the key focus areas. This model is generic and applicable to different industries. Using the balanced scorecard, the following questions arise: *what must we excel at? How do customers see us? How do we look to shareholders? Can we continue to improve and create value?* These questions also include overlap with some traditional logistical supply chain goals [5]. These traditional goals include increasing efficiency, improving customer service, increasing sales and improving relationships. When analysing supply chain, SAP analyses four areas [6]. The first area is related to customers, which is to deliver perfectly. The second area is related to employees, in which the aim is to work productively. The third area considering stakeholders covers the ability to grow profitably. The fourth area used for supply chain companies is related to the environment, where companies should act sustainably.

In this study, the key focus areas are specific to the road carrier business. In literature and interviews, the different areas and goals are discussed. The balanced scorecard, traditional areas and SAP interpretation are discussed with road carrier to indicate the most important topics. Literature used is divided into specific transportation and logistics articles, as well as business management views. Articles reviewed include both transportation specific as well as logistic and supply chain topics [7] [8] [9] [10] [11] [12] [13]. Business management books used include [14] [15] [16].

Four different carriers are interviewed [17] [18] [19] [20]. These interviewed parties speak from their own experience and can be different from other companies. To give an indication of the interviewed parties, carriers from three sizes are interviewed. Small companies are up to 100 trailers, medium is 100-1000 trailers and large is more than 1000 trailers. Two are large (Waberer's and Girteka), one medium (Peter Appel) and a smaller carrier (Troost Group) are interviewed. Their different business sizes will also give insight into different priorities. The strategies of these companies also differ, which is why not all companies agree on performance indicators.

The findings from these interviews led to four key focus areas. These key focus areas indicate the four areas in which goals should be identified. For each focus area, goals are determined. These groups will combine several performance indicators that are indicators of the performance regarding the focus area. For each focus area, a group in which goals can be identified is discussed. This has led to the following key focus areas, including the groups which are correlated (see Figure 5).

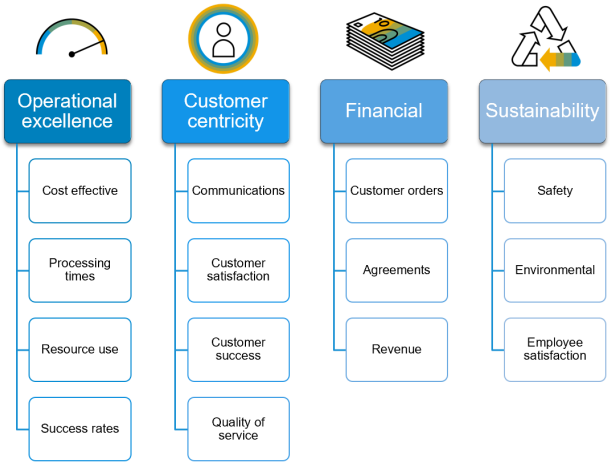

Fig. 5: Focus groups per key area

Using these key focus areas and groups, performance indicators can be chosen. Using literature about performance indicators, specific to supply chain, transportation and general management, a set of 96 performance indicators is identified. These are divided into 31 customer centricity, 12 financial, 38 operational excellence and 16 sustainability. These are also allocated to the 14 focus groups.

Categories are described to indicate the difference between strategical and operational performance indicators. The performance indicators are further defined by the aggregation level. The aggregation level is divided up the unit (e.g. number, percentage), value (e.g. maximum, average), time period (per month, real-time) and filter (per region, partner). Several levels indicate what exactly needs to be measured per performance indicator. With that information per performance indicator, the following step is to associate the indicators.

B. *Association of performance indicators*

Using the information from the activities, the next step is to associate the performance indicator with the relevant business unit and activity, as well as the correct stakeholder. By analysing the generic business units and common activities

for carriers, six business units are determined. Figure 6 indicates the association of performance indicators with different activities.

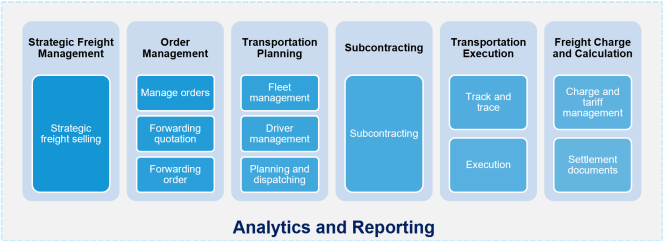

Fig. 6: Business units and related activities

By analysing the activities and looking at the specific objectives, a distinction can be made between responsible stakeholders. Three levels can be established. The first level is the executive level, second is management and third is role-specific. The chosen levels are used to identify a selection of users. The road carrier activities cover a large number of operations, and by analysing the users, a selection is made. The executive level is determined to answer the top-level question: what are the ten most important performance indicators? The management and operational side are split to divide performance indicators per focus group, or activity. The management level includes performance indicators that can be analysed by managers who are not directly acting in the activity. Specific role performance indicators include performance indicators directly related to the activity.

C. Tracking of performance indicators

For each performance indicator, data needs to be collected. Information can be retrieved from many different data sources, from IT to IoT devices and external sources. In this section, each data source will be analysed and potentially connected with a performance indicator. As visualized in Figure 7, there are several steps that need to be taken to identify data sources. The first question that is asked is, *what essential information needs to be produced?* The next step is to identify a data source to each part of essential information. By analysing the data sources, new insights into performance indicator tracking are gained. These insights also have the possibility to introduce new measurements.

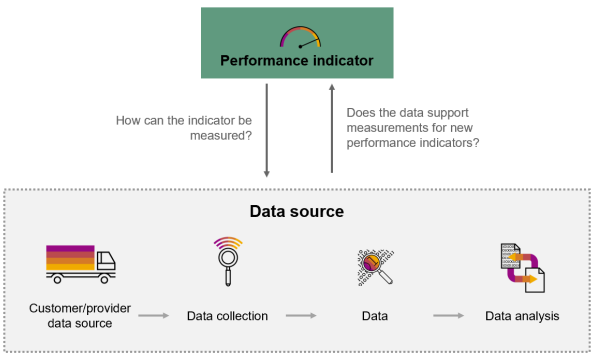

Fig. 7: Tracking performance indicators

In four areas, a total of 22 data sources are analysed and categorized. In the IT area, 7 separate sources are identified. Truck and trailers data sources include the tachograph, GPS, cameras and sensors, in which sensors are split into 6 usable sensors. External data sources include sources for weather, traffic, toll and road conditions. Recent studies have shown that there is a significant difference between how companies think their clients and customers rate their products and service and how they actually perceive this. This is called the experience gap, which indicates that 80% of CEO's believe they deliver a superior experience, and only 8% of their customers agree [21]. With a large amount of operational data available, companies are often performing well in this area. Using surveys, the experienced data can also be analysed. This is the human factor that can be an important indicator of what is really happening. For each performance indicator, one or more data sources can be analysed. The data sources are all inspected from data source to how the data is collected and analysed. The result of the data sources can be seen in Figure 8.

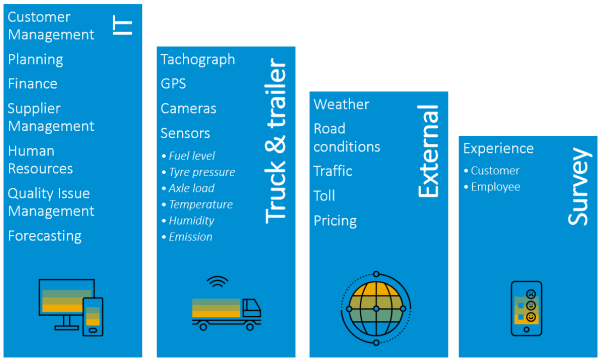

Fig. 8: Overview data sources

The insights from these data sources also contribute to improving performance indicators or adding new indicators. Each data source is analysed. For most data sources, new specific performance indicators can be determined. These new performance indicators are analysed using the proposed method steps and associated with activity and stakeholder. New sensors and external information contribute to a number of additional data sources. However, most of the additional data sources use information produced from single data sources. Therefore, a number of data sources contribute value in the form of improving performance indicator measurements. For example, loading and unloading times can be calculated using logs from the driver. However, using load sensors, the times can be calculated more precisely. Performance indicators are changed and additional indicators are added to conclude the final step of the proposed method.

IV. Developed Performance Indicator Framework

The requirements of the developed framework are that a) give insight into performance indicators for road carriers and b) indicate how to track indicators using data sources. Using Excel, the performance indicators are stored. A pivot table functions as the core of the framework. An input tab is used

to store all the information regarding performance indicators. To show the level of detail for each performance indicator, performance indicators have the indicators seen in Figure 9. The pivot table will use the information and visualize this in a way best usable.

Fig. 9: Performance indicator information

A. *Framework development*

The results of the method used are used to create a performance indicator framework. The requirements for the framework indicate that the framework should be able to identify performance indicators per relevant stakeholder. There are several stakeholders that can use such a framework. In Figure 10, the five options are shown. For each option, a set of performance indicators can be identified.

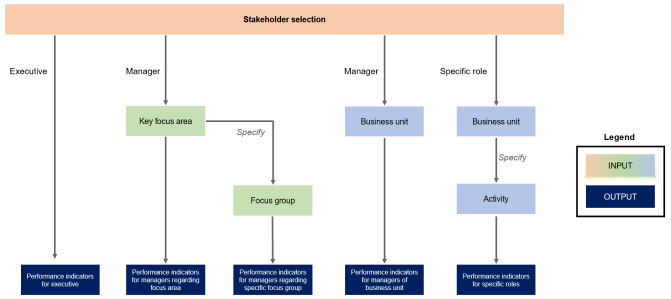

Fig. 10: Framework blueprint (colors indicate input areas)

This overview can also be read from the bottom up. For a carrier who is interested in how the performance of their fleet management department, the framework can be used. For this example, looking to the bottom right corner, the performance indicators for role-specific employees are needed. To achieve this, the framework is used by selecting a specific role. Next, the business unit (transportation planning) and next, the related activity, which would be fleet management. For a management function, there are two options. A management stakeholder can be used to identify performance indicators specific to focus groups or business units.

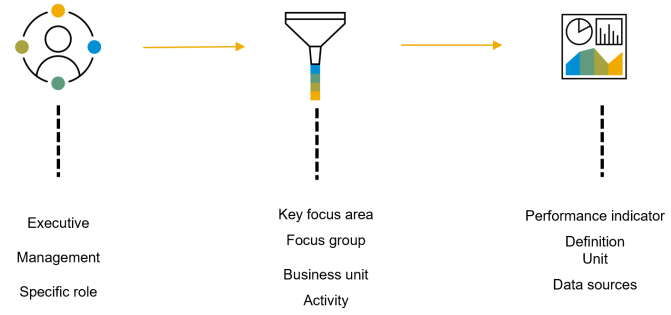

Fig. 11: Framework overview

The output of the framework consists of a list of performance indicators and associating definition and unit. The output will also indicate the data sources per performance indicator. In that way, a carrier or service provider will be able to use the information to develop new solutions. The output is developed using a pivot table and relevant filters. The choices made by a stakeholder function as filters. The output is displayed next to the input and consists of the performance indicators, the definition, unit and relevant data source(s).

B. *Implementation of the performance indicator framework*

The framework is developed using generic information and does not apply to a specific carrier. A carrier has the opportunity to adjust the framework in order to fit the company better. The key focus areas identified are used to group the goals of a carrier company. The areas may be different per carrier and can be adjusted in the framework. This also applies to business units and activities. The stakeholders can combine activities or responsibilities that may be distributed differently. That means that the framework can be adjusted in a way applicable to the carrier. A software provider interested in developing software for the carrier can use the framework. Using the information and connections, the software can be produced to give insight into the performance indicators. In the form of a dashboard or other reporting, the measurements can be used.

The framework is developed focusing on truckload carriers in Europe. This means that several special industries are left out. These include the LTL (less than truckload), bulk, LSP (logistic service provider), dangerous and high-value goods. The framework consists of a lot of logistic generic aspects. These aspects can be used for future frameworks. In this section, some changes in the framework are identified. A suggestion on areas to improve or change is given. First, the key focus areas are analysed to determine if these are similar to the FTL framework. Changes in the business units and data sources are also noted.

	Overall	Operational excellence	Customer centricity	Financial	Sustainability	Business units	Data sources
Less than truckload	Transportation per freight unit.	Utilization per truck. Consolidation performance.	More focus on service options, less on OTD.	Pay per portion, new aspect to tariffs.	Efficiency of trailer, possible more within city (emission zones).	Planning per unit, scheduling, and more complex charging.	More data from planning. Schuduling information.
LSP	More logistical aspects.	Efficiency in warehousing and inventory.	More responsibility of overall process.	Costing of warehousing and inventory.	Warehousing employees, emissions of other logistic areas.	Include planning with warehousing and inventory. More activities.	More data from warehousing, inventory, customers.
Bulk	Transport per weight or volume.	Change in efficiency. Loading unloading different.	Different customers.	Costing per weight or volume.	Safety during loading and unloading.	Planning changes for loading and unloading. Quality assurance.	Weight and volume measurements.
Dangerous goods	FTL movement of dangerous goods. Safety aspect increases.	Operations focus on safety aspects.	Customer importance of safety.	Possibly more focus on quality of transport than pricing.	Include safety aspects.	Quality assurance and safety activities.	Information on safety issues and improvements.
High value goods	FTL movement of high value goods.	Efficiency aspects on planning and security.	Focus on security and reliability.	Insurance aspects.	Possibly include damages and stealing.	More complex settlements and quotations.	More focus on location, safety and security.

Fig. 12: Implementing framework for other transport specialties

The main differences between LTL and FTL industries lie in the type of service. A truckload carrier is responsible for leasing the trailer to a customer. For LTL goods have to be combined, often leading to more efficient use of the trailer, but not the flexibility in delivery times. The majority of the framework can therefore be used for LTL carriers. The activities of planning freight units, instead of orders should be taken into account.

The differences for LSP lie in the addition of extra logistic processes. Bulk is the transport of unpacked goods (for example sand). Loading and unloading changes but the overall process is similar to the FTL business. Transportation of dangerous and high-value goods demand more focus on certain aspects. Safety, security and tariff management would need to be reviewed. Another important aspect is subcontracting. For each speciality, subcontracting can be different from the FTL business.

V. Conclusions and recommendations

A. Reflecting on the proposed method

The proposed method combines the top-down approach by Ganesan & Paturi with the Lim mechanism. The combination results in a more complete approach to tracking performance indicators and the addition of performance indicators due to data source analysis. Following the steps results in a successful association of the framework. This approach has led to the information used in the performance indicator framework.

The method can be improved in some areas. When a performance indicator is identified, their next step is to categorize and determine a unit. As the responsible unit and stakeholder have not been associated, this is not always directly possible. From business activities and stakeholders, new performance indicators can be identified. Therefore, a feedback loop between activity and unit could improve the method. This would introduce a step in which the activities are analysed and the aggregation level could be improved.

The data sources are changing and as a result, the possibilities in the data sources increase. The relation between new or additional data sources and performance indicators is identified in the proposed method. A next step would be to identify how these data sources can be used to improve certain activities of the carrier. The possibility could arise that using data for these activities would result in data-driven decision making. It will require extra research to indicate what the direct connection between new data and performance indicators is. In this research, the new data sources are connected to performance indicators. The next step could be to analyse the value of each data source.

B. Conclusions

Reflecting on the research objective. The most important performance indicators are identified, defined and associated using the proposed method. The relevant data sources are analysed and the tracking of performance indicators is described. Using the data sources, performance indicator tracking is improved or new indicators are added. These results are combined in a useful framework.

Therefore, the result is used to reflect on the method used. Possible improvements of the method can be used in future studies. This proposed method can be improved by introducing a feedback loop between the activities and performance indicators. This research has shown that understanding the activities is important for establishing performance indicators. Another improvement is determining the additional value of data sources. This research has shown what data sources are used for performance measurements. These data sources often posses the information for operations within a carrier. Using the information, new performance indicators are identified. Using these insights, the method can be used for the development of frameworks in other industries.

C. Recommendations

The developed framework is verified by analysing the possible input and output and comparing this with the expected outcome. During interviews, performance indicators, activities and data sources are discussed. However, the framework is not validated by experts. This is due to the fact that no clear way to validate the framework is defined. The framework is new and future research into a usable validation could provide a valuable addition to the framework. The size of the framework is too large and needs instruction for experts to validate. This research indicates how the framework can be used. A future study could provide information on how these and similar frameworks can be validated.

This research also introduces areas in which further research can be carried out. The performance measurement cycle consists of a controlled system, analytics, and action and controller. The research has identified the relations between analytics and the controlled system. Using the identified data sources and performance indicators, the information can be used to determine how to use the data. Performance indicators are valuable to determine the performance but they can also be used to drive decisions. Further research into the relevant activities and information these activities can produce, may lead to insight into how data can be used in decision making.

References

[1] Y. Wang, L. Feng, H. Chang, and M. Wu, "Research on the impact of big data on logistics," in *MATEC Web of Conferences*, vol. 100. EDP Sciences, 2017, p. 02015.

[2] L. Tavasszy, "Assignment Engineering - Performance measurement for the trucking industry," 2020. [Online]. Available: https://brightspace.tudelft.nl/d2l/le/content/ 127826/viewContent/976549/View

[3] E. Ganesan and R. Paturi, "Key performance indicators framework-a method to track business objectives, link business strategy to processes and detail importance of key performance indicators in enterprise business architecture," *AMCIS 2009 Proceedings*, p. 736, 2009.

[4] C. Lim, K. H. Kim, M. J. Kim, J. Y. Heo, K. J. Kim, and P. P. Maglio, "From data to value: A nine-factor framework for data-based value creation in information-intensive services," *International Journal of Information Management*, vol. 39, no. December 2017, pp. 121–135, 2018. [Online]. Available: https://doi.org/10.1016/j.ijinfomgt.2017.12.007

[5] M. Merchant, "Using Logistics to Win in a Multichannel World," 2006. [Online]. Available: https://multichannelmerchant.com/news/using-logistics -to-win-in-a-multichannel-world/

[6] SAP SE, "Making your Supply Chain Resilient to Times of Disruption," *VNSG*, 2020.

[7] J. García-Arca, J. C. Prado-Prado, and A. J. Fernández-González, "Integrating KPIs for improving efficiency in road transport," *International Journal of Physical Distribution and Logistics Management*, vol. 48, no. 9, pp. 931–951, oct 2018.

[8] R. G. Kasilingam, *Logistics and Transportation*. Springer US, 1998.

[9] B. Tjahjono, C. Esplugues, E. Ares, and G. Pelaez, "What does Industry 4.0 mean to Supply Chain?" *Procedia Manufacturing*, vol. 13, pp. 1175–1182, jan 2017.

[10] R. Ploos Van Amstel and G. D'hert, "Performance Indicators in Distribution," *The International Journal of Logistics Management*, vol. 7, no. 1, pp. 73–82, jan 1996.

[11] A. Bask, M. Rajahonka, S. Laari, T. Solakivi, J. Töyli, and L. Ojala, "Environmental sustainability in shipper-lsp relationships," *Journal of Cleaner Production*, vol. 172, pp. 2986–2998, 2018.
[12] S. Chi, "Data-driven service innovation strategy for Scania Data fuelling Scania's future business," Tech. Rep., 2020.
[13] FreightBestPractice, *Performance Management for Efficient Road Freight Operations*. Department of Transport, 2010.
[14] J. Coyle, E. Bardi, and J. Langley, *The management of business logistics*, 5th ed. 610 Opperman Drive: West Publishing Company, 1992.
[15] A. Rushton and J. Oxley, *Handbook of Logistics and Distribution Management*. Kogan Page, 1991.
[16] M. Christopher and R. Yallop, "Audit your customer service quality," *Focus*, vol. 9, no. 5, pp. 1–6, 1990.
[17] Waberer's, "Interview: Performance indicators with waberer's business intelligence and iot specialist," Sep 2020.
[18] Girteka, "Interview: Performance indicators with girteka chief information executive," Aug 2020.
[19] TroostGroup, "Interview: Performance indicators with troost group logistics," Nov 2020.
[20] PeterAppel, "Interview: Performance measurement with peter appel's business analyst," Nov 2020.
[21] Qualtrics, "Manage every experience that matters: Why X-data is the new imperative," 2017. [Online]. Available: https://www.qualtrics.com/blog/manage-every-experience-that-matters/

B

Definition list

During this research, a number of definitions are discussed. These definitions are can be described in multiple ways and to elaborate on the use in this study a list is set up. The definition list is described in alphabetical order. For each term, the definition used in this research is given.

Activity
A specific activity or function of the road carrier company. Activities are specified per business unit.

Actor
Parties involved are also regarded actor.

Business unit
For a typical road carrier company, the activities can be combined in six business units.

Data-driven
Decisions are made based on data an not by intuition or personal experience.

Execution
The state in which an activity is executed.

Executive
Highest level of corporate officers in a company.

Framework
A structure used to support something.

Focus group
The specified group defined within a key focus area.

Full truckload
A carrier business type focused on the movement of trailers to a single customer.

Issue
A problem that influences an activity or person.

Logistics service provider
A business which can be used for outsourcing activities such as warehousing, transport, distribution and fulfilment.

Management
Company employee categorized in a management function covers either a business unit or goal group.

Mechanism
A theory used to describe links in a system.

Operations
Activities within a company in which the state is active.

Partner
A company used to work together with or subcontract certain activities.

Key focus area
An area in which the overall business goals of a company are combined.

Process
A series of actions.

Road carrier
A company engaged in transportation by road.

Role specific
Definition of stakeholder which is only applicable to the role carried out by that person.

Service provider
An organisation focused on carrying out a specific service.

Software provider
A company focused on the development, maintenance and publication of software.

Stakeholder
A party or person relevant to a certain business area, activity or goal.

Subcontracting
The act of outsourcing an activity to another company.

Transportation sector
Industry section focused on transportation.

C

Literature overview

This appendix provides insight into literature used during the study. First, a study into the data to value chain is described. Two frameworks designed by Ganesan & Paturi are also discussed.

Data to value chain

The term 'data to value' has been described in many different ways. The term denotes the value of data. In this section, a short introduction in data to value is given, followed by a more detailed description of the Lim et al. framework, which is used in this study. The data to value chains studied (see figure C.1)(Lim et al., 2018),(Heeks & Shekhar, 2019),(Rado Kotorov, 2017),(Jony et al., 2016),(Curry, 2016). show there are many different perspectives of how data can be viewed.

	Data				Information		Value	
Lim et al. (2018)	Data source	Data collection	Data	Data analysis	Information on data source	Information delivery	Customer	Value in information use
Heeks & Shekar (2019)	Data source and capture				Information process and output		Decisions and actions	
Kotorov (2017)	Raw data	Data capture	Enriched data	Analyzed information		Decision management applications	Customer facing	
Jony et al. (2016)	Data				Information	Knowledge	Wisdom	
Curry (2016)	Data acquisition		Data analysis		Data creation and storage		Data usage	

Figure C.1: Data to value chains in literature

The CEBA framework described by Ganesan & Paturi is visualized in Figure C.2. This shows the complex business situation and connections between sections. The business motivation model is visible on the top, with a connection to the balanced scorecard on the right. The figure functions as a starting point and indicates how the two theories are useful.

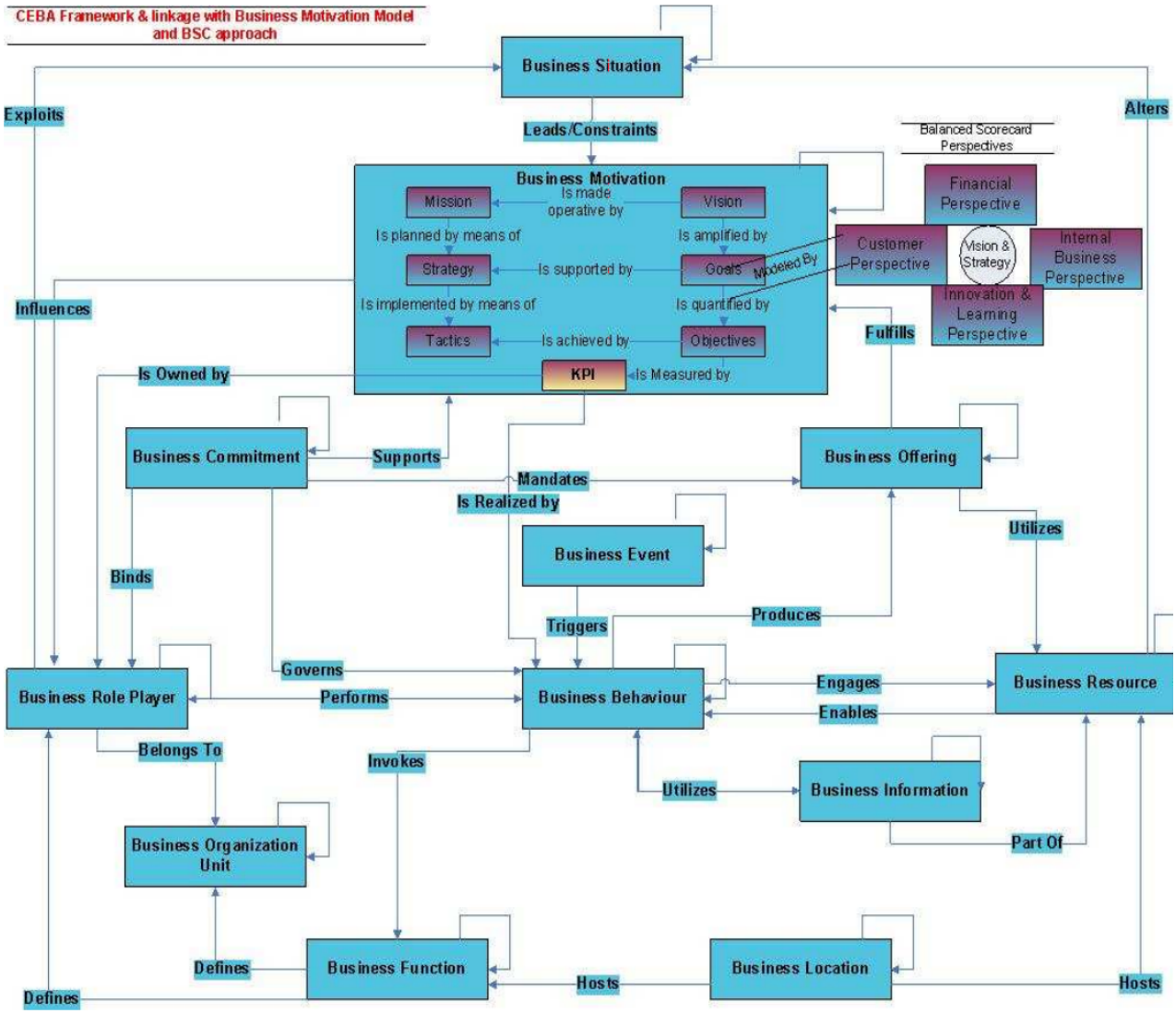

Figure C.2: Composite KPI Framework - Fitment of CEBA, BMM and BSC

The KPI classification scheme is used during the association of performance indicators. The enterprise can be described using business units and business processes. For each area, strategical or operational performance indicators can be defined. Similar to the developed performance indicator framework, this shows how performance indicators can be part of activities and business units, as well as indicate operational and strategical goals.

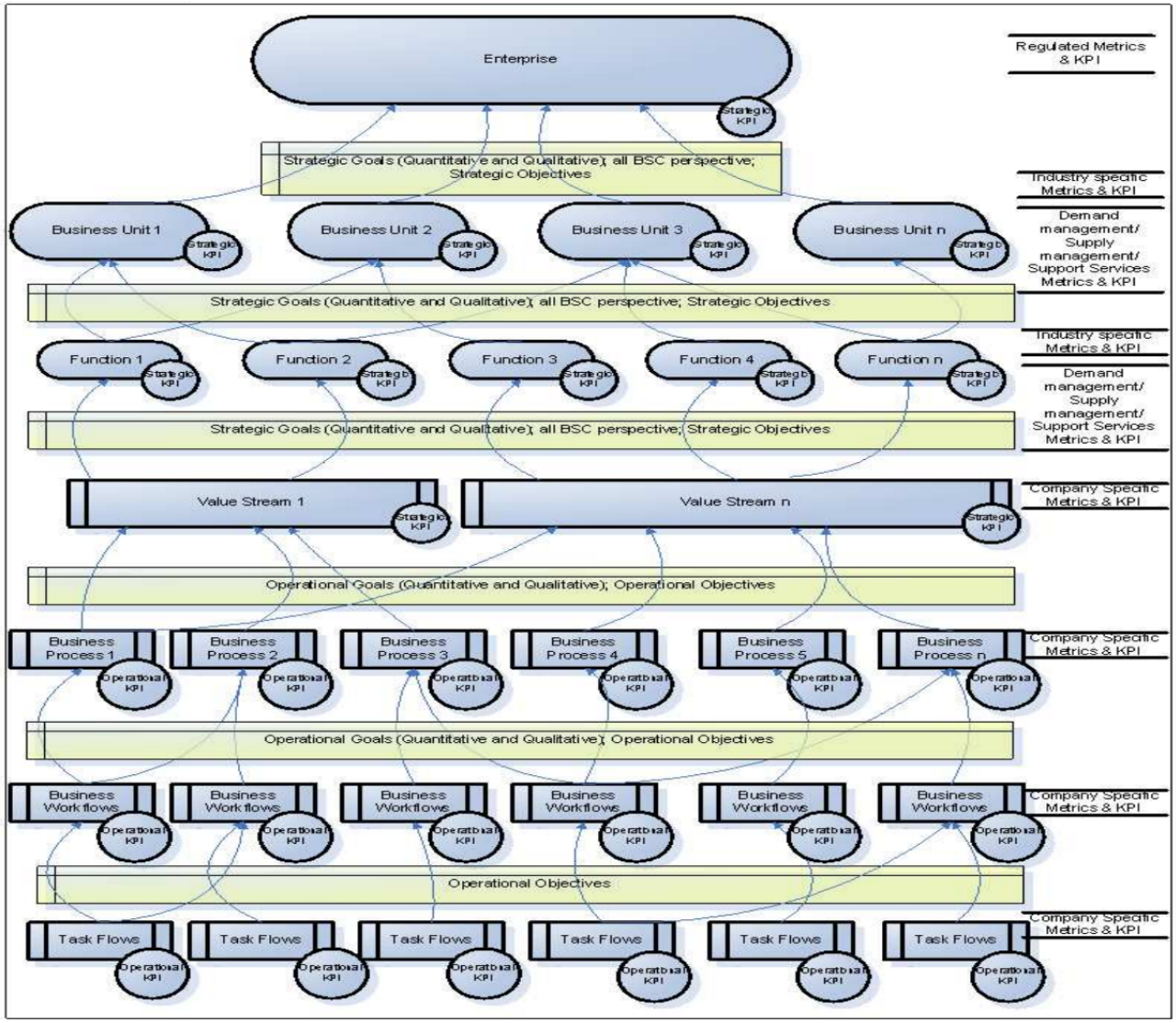

Figure C.3: KPI Classification Framework

D

Interviewed road carriers

In this appendix an overview of the conducted interviews is described.

D.1. Waberer's International I

Topics covered: **Main customers of Waberer's International; Planning models; Improvement areas overall business; Sensors; Human factor using technical equipment; Safety aspects; Sales; Pricing.**

Waberer's main customers are FTL carrier, no LTL transport, which means homogeneous customers. The fleet includes 4000 trucks and 4000 trailers. Business focuses on long haul. Own fleet execute more than 1000km, less is subcontracting. Only non-dangerous goods. No special needs goods. Half of customers key account (contract), other half is spot market (competitive).

Taxi model first used, this year focus on smaller areas, not all of Europe. In long haul own truck and trailers, subcontracting is minor (<20%).

Road carriers can improve on planning engine: paired orders and free capacity. Routing engine: planned precisely the exact route. Which route from a to b. IoT, information from trailers and truck. How to react if driver is not driving the right path. How can technologies support business processes. Not only ex post analytical use. How to send message if truck is not driving right.

Toll costs are important. French highways are expensive. How to decrease highway cost. Necessary to build in technology for business processes.

Truck sensor: global provider companies are black box, installed into the truck. Every 5 min GPS is sent, every 30 min data package, temperature, fuel level, cruise control, almost real-time. Approx every hour the data is refreshed. Control processes started from this (i.e. where is my truck).

Trailer sensor is different physical object. It can tell if trailers is connected, precise data of unloading (driver is not needed to push button, which is difficult), avoid human factor. Technical support. Door sensor is built into trailer, date and time of coupling, loading, unloading. Tire temperature and pressure, to avoid safety. Very expensive to retrieve truck. When to replace tire. Depends on type of trailer. Sensor information will work also with 3G, not 4G or 5G needed.

Tachograph is needed. For small companies, the high level technology trucks and high level drivers. Human factor is important. Driver is very important factor, how to train driver. Take photo is there is an accident. Using cruise control system (cooperation between truck and driver), fuel consumption. Technology not usable without good driver (i.e. information about hill ahead to adjust driving gear/shift). Analyze number of drivers able to follow instructions. Big fleet with high fluctuations you need high quality process based.

Safety aspects, maintenance and service very important. How to remotely test driver of alcohol or drug use. IoT on the driver (dream list) on new ideas. Drivers as primary factor is necessary, see if driver is in a good condition. With smartwatch? In what conditions is the driver. No experience of companies who do this. Low fluctuation of drivers is needed for new technology.

Sales: number of order is target, not good enough. Incentive system is not aligned with profit system. Absolute revenue is not aligned with profit. What is the actual margin. One part is commercial sales, other is execution.

Price is based on dynamic pricing, oil price can be influence. Which customers connected to oil price. In tender pricing, the spot price. If not, when oil price is low is bad for customer. Geographical points, areas behave different, nobody is in south Italy (no touring lower than Rome), put these aspects into pricing tool.

Go and no-go zones if customers do not pay extra (or structural line), how to support spot business, the missing area of key account. If unloading is known, try and find spot business for return. How to forecast sales (customer/area). Who can make the best forecast. Combination between human and technology.

With knowledge about customer. With good OTD, the customer is satisfied. Satisfaction surveys, marketing big. All about OTD. What is reason for delay. Quality KPI is OTD. How can planner balance between commercial and execution side. Commercial: later is safer, from execution: push fleet to be on time.

What can improve overall business: human factor. If the driver is disciplined well, the fleet is very well. How can drivers improve. Different nations. What is important for a driver.

D.2. Waberer's International II

Topics covered: **Data sources; Key performance indicators; Utilization of assets; Planning time; Subcontracting; Quality; Pricing; Aggregation levels.**

Efficiency important, also measuring it.

Specific key performance indicators. Utilization extend unmoved trucks and unmoved trailers (collect how many trucks unmoved in last 24 hours, based on GPS position). If a truck is not moving, company is burning money.

Planning time, time to create forwarding order. Currently forwarding order is manually made.

Who is generating how many forwarding orders is important. Two parts: own fleet and subcontracting party. Transportation for own fleet and forwarding for subcontracting.

Regarding subcontracting: subcontractor qualifications (quality of service, flexibility of orders acceptance, delay, communication of complaints), total points to compare subcontractors.

Quality to be measured with customer responses.

Resource use is important: maximum percentage empty km, otherwise not affordable, or high charge level. Different KPIs to measure use. Mostly from distance point of view. Dis balance of fleet not included.

Important is also the price level: euro versus distance is commercial distance. Distance payed by customer.

Import FWO percentage is also important for driver experience as drivers need to return home on time.

D.3. Girteka Logistics

Topics covered: **Gap technology and measurements; Main Customers; Efficiency; Safety; Planning time; Profitability; Fleet management; New sensors; Sales; Optimization; Complaints; Traceability.**

Al lot of changes in what you want to measure, measuring wrong thing is not the good thing. A huge gap in transportation and technology. KPI's is also a struggling thing for Girteka.

Majority of orders done by Girteka own fleet. Business legs in different EU areas. Subscription (rent truck with driver), small part of forwarding business. Girteka sees opportunities in forwarding. Warehousing is used for repacking, labeling, paperwork, is part of the value chain. Good to be FTL, and have a settlement. Girteka successful because of execution, no technology, no business model.

Fuel efficiency, day to day distance, empty mileage, same day loading (keep them busy), subcontracting (experience, are subcontractors using same KPI's). What is also important is safety, is a huge cost base. Measure per million miles. Planning time per order is no time, use AI, investigate, create automatically, only driver should accept it. Also look at sales part, how much revenue should each sale make.

Safety also about possible risk. Drivers banned by clients can be of many reasons. Scoring of driver, also for motivation.

Look at truck, what is fleet management. When is truck replaced, proactive looking. At certain condition, exploitation, situation (mountains). Look at inspections. Breakdowns. Cost of service per km. What is total cost of having this type of truck. Cost per day per truck. How is truck used? In future to predict maintenance. Collaboration with manufacturer for truck data. Timing and know how to do this.

Wearables for driver for health may be interesting. Use equipment in truck first, make is seamless in day to day operations. Make it safe (no disturbance), no distractions. Number two is to link business selling and execution. If delivery is well and sales is wrong, no money, other way also no success. Is huge investment. Special conditions for different areas, if broken, the different. Predict health issues. Privacy also important.

Number of contract agreement, number of order, measure money, measure OKR, short term, how fast accumulate. Want to make agile team setup. Profit earning per truck. What is influence of dis-balance, what is influence of order. How to measure dis-balance in trucks. Measure core lanes, how many days of planning. Feeling that if trucks is on location in couple of days, you should or not do it. From november the feeling is changed for AI. Automatic calculation. Not individual level, but on fleet level. What is the best link. IoT devices.

Optimization in cost, lines, for customer for pricing, how you have been doing. For customer, analysis. Show customer what things are going well and which are not. Can show bill for demurrage. Also collect statistics. Was driver happy, what was delay.

Huge gap between customer service and whole. Numbers P&O report. Orders are measured, but not consistently. Not analyzed. You cant have standing trucks, but also not comply with orders. Sometimes orders are not interesting. Orders with special request. How are these taken. Service level agreement is SLA. If we agree with customer, if less than contracted cars, its problem for carrier, but if customer wants more, there are possibilities. Look at partnership agreement.

Attitude of management is not measured. Interesting for report. Look at connection with client. Complex situations, are there explanations. Management reaction time is important. I.e. drunk driver, need to react instantly, very important.

Understand what percentage of trucks arrive, damages, measure also how clients keeping promise. How clients pay the bill, history of delay in paying. Define risky clients, see pattern. Invoice, date sent, due date, date payed. Why is late payment. Look at correlations. Quality of service. On-time delivery is important. Condition of trailer is always good, fridge could be bad. Clean or not clean, it has to be clean. Pharmacy, special washing. Temperature control is important. Looking backwards six weeks for consistency in transit time. Consistency is important.

Traceability is important, is trailer always visible to client. Special application, is that also done. If client wants to use special application, that should be done (photo of documents). How much of journey is fulfilled with all good (so not forgetting to push button). Specific demands and traceability.

D.4. Troost Transport

Topics covered: **Added value carrier; Strategies compered to LSP; Quality level; Emissions; Use of truck data; Brexit, Corona pandemic; Challenges for the future.**

Added value not in driving a to b but all in packet. Aim to cover all actions. Use of partners in region

Quality and price important, pay what you get.

Measure how long truck is in area. Measure client use. Price always important. Use data for planning.

Not many KPI's, aim to have service level of 100%. Trusting clients, base has to be good.

Truck shows emission. Investments very expensive. Often only affordable if client shares finances.

GPS shows location, only used if truck is late. Not measuring daily. Can be important for valueable goods.

Use of board computer for information. Orders are send, documents scanned. Explain driving hours, loading and unloading times. Used by analyst in office. Board computer is connected to tachograph.

Strategy shift from carrier to forwarder.

Sustainability differs per client. Clients can demand but if financial side is incomplete there is no deal.

Brexit is still not clear (December 2020). How will documents change, customs, quality assurance.

Fuel prices low during corona pandemic.

Biggest challenge for future is costs, drivers home on time, rising toll, taxes clients, congestion at ports.

D.5. Peter Appel Transport

Topics covered: Main customer; Chartering; Data use; Measurements; Pricing; Sustainability.

Business layout of Peter Appel. 680 trucks. Focuses on food and retail. Wholesale markets. Transport from distribution center to store (chartering).

Data analyses of issues, planning, HR.

Measuring of fines, toll.

Difference pricing per period.

Sustainability is focused on truck label. Most EURO6.

E

Overview framework

This section provides an overview of the framework and insight into the program used. The back end of the framework is also described in this appendix.

Framework design

In Figure E.1 a screenshot of the usable framework is given. On the left is the input area. The right reports the output. The input is usable from top to bottom. A choice for user is made, and either a key focus area or business unit is specified. Further specifications into the focus groups and activities can be selected. The scenario section below can be used in combination or separately. By choosing the impact of the scenario, affected performance indicators are reported.

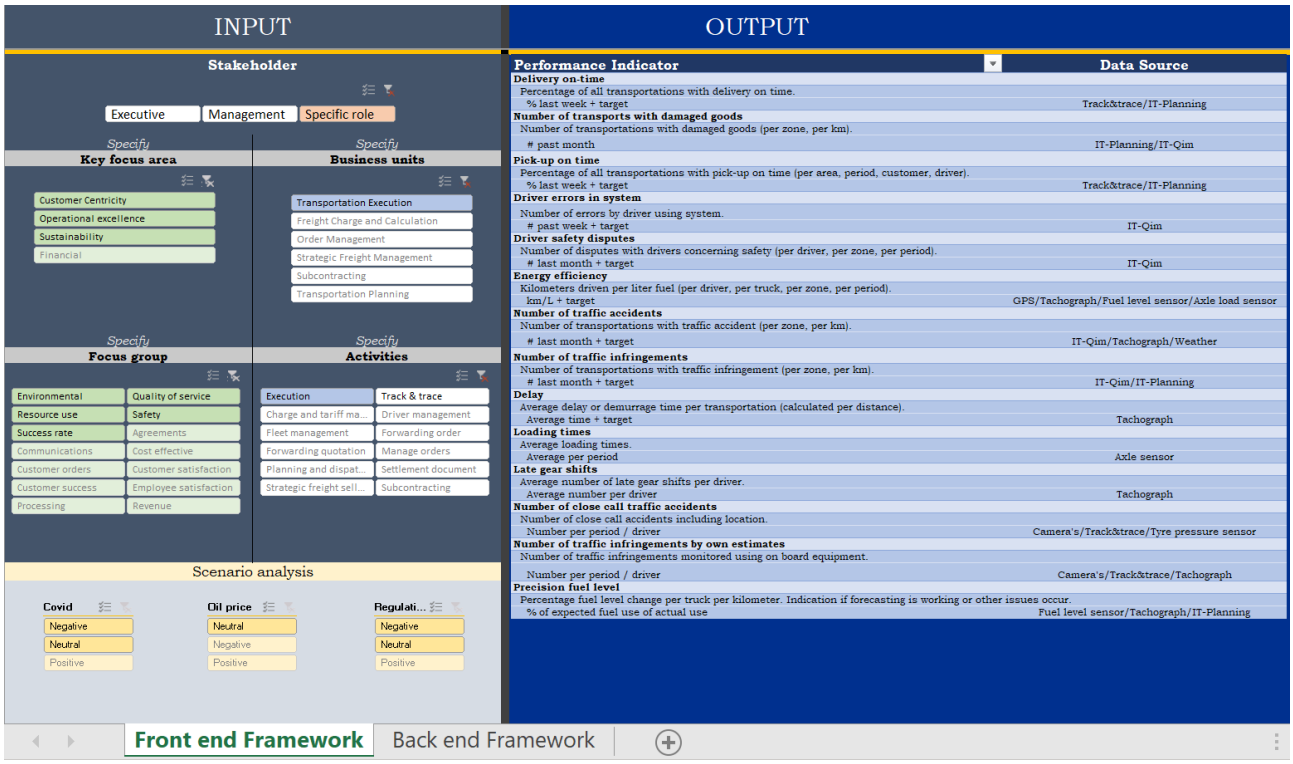

Figure E.1: Overview of framework

Specification of Excel file

The excel file uses a pivot table to report the performance indicators. In Figure E.2, the back end of the framework is shown. Each row indicates a possible performance indicator. The columns specify all characteristics of the performance indicator.

Key focus area	Focus group	Performance indicator	Unit	Definition	User	Business unit	Activity	Increased oil price	Covid crisis	Increased transport regulations	Data source (summary)	Information needed
Key focus are	Focus group	Performance indicator	Unit	Definition	User	Business unit	Activity	Oil price	Covid	Regulations	Data source	Information
Operational excellenc	Success rate	**Freight agreement to success rate**	%/last year + previous years + target	Percentage of agreement/contract requests which are successful and lead to Freight Agreement.	Management	Strategic Freight Management	Strategic freight selling	Neutral	Negative	Neutral	IT-Customer	Number of Freight Agreement requests [IT-Customer], Number of Freight Agreements [IT-Customer]
Operational excellenc	Success rate	**Freight agreement to success rate**	%/last month + target	Percentage of agreement/contract requests which are successful and lead to Freight Agreement.	Role specific	Strategic Freight Management	Strategic freight selling	Neutral	Negative	Neutral	IT-Customer	Number of Freight Agreement requests [IT-Customer], Number of Freight Agreements [IT-Customer]
Operational excellenc	Success rate	**Order RFQ acceptance rate**	%/month + previous months + target	Percentage of Forwarding Order requests which are successful and lead to Forwarding Order.	Management	Order Management	Forwarding quotation	Neutral	Negative	Neutral	IT-Customer	Number of Forwarding Order requests received [IT-Customer], Forwarding Orders in system [IT-Customer].
Operational excellenc	Success rate	**Order RFQ acceptance rate**	%/last month + target	Percentage of Forwarding Order requests which are successful and lead to Forwarding Order.	Role specific	Order Management	Forwarding quotation	Neutral	Negative	Neutral	IT-Customer	Number of Forwarding Order requests received [IT-Customer], Forwarding Orders in system [IT-Customer].
Operational excellenc	Success rate	**Subcontracting issues**	#/last month + previous months + target	Number of issues with subcontracting party.	Management	Subcontracting	Subcontracting	Negative	Neutral	Negative	IT-Supplier	Issues received from subcontracting party [IT-Supplier].
Operational excellenc	Success rate	**Subcontracting issues**	#/per party	Number of issues with subcontracting party.	Role specific	Subcontracting	Subcontracting	Negative	Neutral	Negative	IT-Supplier	Issues received from subcontracting party [IT-Supplier].
Operational excellenc	Success rate	**Number of orders import**	%/last month + target	Number of orders import (for driver to get back).	Management	Order Management	Forwarding order	Neutral	Neutral	Neutral	IT-Planning	Destination of order [IT-Planning], Pick-up location of order [IT-Planning].
Operational excellenc	Success rate	**Number of orders import**	Planned % + target	Number of orders import (for driver to get back).	Role specific	Order Management	Forwarding order	Neutral	Neutral	Neutral	IT-Planning	Destination of order [IT-Planning], Pick-up location of order [IT-Planning].
Operational excellenc	Resource use	**Utilization of trucks**	% used in past month + previous months	Total time vehicle is in use compared to total time vehicle is available (per period).	Management	Transportation Planning	Fleet management	Neutral	Neutral	Neutral	IT-Planning/Tachograph	Number of trucks [IT-Planning], Status of truck [Tachograph]
Operational excellenc	Resource use	**Utilization of trucks**	% used in past month + target	Total time vehicle is in use compared to total time vehicle is available (per period).	Role specific	Transportation Planning	Fleet management	Neutral	Neutral	Neutral	IT-Planning/Tachograph	Number of trucks [IT-Planning], Status of truck [Tachograph]
Operational excellenc	Resource use	**Utilization of trailers**	% used in past month + previous months	Total time trailer is in use compared to total time trailer is available (per period).	Management	Transportation Planning	Fleet management	Neutral	Neutral	Neutral	IT-Planning/Tachograph	Number of trailers [IT-Planning], Status of trailer [Tachograph]
Operational excellenc	Resource use	**Utilization of trailers**	% used in past month + target	Total time trailer is in use compared to total time trailer is available (per period).	Role specific	Transportation Planning	Fleet management	Neutral	Neutral	Neutral	IT-Planning/Tachograph	Number of trailers [IT-Planning], Status of trailer [Tachograph]
Operational excellenc	Resource use	**Unmoved trucks**	# per day last months	Trucks that have not moved in the past 24 hours.	Management	Transportation Planning	Planning and dispatching	Neutral	Neutral	Neutral	Tachograph	Status of truck past 24 hours [Tachograph]
Operational excellenc	Resource use	**Unmoved trucks**	#/last day + target	Trucks that have not moved in the past 24 hours.	Role specific	Transportation Planning	Planning and dispatching	Neutral	Neutral	Neutral	Tachograph	Status of truck past 24 hours [Tachograph]
Operational excellenc	Resource use	**Unmoved trailers**	# per day last months	Trailers that have not been used in the past 24 hours.	Management	Transportation Planning	Planning and dispatching	Neutral	Neutral	Neutral	Tachograph	Status of trailer past 24 hours [Tachograph]
Operational excellenc	Resource use	**Unmoved trailers**	#/last day + target	Trailers that have not been used in the past 24 hours.	Role specific	Transportation Planning	Planning and dispatching	Neutral	Neutral	Neutral	Tachograph	Status of trailer past 24 hours [Tachograph]
Operational excellenc	Resource use	**Waiting time**	Average time last week + previous months	Waiting time per vehicle	Management	Transportation Planning	Planning and dispatching	Positive	Negative	Negative	Tachograph	Average time vehicle is in waiting mode [Tachograph].
Operational excellenc	Resource use	**Waiting time**	Average time last week + target	Waiting time per vehicle	Role specific	Transportation Planning	Planning and dispatching	Positive	Negative	Negative	Tachograph	Average time vehicle is in waiting mode

Figure E.2: Information sheet framework

In Figure E.3, a screenshot of the sources is shown. During the study, this sheet provided an overview of the performance indicators and references in literature, as well as in interviews. The sheet is used to identify sources and is not actively used in the framework.

Business Area	KPI owner	Performance Indicator	Detailed description	(García-Arca et al., 2018) A	(Kaslingam, 1998) B	(Tjahjono et al., 2017) C	(Van Amstel & D'Hert, 1996) D	(Bask et al., 2018) E	(Shuckan, 2020) F	(Freight Best Practice, 2010) G	(Coyle et al., 1992) H	(Ruskton & Oxley, 1991) I	(Christopher & Yallop, 1990) J	SAP: Tom Hornstra P	(Johanna Szatmari (13-8-2020) K	Webevers (7-9-2020) L	Gineta (21-8-2020) M
Planning and Dispatching	Transportation planner	**Distance travelled after delivery**	Distance truck travels after delivery location (per zone).	●		●	●		●					●		●	●
Planning and Dispatching	Transportation planner	**Distance traveled to pick-up**	Distance truck travels to pick-up location (per zone).	●		●	●		●					●		●	●
Track and tracing	Transportation manager	**Number of damaged goods**	Number of transportations with damaged goods (per zone, per km).	●	●	●	●	●		●		●		●			●
Track and tracing	Transportation manager	**Number of traffic infringements**	Number of transportations with traffic infringement (per zone, per km).	●	●	●	●	●		●				●	●		●
Track and tracing	Transportation manager	**Number of traffic accidents**	Number of transportations with traffic accident (per zone, per km).	●	●	●	●	●		●				●	●		●
Fleet Management	Capacity planner	**Number of failed/overdue safety inspections**	Number of failed/overdue safety inspections (per period).							●				●	●		●
Track and tracing	Dispatcher	**Delay/demurrage**	Average delay or demurrage time per transportation (calculated per distance).	●	●						●	●		●			●
Track and tracing	Dispatcher	**Pick-up on time**	Percentage of all transportations with pick-up on time.	●	●	●		●			●	●		●	●		●
Track and tracing	Dispatcher	**Deliveries on time**	Percentage of all transportations with delivery on time.	●	●	●		●		●	●	●		●	●		●
	Transportation manager	**Reaction time to disturbances**	Average time for management to react to disturbance.		●	●		●			●	●		●	●		●
Track and tracing	Process administrator	**Errors in tracing**	Number of issues concerning track and trace (per zone, per truck, per period).	●		●		●			●	●		●			●
Track and tracing	Transportation manager	**Number of delivery point problems**	Number of issues at delivery points (per customer, per zone).	●										●		●	●
Track and tracing	Dispatcher	**Consistency of transit time**	Considering an average travel time per kilometer, what percentage of transportations is carried out within a feasible distribution)	●	●	●	●	●			●	●		●			●

Figure E.3: Literature sources per performance indicator

F

Framework results

This appendix provides an overview of the results. Results are produced using the framework and a selection of results is discussed. The results for executives, 14 focus groups and 12 activities are given.

Performance indicators for executive user

Booked order value	
Total value of Forwarding Orders.	
€	IT-Customer
Expected growth in freight agreements	
Expected number of Freight Agreements to be settled in the coming period.	
% expected next year	IT-Forecasting
Forewarding order forecast	
Expected number of Forwarding Orders to be handled the coming period.	
# next period + previous months	IT-Forecasting
Number of order RFQ received	
Number of customer Forwarding Orders received (per customer, per zone, per time, per ...).	
# last week + previous months	IT-Customer
Customer retention rate	
Percentage of customers who have done business before, compared to new customers.	
%	IT-Customer
Delivery on-time	
Percentage of all transportations with delivery on time.	
% last week + target	Track&trace/IT-Planning
Commercial distance	
Distance travelled paid by customer.	
Percentage paid/travelled + previous months	IT-Planning
Driver satisfaction	
Grade given by driver to determine satisfaction.	
grade + previous months	Survey
Customer satisfaction grade	
Number to be calculated using customer input.	
grade	Survey
Net Promoter Score	
The net promoter score is a score given by clients to determine whether they would promote the companies products.	
Score	Survey

Figure F.1: Executive relevant performance indicators

Performance indicators for management used per focus group

Expected growth in freight agreements	
Expected number of Freight Agreements to be settled in the coming period.	
% expected next month	IT-Forecasting
Number of active freight agreements	
Total number of Freight Agreements settled in period.	
# + last week + last month	IT-Customer
Number of agreement request received	
Number of agreement/contract requests received.	
# last week + previous months	IT-Customer

Figure F.2: Management relevant performance indicators: Agreements

Attitude of management	
Experience of management in the forming of the Freight Agreement. Customer number to indicate how contact, negotiations, documents are experienced.	
grade + previous months	Survey
Disputes regarding settlements	
Number of disputes with customer regarding settlement documents.	
Average % + previous months	IT-Customer

Figure F.3: Management relevant performance indicators: Communications

Driver cost	
Driver cost, distance travelled/number of trips.	
€/km	IT-Finance/Tachograph/IT-Planning
Maintenance cost	
Maintenance cost planned/unplanned, distance travelled/number of trips (per truck, area, period).	
Cost/km + previous months	IT-Finance/Tachograph/IT-Planning
Cost of maintenance parts	
Average prices per component of maintenance.	
Prices	Pricing
Cost per truck km (running cost)	
Driver costs, fuel costs, maintenance cost planned/ unplanned, distance travelled/number of trips.	
€/km	IT-Finance/Tachograph/IT-Planning
Drive time analysis	
Grade calculated using input from Tachograph.	
Grade per driver	Tachograph
Ratio budget cost/actual cost	
Planned cost in budget compared to actual cost made	
% last month + previous months	IT-Finance

Figure F.4: Management relevant performance indicators: Cost effective

Forewarding order forecast	
Expected number of Forwarding Orders to be handled the coming period.	
# next period	IT-Forecasting
Number of order RFQ received	
Number of customer Forwarding Orders received (per customer, per zone, per time, per ...).	
# last week + previous months	IT-Customer

Figure F.5: Management relevant performance indicators: Customer orders

Brand experience	
Grade given to the experience of the brand (company).	
grade	Survey
Customer satisfaction grade	
Number to be calculated using customer input.	
grade + previous months	Survey
Net Promoter Score	
The net promoter score is a score given by clients to determine whether they would promote the companies products.	
Score	Survey

Figure F.6: Management relevant performance indicators: Customer satisfaction

Alignment with subcontracting party	
Considering a set of KPI's, are subcontracting party goals aligned (percentage).	
Average grade	IT-Supplier/Survey
Customer retention rate	
Percentage of customers who have done business before, compared to new customers.	
%	IT-Customer
Flexibility of pricing	
Difference between actual cost made and the price for customer.	
Average difference past weeks	IT-Finance
Freight agreements with special request	
Percentage of Freight Agreements which have a special component.	
% of agreements this year with special request	IT-Customer
Orders handled with special request	
Number of Forwarding Orders with a special component (rush, no-go zone..)	
% of orders this year	IT-Customer
Perfect order rate	
(Total number of customer Forwarding Orders received - Forwarding Orders unable to handle)/(total number of Forwarding Orders).	
%/last week + previous months	IT-Customer

Figure F.7: Management relevant performance indicators: Customer success

Driver satisfaction	
Grade given by driver to determine satisfaction.	
grade + target	Survey
Late dispatch or return	
Number of drivers back from work later than expected.	
% + previous months	IT-Planning/Track&trace

Figure F.8: Management relevant performance indicators: Employee satisfaction

Emission per truck	
Average emission per truck per kilometer driven.	
Average CO2/truck/km + previous months	IoT sensor/Tachograph
Truck label	
Number of trucks per label and exploitations	
Distribution of labels	IT-Planning

Figure F.9: Management relevant performance indicators: Environmental

Customer order cycle time	
Time between a Order RFQ and customer confirmation of Forwarding Order.	
Average time past week + previous months	IT-Customer
Planning time per order	
Time between Forwarding Order in system and planned to Freight Order.	
Average time past week + previous months	IT-Customer/IT-Planning
Time to reach agreement	
Time between receiving a request and finalizing the Freight Agreement (per customer/area).	
Average time past week + previous months	IT-Customer

Figure F.10: Management relevant performance indicators: Processing times

Consistency of transit time	
Considering an average travel time per kilometer, what percentage of transportations is carried out within a feasible distribution).	
SD past week + previous months	IT-Planning
Delivery on-time	
Percentage of all transportations with delivery on time.	
% last week + target	Track&trace/IT-Planning
Freight bill accuracy	
Average difference between quotation in Forwarding Order and final invoice in percentage.	
% difference last week + previous months	IT-Customer
Number of transports with damaged goods	
Number of transportations with damaged goods (per zone, per km).	
Average percentage + previous months	IT-Planning/IT-Customer
Pick-up on time	
Percentage of all transportations with pick-up on time (per area, period, customer, driver).	
% last week + target	Track&trace/IT-Planning
Time between POD and invoice	
Average time between receiving Proof of Delivery and the invoice being sent to the customer.	
Average time + previous months	IT-Customer
Traceability	
Percentage of tracking events completed without issue.	
% without issue past week + previous months	Track&trace
Delay	
Average delay or demurrage time per transportation (calculated per distance).	
Average time + previous months	Tachograph
Expected late deliveries	
Number of trucks that have an expected arrival time later than planned.	
#	Speed limits/Tachograph/Weather/Traffic/Track&trace
Trailer condition issues	
Percentage of goods with transport that needs temperature or humidity control that are successful.	
Percentage succesful	Humidity sensor/Temperature sensor

Figure F.11: Management relevant performance indicators: Quality of service

Commercial distance	
Distance travelled paid by customer (per customer, zone, period).	
Percentage paid/travelled + previous months	IT-Planning/IT-Customer
Disblance to fleet distribution	
Total percentage of destinations within no-go zones (per area, period).	
% past week + previous months	IT-Planning/GPS
Empty leg distance	
Percentage of total driven distance with no freight compared to total distance driven (per zone, per period).	
% over last month + previous months	Tachograph/IT-Planning
Energy efficiency	
Kilometers driven per liter fuel (per driver, per truck, per zone, per period).	
km/L + previous months	GPS/Tachograph/Fuel level sensor/Axle load sensor
Transit speed	
Actual vs planned kilometers travelled per day.	
%/last week + previous months	Tachograph/IT-Planning
Unmoved trailers	
Trailers that have not been used in the past 24 hours.	
# per day last months	Tachograph/IT-Planning
Unmoved trucks	
Trucks that have not moved in the past 24 hours.	
# per day last months	Tachograph/IT-Planning
Utilization of trailers	
Total time trailer is in use compared to total time trailer is available (per period).	
% used in past month + previous months	IT-Planning/Tachograph
Utilization of trucks	
Total time vehicle is in use compared to total time vehicle is available (per period).	
% used in past month + previous months	IT-Planning/Tachograph
Waiting time	
Waiting time per vehicle	
Average time last week + previous months	Tachograph/IT-Planning
Driver efficiency performance	
Performance rarting for shifting, acceleration, cruise control, braking.	
Average rating	Tachograph/Axle load sensor
Energy use humidity	
Energy use for humidity control.	
kWh	IoT sensor
Energy use temperature	
Energy use for temperature control.	
kWh	IoT sensor
Utilization of drivers	
Number of drivers available and number of drivers on commercial duty.	
% last week + target	IT-HR/IT-Planning

Figure F.12: Management relevant performance indicators: Resource use

Booked order value	
Total value of Forwarding Orders.	
€	IT-Customer
Business share per customer	
Average customer profit as part of total profit (per customer).	
€	IT-Finance
Planned freight cost	
Expected cost of transportation per order.	
€ + next month	IT-Forecasting
Profitability per order	
Percentage or number of profit per order.	
Average percentage + previous months	IT-Finance
Salary forecast	
Expected salary costs.	
Percentage growth	IT-HR
Value change trailer	
Change in pice of trailers.	
Average price per period	IT-Finance
Value change truck	
Change in price of trucks.	
Average price per period	IT-Finance

Figure F.13: Management relevant performance indicators: Revenue

Average age of truck	
Average age of trucks (per area).	
years	IT-Planning
Driver safety disputes	
Number of disputes with drivers concerning safety (per driver, per zone, per period).	
# last month + previous months	IT-Qim
Number of breakdowns	
Number of trucks breakdowns (per period, per zone).	
#	IT-Qim
Number of failed/overdue safety inspection	
Number of failed/overdue safety inspections (per period).	
# last month + previous months	IT-Planning
Number of traffic accidents	
Number of transportations with traffic accident (per zone, per km).	
# last month + previous months	IT-Qim/Tachograph/Weather
Number of traffic infringements	
Number of transportations with traffic infringement (per zone, per km).	
# last month + previous months	IT-Qim/IT-Planning
Truck exploitation	
Truck kilometers driven per truck (extra quotation per zone due to different terrain).	
Average km + previous months	Tachograph/Weather

Figure F.14: Management relevant performance indicators: Safety

Freight agreement to success rate	
Percentage of agreement/contract requests which are succesull and lead to Freight Agreement.	
%/last year + previous years + target	IT-Customer
Number of orders import	
Number of orders import (for driver to get back).	
%/last month + target	IT-Planning/IT-Customer
Order RFQ acceptance rate	
Percentage of Forwarding Order requests which are succesful and lead to Forwarding Order.	
%/month + previous months + target	IT-Customer
Subcontracting issues	
Number of issues with subcontracting party.	
#/last month + previous months + target	IT-Supplier
Forecasting reliability	
Difference between forecasts and real costs, time and grades.	
Percentage	IT-Forecasting

Figure F.15: Management relevant performance indicators: Success rates

Performance indicators for specific role users per activity

Flexibility of pricing	
Difference between actual cost made and the price for customer.	
Average difference past weeks	IT-Finance
Freight bill accuracy	
Average difference between quotation in Forwarding Order and final invoice in percentage.	
% last week	IT-Customer
Time between POD and invoice	
Average time between receiving Proof of Delivery and the invoice being sent to the customer.	
Average time + target	IT-Customer
Terms of payment	
Number of issues concerning the term of payment.	
#	IT-Customer

Figure F.16: Relevant performance indicators for specific role: Charge and tariff management

Customer acceptance of driver	
Customers who have issue with driver (per zone).	
#	IT-Qim
Lack of driver	
More demand for drivers than drivers available.	
# of issues last month	IT-Planning/IT-HR
Driver cost	
Driver cost, distance travelled/number of trips.	
Planned maintenance cost/truck	IT-Finance/Tachograph/IT-Planning
Driver satisfaction	
Grade given by driver to determine satisfaction.	
grade	Survey
Driver availability	
Percentage of drivers available per period.	
Percentage	IT-HR
Driver efficiency performance	
Performance rarting for shifting, acceleration, cruise control, braking.	
Rating per driver	Tachograph/Axle load sensor
Utilization of drivers	
Number of drivers available and number of drivers on commercial duty.	
Current %	IT-HR/IT-Planning

Figure F.17: Relevant performance indicators for specific role: Driver management

Delivery on-time	
Percentage of all transportations with delivery on time.	
% last week + target	Track&trace/IT-Planning
Number of transports with damaged goods	
Number of transportations with damaged goods (per zone, per km).	
# past month	IT-Planning/IT-Qim
Pick-up on time	
Percentage of all transportations with pick-up on time (per area, period, customer, driver).	
% last week + target	Track&trace/IT-Planning
Driver errors in system	
Number of errors by driver using system.	
# past week + target	IT-Qim
Driver safety disputes	
Number of disputes with drivers concerning safety (per driver, per zone, per period).	
# last month + target	IT-Qim
Energy efficiency	
Kilometers driven per liter fuel (per driver, per truck, per zone, per period).	
km/L + target	GPS/Tachograph/Fuel level sensor/Axle load sensor
Number of traffic accidents	
Number of transportations with traffic accident (per zone, per km).	
# last month + target	IT-Qim/Tachograph/Weather
Number of traffic infringements	
Number of transportations with traffic infringement (per zone, per km).	
# last month + target	IT-Qim/IT-Planning
Delay	
Average delay or demurrage time per transportation (calculated per distance).	
Average time + target	Tachograph
Driver performance in traffic	
Grade given to determine driver performance in traffic.	
grade	Tachograph/Traffic
Late gear shifts	
Average number of late gear shifts per driver.	
Average number per driver	Tachograph
Loading times	
Average loading times.	
Average per period	Axle sensor
Number of close call traffic accidents	
Number of close call accidents including location.	
Number per period / driver	Camera's/Track&trace/Tyre pressure sensor
Number of traffic infringements by own estimates	
Number of traffic infringements monitored using on board equipment.	
Number per period / driver	Camera's/Track&trace/Tachograph
Precision fuel level	
Percentage fuel level change per truck per kilometer. Indication if forecasting is working or other issues occur.	
% of expected fuel use of actual use	Fuel level sensor/Tachograph/IT-Planning

Figure F.18: Relevant performance indicators for specific role: Execution

Condition of trailer	
Issues due to condition of trailer (unclean, temperature control, ...).	
# last month	IT-Qim
Lack of vehicle	
Demand more for vehicle than vehicles available.	
# of issues last month	IT-Planning
Maintenance cost	
Maintenance cost planned/unplanned, distance travelled/number of trips (per truck, area, period).	
Planned maintenance cost/km	IT-Finance/Tachograph/IT-Planning
Number of breakdowns	
Number of trucks breakdowns (per period, per zone).	
#	IT-Qim
Number of failed/overdue safety inspection	
Number of failed/overdue safety inspections (per period).	
# last month + target	IT-Planning
Utilization of trailers	
Total time trailer is in use compared to total time trailer is available (per period).	
% used in past month + target	IT-Planning/Tachograph
Utilization of trucks	
Total time vehicle is in use compared to total time vehicle is available (per period).	
% used in past month + target	IT-Planning/Tachograph
Attemps at theft	
Number of attempts to steal from truck or trailer (per region).	
#	IT-Qim/Camera's
Downtime per truck	
Average downtime per truck.	
Number per truck	IT-Planning
Number of tyre pressure issues	
Number of issues concerning tyre pressure.	
Number per period / truck	Tyre pressure sensor
Trailer condition issues	
Percentage of goods with transport that needs temperature or humidity control that are successful.	
Percentage succesful	Humidity sensor/Temperature sensor
Vehicle replacements	
Number of vehicles replaced in period of time.	
Number per period	IT-Planning

Figure F.19: Relevant performance indicators for specific role: Fleet management

Perfect order rate	
(Total number of customer Forwarding Orders received - Forwarding Orders unable to handle)/(total number of Forwarding Orders).	
%/last week	IT-Customer
Number of orders import	
Number of orders import (for driver to get back).	
Planned % + target	IT-Planning/IT-Customer

Figure F.20: Relevant performance indicators for specific role: Forwarding orders

Profitability per order	
Percentage or number of profit per order.	
Average percentage + previous months	IT-Finance
Order RFQ acceptance rate	
Percentage of Forwarding Order requests which are succesful and lead to Forwarding Order.	
%/last month + target	IT-Customer

Figure F.21: Relevant performance indicators for specific role: Forwarding quotations

Number of order RFQ received	
Number of customer Forwarding Orders received (per customer, per zone, per time, per ...).	
# last week + target	IT-Customer
Orders handled with special request	
Number of Forwarding Orders with a special component (rush, no-go zone..)	
% of orders this month	IT-Customer
Customer order cycle time	
Time between a Order RFQ and customer confirmation of Forwarding Order.	
Average time past month + target	IT-Customer
Forwarding order forecast	
Expected number of Forwarding Orders to be handled the coming period.	
# next week	IT-Forecasting
Time between customer contact and response	
Average time between a customer contact and response.	
Duration	IT-Customer

Figure F.22: Relevant performance indicators for specific role: Manage orders

Disblance to fleet distribution	
Total planned percentage of destinations within no-go zones.	
% planned in no-go zone + target	IT-Planning/GPS
Empty leg distance	
Percentage of total driven distance with no freight compared to total distance driven (per zone, per period).	
% over last week + previous weeks	Tachograph/IT-Planning
Late dispatch or return	
Number of drivers back from work later than expected.	
% last week + target	IT-Planning/Track&trace
Planning time per order	
Time between Forwarding Order in system and planned to Freight Order.	
Average time past month + target	IT-Customer/IT-Planning
Transit speed	
Actual vs planned kilometers travelled per day.	
%/last week + target	Tachograph/IT-Planning
Unmoved trailers	
Trailers that have not been used in the past 24 hours.	
#/last day + target	Tachograph/IT-Planning
Unmoved trucks	
Trucks that have not moved in the past 24 hours.	
#/last day + target	Tachograph/IT-Planning
Waiting time	
Waiting time per vehicle	
Average time last week + target	Tachograph/IT-Planning
Average prive per toll route	
Average price per route.	
Prices	Toll
Realiability of road	
Percentage of planned routes through critical road area.	
Percentage	Road /IT-Planning
Traffic impact	
Percentage of planned routes through critical traffic area.	
Percentage	Traffic /IT-Planning
Weather impact	
Percentage of planned routes through critical weather area.	
Percentage	Weather /IT-Planning

Figure F.23: Relevant performance indicators for specific role: Planning and dispatching

Disputes regarding settlements	
Number of disputes with customer regarding settlement documents.	
# last week	IT-Customer

Figure F.24: Relevant performance indicators for specific role: Settlement documents

Number of active freight agreements	
Total number of Freight Agreements settled in period.	
# + last week + last month	IT-Customer
Number of agreement request received	
Number of agreement/contract requests received.	
# last week + target	IT-Customer
Attitude of management	
Experience of management in the forming of the Freight Agreement. Customer number to indicate how contact, negotiations, documents are experienced.	
grade + issue areas	Survey
Freight agreements with special request	
Percentage of Freight Agreements which have a special component.	
% of agreements this year with special request	IT-Customer
Freight agreement to success rate	
Percentage of agreement/contract requests which are succesull and lead to Freight Agreement.	
%/last month + target	IT-Customer
Time to reach agreement	
Time between receiving a request and finalizing the Freight Agreement (per customer/area).	
Average time past month + target	IT-Customer
Net Promoter Score	
The net promoter score is a score given by clients to determine whether they would promote the companies products.	
Score	Survey

Figure F.25: Relevant performance indicators for specific role: Strategic freight selling

Alignment with subcontracting party	
Considering a set of KPI's, are subcontracting party goals aligned (percentage).	
Average grade	IT-Supplier/Survey
Delay at transshipment location	
Average delay per transshipment location.	
time	Tachograph
Subcontracting issues	
Number of issues with subcontracting party.	
#/per party	IT-Supplier
Change in subcontracting alignment	
Difference in grades given to subcontracting parties.	
Grade change	IT-Supplier

Figure F.26: Relevant performance indicators for specific role: Subcontracting

Consistency of transit time	
Considering an average travel time per kilometer, what percentage of transportations is carried out within a feasible distribution).	
SD past week + target	IT-Planning
Traceability	
Percentage of tracking events completed without issue.	
% last week + target	Track&trace
Emission per truck	
Average emission per truck per kilometer driven.	
CO2/truck/km + target	IoT sensor/Tachograph
Truck exploitation	
Truck kilometers driven per truck (extra quotation per zone due to different terrain).	
Average km	Tachograph/Weather
Expected late deliveries	
Number of trucks that have an expected arrival time later than planned.	
#	Speed limits/Tachograph/Weather/Traffic/Track&trace

Figure F.27: Relevant performance indicators for specific role: Track & trace