MSc. Thesis: Different Levels, same Goals: How to enable members of the organization to harmonise Alignment

Christos Topalidis
September 2020

ProRail

TU Delft
Delft University of Technology

Table of Contents

List of Figures

List of Tables

List of Abbreviations

AM: The Asset Management Department of ProRail
CM: The Capacity Management department of ProRail
IGP: Sub-division of AM. Engaged in big projects as the connecting link between AM and Projects
MC: Management Concession
MP: Management Plan
PHS: High Frequency Train Transport
PMS: Performance Management System

Colophon

Title: Interrelationships in ProRail's Performance Agreements

Student: Christos Topalidis

Student Number: 4463099

Faculty: Civil Engineering

Master Program: Construction Management and Engineering

Committee Members:

- Prof.dr.ir. Marcel J.C.M. Hertogh, Committee Chair, TU Delft, Civil Engineering Faculty
- Prof.Dr. Hans Bakker, Acting Committee Chair, TU Delft, Civil Engineering Faculty
- Dr. ir. Martine van den Boomen, First supervisor (Until Mid-Term Meeting), TU Delft, Civil Engineering Faculty
- Dr. ir. Bauke Steenhuisen, First supervisor (Mid-Term Meeting and onwards), TU Delft, Technical Management and Policy Faculty
- Ing. Judith de Boer, Company Supervisor, ProRail

Delft, Kingdom of the Netherlands, September 2020

Acknowledgements

This thesis represents the last step in obtaining my Masters in Construction Management and Engineering. While completing the courses of the program was mostly a personal effort, this document would not have been possible, if not for the help of some exceptional individuals.

First of all, I would like to thank each member of my committee individually. I would like to thank Dr Hertogh for his contributions as Chair of the committee. Thank you for your understanding and your advice on the milestones of this journey.

Furthermore, I would like to thank Dr. van den Boomen. It was she, that gave me this opportunity when I first stepped into her office in my search for a thesis project. Thank you for your time, advice and feedback which were valuable to increase my academic knowledge.

The advice and guidance of Dr Steenhuisen were of paramount importance. Thank you Bauke for your time and for steering me in the right direction during this endeavour. Your time and effort had a high impact on completing this thesis.

This project required the contribution of several people for the survey of the first part. Judith de Boer not only introduced me in the exciting world of Dutch rail, but she also introduced me to highly experienced individuals who provided me with practical knowledge. Thank you, Judith, for your time, effort, advice, and for motivating me along the way.

Last but not least, I would like to thank the 26 individuals who invested their time in my survey and all of the ProRail managers, who advised me in separate instances during my time in the organization. A special thanks also to Dr Bakker who, due to unforeseen circumstances. had to function as the Acting Chair of my committee.

However, all of my efforts would not have been possible without the support and understanding of my family and friends. I would like to thank my father, Anastasios Topalidis and my mother, Demetra Papatheodosiou, for their unwavering faith and support in me as well as my dear friends both in Greece and in the Netherlands who were with me all of this time.

Christos Topalidis,

Delft, Kingdom of the Netherlands, September 2020

Executive Summary

Introduction

The Dutch railway system is the most intensively used in Europe. This fact, although fascinating, it creates complexity and many interfaces in its operation. The performance of such a system is governed by many aspects and involves many parties. Furthermore, these aspects and parties will have different needs and perceive performance in a different way.

In order for the system to operate as smooth as possible, performance agreements are being made in different organizational levels. These agreements guide ProRail on how to manage the railway system and what it should achieve regarding several performance aspects.

However, the railway system, as well as ProRail, are not single entities. They are comprised of several organizational levels. Each of these levels has its own needs and peculiarities, which in theory should be represented by their prescribed performance requirements.

This creates a coupling between the performance agreements. They should be suitable for each organizational level while at the same time connected. These interrelationships can provide an overview of how the system performs and where adjustments should be made. Nevertheless, if their coupling is too strong, the organization can become cumbersome and stagnate. On the other hand, if their coupling is too relaxed, there will be no guidance and connection to what ProRail wants to achieve regarding the performance of the system.

This thesis would like to examine the interrelationships between three performance agreements of ProRail. The Management Concession, Plan and its Performance Management System. The examination is focused on how well these agreements are coupled regarding different performance areas. Its proposed advice is a framework which can potentially alleviate the weaknesses described above.

Its purpose is to strengthen the coupling of performance agreements while at the same time, leave enough room for adjustments and innovation. Moreover, the structure of the framework intends to minimize shielding behaviours by providing a process-based approach in the communication of performance requirements.

In order to achieve its goal, the thesis formulates one Main Research Question with three Sub Research Question to help build its line of reasoning. The following list presents these questions to the reader.

- ***MRQ:*** *How to improve the current alignment of Performance Indicators in the Management Concession, Management Plan and Performance Management System of ProRail?*
    - **S.RQ1:** *What are the shared and non-shared performance areas the internal stakeholders of ProRail find important?*
    - **S.RQ2:**
        a. *What is the current state of alignment between the Management Concession, Plan and Performance Management System?*
        b. *What potential problems can misalignment create?*
    - **S.QR3:** *How can the current alignment be improved?*

Research Methods

The performance of a railway system can have many aspects. This is the reason the first S.RQ is created. An answer to it can be used as a *"compass"* to scope down shared and non-shared performance areas for further analysis. The answer to this question will also be used as a tool to make hypothesises about the analysis of the performance agreements.

Shared areas are expected to be more well-aligned than non-shared ones. The reverse may be grounds for further consideration on how to communicate these areas to different levels. Therefore, this thesis will attempt to identify these performance areas by making use of the Q-Method.

For the second S.RQ, the author examines the three performance agreements mentioned above. The focus of this examination is the results of the Q-Method. Through a review of the MC, MP and the PMS, the author intends to showcase the coupling of performance areas between these agreements. This examination is expected to make apparent a line of reasoning between the agreements and their performance standards. This coupling should be evident both from a top-down and bottom-up perspective.

To provide an answer to the last S.RQ, the author uses literature over performance management and the implementation of PMSs. Through this review, the author proposes the implementation of a process-based framework for the production of performance requirements. Furthermore, instead of using one central dashboard for them, the author advises the use of three separate tools to represent the different organizational levels better

Results

The implementation of Q-Method produced three distinct schools of thought regarding performance. The first perspective is oriented towards the safety of the railway system while the second and the third regard its reliability as the most important performance area. Moreover, the method showcased that there exist three performance areas where the participants agreed over their importance. These areas revolve around environmental sustainability, limiting the nuisance of the surrounding environment and the physical connection of freight inside the system.

The examination of the performance agreements focused itself on these areas. The expectation was that the requirements of the shared areas would have a much stronger coupling amongst the performance agreements. After analysing each one separately, it is concluded that *"Safety"* and *"Reliability"* present two excellent examples of aligned performance areas. There is a solid line of reasoning in their performance requirements in all of the agreements. The fact that the non-shared areas were very well aligned was surprising, and the opposite of what the author hypothesized.

Although all of the agreements include *"Sustainability"* in their clauses, they do not provide a structure which makes a connection between their performance requirements. In contrast with the other performance areas analysed in this manner, this one does not provide clear goals and standards on how to measure them. The way *"Sustainability"* is structured in the agreements could invoke the weaknesses mentioned in the above paragraphs. This is why it is used as an example performance area to showcase the proposed framework.

Conclusions

This thesis concludes by presenting the principles of this framework to the reader. Instead of a purely top-down approach, it is advised to include process-based elements in the creation of performance metrics.

Furthermore, the creation of three separate dashboards is advised to make clear for what each organizational level should strive for. The three discussion tables created with such an approach involve the Strategic, Tactical and Operational tables. The dashboards follow the same designation. In this manner, ProRail can connect short and long term goals.

The process-based nature empowers the low levels of the organization to be involved in the procedure of producing performance metrics. This will minimize the chance of shielding against them. The discussions of each round connect these metrics making their tracking by both top and low management easier and apparent.

1 Research Outline

Chapter 1 introduces the reader to the outline of this thesis. Section 1.1 presents initial information over the performance agreements of the Dutch railway system. Moreover, the section summarises how the agreements and ProRail itself is structured,

Section 1.2 elaborates on how the performance agreements are interrelated with each other. It also provides information over possible problems a de-coupling of these relations can entail for ProRail and the system itself. In Section 1.3, the reader can find information over the Amsterdam-Eindhoven corridor.

This introduction attempts to connect the content of the previous section with a part of a system. This connection intends to showcase how the agreements can influence the system or parts of it. A visualization of what was described in Sections 1.1 and 1.2 is also given.

Section 1.4 presents the research questions of this project. One main research question and three sub-research questions are formulated. The section elaborates on the research objectives and the structure of this report. Last but not least, Section 1.5 showcases the methods which are going to be used in answering the research question.

1.1 Dutch Railway Performance Agreements

The Dutch railway system is the most intensively used in Europe (CBS, 2009). For such a system, to perform adequately, agreements must be made for its performance standards. These agreements start with two main parties. ProRail, the infrastructure management organization and the Ministry of Infrastructure. Together they sign a Management Concession which stipulates how the system should perform (Ministerie van Infrastructuur en Milieu , 2015).

This Concession is translated into a yearly management plan for the system. This Plan (ProRail, 2019) states the mission of ProRail and how the railway system is coping with the performance standards of the Concession. It also elaborates on how the performance target values will be achieved in the following year and which possible adaptions ProRail should implement to adjust for the future. From there on, the Plan is broken down to reach the operational level of the organization.

At this stage, the content of the previous two documents is *"translated"* into a Performance Management System (PMS) for internal ProRail use, and Performance-Based Maintenance Contracts. These contracts are meant to govern the maintenance standards of the system and are procured to external contractors.

The purpose of this agreement is to attempt to govern and monitor the performance of ProRail. However, the railway system is not a single entity. It is comprised of the system itself, administrative region, contract regions and performance-based maintenance areas, for example.

Moreover, ProRail itself follows a similar structure. The organization have different levels with different responsibilities and functions. A top-level manager might not be concerned if the train to Den Bosch had a one hour delay the day before. She would be concerned, however about the way ProRail intends to achieve its long term goals about the reliability of the system.

On the other hand, a manager or subject specialist working in the contract region, including Den Bosch, will be highly concerned about this one hour delay. The long-term reliability goals of ProRail would be entirely out of his scope of work.

The same distinction could be made about performance agreements themselves. The performance goals of the management Concession might be quite general and open to interpretation. The performance indicators of ProRail's PMS might be more to the point and have concrete definitions.

There is also the fact that the railway system should satisfy several performance areas. The system should be reliable, safe, available and friendly to the environment, for example. The agreements made about the system should reflect these aspects. The difference is that different organizational levels, and people, will not always give the same gravity to them. Furthermore, their meaning might be different for each level, as showcased by the previous example.

One could wonder what these differences mean for the railway system. The following chapters will attempt to analyse these aspects and elaborate on positive and possible negative outcomes this plurality might entail for ProRail.

1.2 Interrelationships of Performance Agreements

Despite their contradictions, described in Section 1.1, there should be a coupling between these agreements and levels, since they all try to contribute to the same goal. A high-performing railway system. An argument to support the importance of these interrelationships would be to provide an example where these agreements are de-coupled from each other.

This would mean that the, otherwise, interconnected levels of the system would be seen as units. Moreover, if this would be the case for the system, the same would hold for the organization, ProRail. Its different levels, which should communicate and collaborate, would be completely independent. This situation would resemble a ship where the captain, the executive officer and the first mate do not talk to each other. How would the sailors know where the ship should sail? Moreover, how would the captain know if there was a hole on the keel?

The interrelationships between these agreements provide a direction to ProRail and the railway system. While the subject specialist at the operational level is not concerned with the exact *"destination of ProRail"* directly, he should know the general direction the company wishes to follow. On the other hand, the top-level manager should not know every single little detail about the state of the system, but the metrics she uses should provide a thorough and truthful overview of it.

An argument can be made at this point, about the way the agreements are structured. If they should be coupled, why not make a single agreement about all the elements of the system and the organizational levels? As explained in Section 1.1, both of these elements are comprised of different levels with different needs.

A *"one solution for all"* approach would neglect these differences and would greatly hinder the capacity of ProRail to operate the system. This is why the interrelationships between the agreements are so important. Their symbiotic relationship provides the purpose and the means to achieve it at the same time.

However, it seems that this symbiotic relationship is not always possible. As with any bilateral relationship, problems can be created in this chain. The following example can serve as an explanatory argument about the previous sentence. The Concession stipulates that one of the leading performance areas, the system must abide by, is *"Reliability"* (Ministerie van Infrastructuur en Milieu , 2015). The MC also provides Information and Performance indicators for someone to know when the system is considered reliable.

The Management Plan (ProRail, 2019) continues to elaborate on the performance area of *"Reliability"*. More details are given over which metrics are used to define it and the means of their measurement. In the end, a manager at the operational level would have a set of performance indicators about reliability which he should abide by.

What will it mean for the system if, these standards cannot be traced back to the goals of the MC? Would the manager have done a good job? The answer to this question seems obvious. Yes. He engaged in actions in order to satisfy these metrics. Nevertheless, did his valuable time and effort contributed to the general reliability of the system? Since in this example, the low-level metrics cannot be traced to strategic goals, the author would argue that the answer to this question is inconclusive.

Another problem could arise from the way these agreements are made. Their structure is mostly top-down. In this organizational structure, the highest levels of management draw up a plan and communicate it to lower levels. For the Dutch railway, this plan is the Management Concession, and its communication is being made through the Management Plan.

In this process, the manager of the example has little say on how these standards are formulated. This fact creates a paradox. The manager of the example has the most knowledge and experience of how the system *"behaves"* in reality. However, he is being asked to follow guidelines formulated by parties with, comparatively, far less comprehension of the system's reliability.

In the first instance, the manager followed these guidelines and potentially wasted his time and effort. Another possibility is to contest them. Indeed these guidelines may conflict what he faces daily. They might conflict with his professionalism and his efforts to contribute to a reliable system (Steenhuisen & van Eeten, 2012). This conflict might create a shielding effect.

The manager of the example will *"pretend"* to follow the guidelines. Since he is located to the level feeding the PMS of ProRail with information, there are ways to engage in a numbers game and in a way, fool the system. This would mean that the guidelines communicated by ProRail would be followed only on paper.

In reality, each manager would cope with a particular situation based on their professionalism and values (de Bruijn , 2002). Off course, this would create a false sense of achievement or even security to ProRail. However, this kind of state would only hinder it in the long run as it creates confusion and frustration in the organization (Wilderom, Stertefeld , & Wouters, 2009).

Furthermore, through these performance agreements, Performance Based Maintenance Contracts are drafted. These contracts are aimed at the maintenance of the system and are procured to external parties. If the translation of performance agreements and requirements are not clear inside ProRail, then what are the consequences for these agreements? If they are based on only "paper performance", this thesis argues that the contracts will not include stipulations which help the general state of the system. To put it very simply, if it is not clear for ProRail itself how performance goals should be accomplished, then how can it be clear for an external party?

The above example had to do with "*Reliability"*. However, a complicated railway system should deliver on multiple facets of performance. Nevertheless, are all of these facets equal? Which performance areas regarding the system are more critical than others and even common in the eyes of ProRail? If a specific part of the system faces power surges and frequent accidents and another unreliable switches where should ProRail dedicate first more resources?

By knowing the answers to the above questions, ProRail could produce more value for its customers, and itself, by using its resources more efficiently. At the same time, if the performance requirements are translated more consistently, there might be a smaller chance of coping or contest them. The performance agreements would be coupled with each other and reality itself.

This could lead to fewer misunderstandings and frustrations inside the organization and will help with improving its performance output. In the end, every link in ProRail's organizational chain would know from where the performance requirements of the system originated, why they should be met and where to dedicate its resource, saving money, effort and time.

1.3 The Amsterdam - Eindhoven Corridor

The PHS Amsterdam – Eindhoven corridor, otherwise known as the A2 corridor, connects the cities of Amsterdam and Eindhoven at the north-west and southeast ends of the Netherlands. Its purpose is to provide high-frequency train trips for passengers and to accommodate freight traffic. It is comprised by Amsterdam Central, Utrecht, Culemburg, Hertogenbosch and Eindhoven.

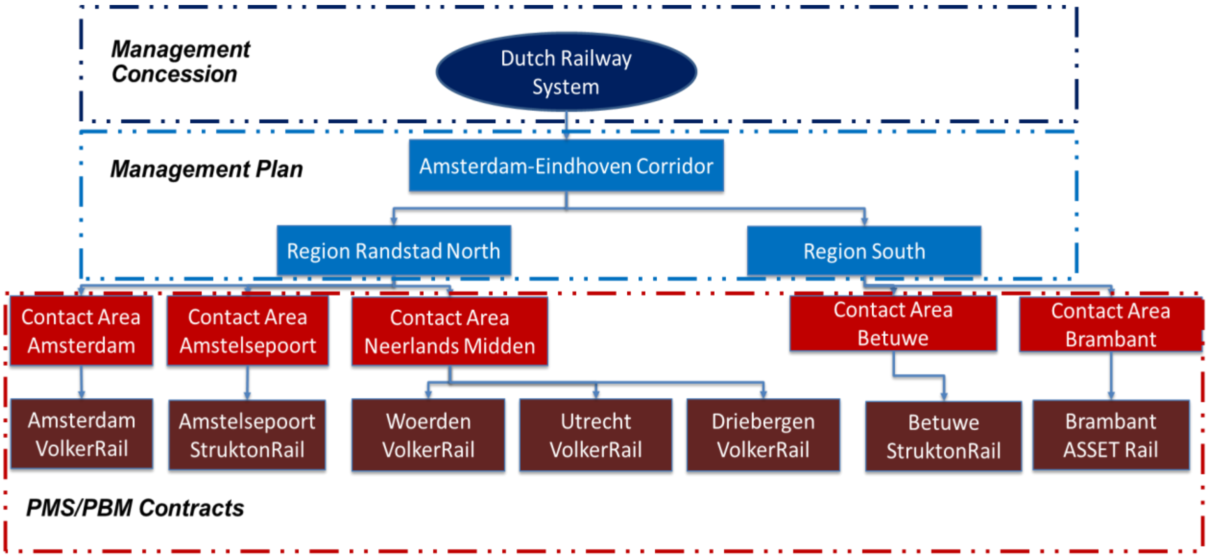
A particular part of the system is chosen to visualise how the system and ProRail itself is structured. This visualisation will make it easier for the reader to understand and connect the terms used in this thesis with real-life situations. One should keep in mind that the A2 corridor is just a part of a complex railway network. This report will not focus on its external interactions.

Moreover, it would be sound to consider implementing the proposed advice of this report in a limited part of the system. As explained in the following chapters, the sudden change will most likely harm the organization and thus the performance of the system.

Such a corridor could be used to initiate a *"pilot"* program. Its results could be then used to assess the effectiveness of the advice and if necessary, make possible modifications. Given that this procedure offers encouraging results, the proposed advice can be scaled up to incorporate more elements.

Given its complexity, managing the corridor as a single unit becomes difficult and not efficient. Thus, the structure of the corridor follows the layered approach described in Section 1.1. The A2 is divided into two different Administrative regions and seven different Maintenance areas governed by 5 Performance-Based Maintenance areas. This is done in order to have smaller parts of it, which are easier to be monitored and managed. Figure 2 presents to the reader a visual representation of the system's decomposition. Moreover, the figure offers a representation of the elements described in previous Sections and how they connect to the corridor.

Figure 1: Decomposition of the A2 Corridor



The above figure begins with the Concession, which governs the entirety of the railway system. A circle represents the railway system. This is made to denote that it is composed of many elements leading up to it.

One of these elements is the Amsterdam-Eindhoven Corridor. This particular element of the system spans two administrative ProRail regions. Randstad North and Region South. The Management Plan governs these two levels. They form part of the system's operations and thus are governed by the instrument which operationalises the MC.

The last two levels include the contract areas of the corridor along with the maintenance areas which compromise them. This part of the corridor is governed by the PMS of ProRail and the Performance-Based Maintenance Contracts. The duality of this level is explained from the fact that maintenance of the system is procured to contractors. However, ProRail is still responsible for its supervision and management. Thus, the accountability about the performance of the system falls on it.

The arrows of the figure are used to denote the connection between these levels. The importance of their interrelations was covered in Section 1.2, along with what problems might appear between them.

This thesis would like to focus on the interrelationships of the MC, MP and the PMS of ProRail. While the PBM Contracts are an essential part of how the system operates, they regard external parties. The three elements the author intends to focus upon, regard internal processes and practices of ProRail. Potential problems and solutions proposed for them have the potential to improve the contracts in the long term. This is the reason it is deemed more urgent to examine the internal elements of the organization.

Another distinction which will be analysed more in Chapter 4 is that the performance agreements of Figure 1 create three different organizational levels. These are the Strategic, Tactical and Operational level. This thesis also intends to analyse the difference between them and how they could help or hinder the coupling or uncoupling of ProRail's performance agreements.

1.4 Research Focus and Structure

Based on the analysis of the previous sections, this thesis would like to argue that a stronger coupling of the performance agreements could potentially safeguard the delivered performance of ProRail. This coupling regards the three separate levels identified in Section 1.3 along with the three agreements the author intends to analyse. The Management Concession, Plan and the PMS of ProRail.

The idea behind this focus is to try to alleviate the potential problems identified in the example of Section 1.2. It is expected that more substantial alignment between these elements could permit ProRail employees to make a more reliable connection of their daily dilemmas regarding performance to the prescribed, from the organization, standards.

Moreover, such an approach could have the potential to connect the three organizational levels. In order for the employees of ProRail to have a *"stronger voice"* in the formulation of performance standards, a stronger feedback loop with top-management might be necessary. If that is the case, then this loop can connect in a more obvious way the performance of the Operational and the Strategic level. Given this is possible, the alignment of performance agreements will not only be on paper but also in the daily activities of ProRail.

To accomplish this purpose, the author formulates the Main Research Question of this project, along with three Sub-Research Questions. The formulation of the latter is being made in order to examine separately essential aspects which can contribute to answering the former. This procedure is presented in Sub-Section 1.4.1. Section 1.4 concludes with Sub-Section 1.4.2, which provides the general structure of this report and elaborates behind its reasoning.

1.4.1 Research Questions and Objectives.

Based on the problems identified in Section 1.2 and the elements analysed in Section 1.3, this research project will attempt to provide an answer to the following Main Research Question:

> ***MRQ:*** *How to improve the current alignment of Performance Indicators in the Management Concession, Management Plan and Performance Management System of ProRail?*

Before providing a definite answer to the MRQ, the author would like first to examine subjects which can build on the reasoning of the final answer. To be able to achieve that, the following three sub-research questions are formulated.

> **S.RQ1:** *What are the shared and non-shared performance areas the internal stakeholders of ProRail find important?*

> **S.RQ2:**
>
> a. *What is the current state of alignment between the Management Concession, Plan and Performance Management System?*
> b. *What potential problems can misalignment create?*

> **S.QR3:** *How can the current alignment be improved?*

In the above questions, the reader can observe the term *"performance areas"* and *"alignment"*. For this thesis, performance areas are defined as the elements the system should deliver upon. Section 1.2 used *"reliability"* to build its arguments. This is one example of a performance area. The term is used because such elements are not mono-valued. This means that reliability is comprised of different aspects which, in the end, determine if the system is reliable or not. These aspects can be punctuality or the number of malfunction in the system. Thus, the term *"area"* attempts to capture this multi-valued approach.

The term *"alignment"* is used with the sense of *"a line of reasoning"*. Stating that a performance area is aligned does not mean that its standards are the same for all agreements and levels. For this thesis, an aligned area is an area where a logical connection is made between these elements. For example, if an operational performance indicator of *"Reliability"* can be traced back and connected to a Strategic goal of the MC, then this is an indication of alignment for this performance area.

The reason for the first S.RQ is to examine the hierarchy of performance areas inside ProRail. What are the potential *"schools of thought"* inside the organization? Are there any performance areas which are equally crucial for ProRail employees? The question will be used as a *"compass"* further in the thesis. By having an answer to it, the author can scope down to more essential performance areas which are shared or form distinct perspectives inside ProRail.

Furthermore, the analysis will be used to make hypothesises for the coupling of these areas in the performance agreements. Requirements of shared areas are expected to have more robust couplings between the agreements. Another use of this analysis is to make the reader and the author familiar with the performance aspects of a railway system.

Instead of analysing technical documents right from the start, this thesis would like to ease in these agreements by first examining the elements which comprise them. The focus on these areas will deliver more value for the following S.RQs.

By S.RQ 2, the author will like to examine the alignment, or else the line of reasoning, between the performance agreements mentioned in Section 1.2. Since S.RQ 1 would have been answered, the analysis will be centred around its results. Through this analysis, the author attempts to showcase the current state of alignment in ProRail's performance agreements. The problems located from this analysis will be, in turn, the foundation of S.RQ3.

The answer to the last S.RQ will be simultaneously the advice of the author to ProRail on how to develop further the *"line of reasoning"* in the performance areas where S.RQ 2 locates potential problems. The combination of these questions will be them used to conclude with an answer for the MRQ. Based on the above, the author formulates the following research objectives:

- *Define which perspectives are formed around performance areas and examine if common areas exist among the internal stakeholder of ProRail.* For this objective, the Q-Method is going to be used. Sub-Section 2.1.1 presents more details over the chosen method.

- *Showcase the interrelationships of performance requirements between the MC, MP and the PMS of ProRail.* To achieve this, the author will focus on the results on the Q-Method and will conduct a review of the performance agreements. The intend of this review is to examine the current state of alignment in the performance areas resulted from the Q-Method. Sub-Section 2.1.2 presents this procedure in more detail

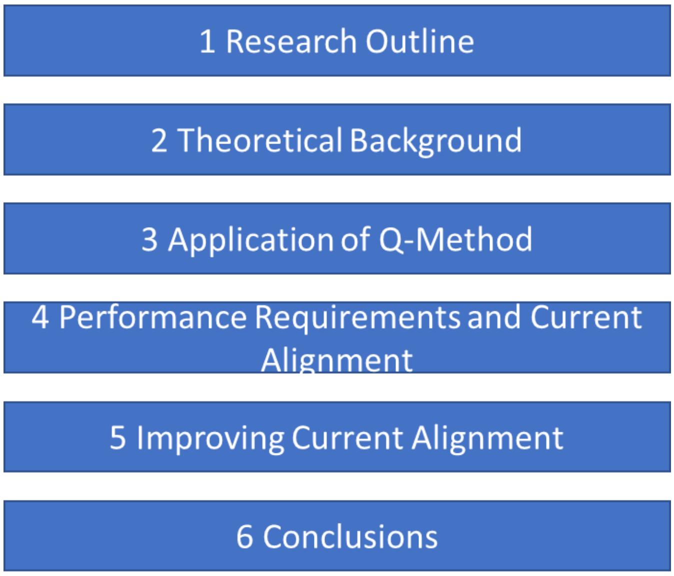
- *Provide advice based on the literature on how the current situation can be improved.* For this objective, the author intends to use his finding from a literature review over performance management and the results of previous S.RQ. The result will be an advice to ProRail over a possible way to reinforce the alignment of its performance agreements. More details over this objective can be found in Sub-Section 2.1.3.

1.4.2 Research Structure

In order to address the subjects presented above the thesis is split into six chapters. The first chapter introduces the reader to the outline of this project. It also presents the research questions and the methods which are going to be used in answering them. The second chapter provides the theoretical background of the subject of the thesis.

Chapters 3 to 5 make use of the methods described in Section 1.5 to provide answers to SRQ 1 to 3, respectively. In the end, Chapter 6 concludes the thesis by presenting the summary of the results for each SQR and main Research Question. The structure of this report can be observed in Figure 2.

Figure 2: Thesis Structure



The line of reasoning behind the above figure is the following. The author first presents the general outline of this research project. Then he presents in more detail the methods which are going to be used to assist him in answering the research questions. In Chapter 3, the first stage of the analysis begins. The results of the Q-Method will create a direction for the project as they will represent specific perspectives inside ProRail. They could also provide additional points of interest in the form of common performance areas.

Chapter 4 continues with this analysis. The performance areas results from Q-Method are scoped down even further. The author attempts to dissect the logic, or the lack thereof, of their performance requirements and showcase positive and negative aspects. Chapter 5 focuses on problematic points located in Chapter 4 and provides an advice to ProRail on how these problems could be alleviated. In the end, Chapter 6 sums up the entirety of the thesis by providing conclusions for each S.RQ. This, in turn, delivers an answer to the MRQ and fulfils the goal of this research project.

1.5 Research Methods

This section elaborates on the methods the author uses to provide answers to the questions of Sub-Section 1.4.1. Each of the three Sub-Sections provides information about the research approach followed for each sub-research question. The Q-Method will be used for S.RQ 1. As explained, it will be used as a *"compass"* to provide a direction for the following parts of the research.

For S.RQ 2, based on the results of Q-Method, the author analyses the current alignment of performance areas in ProRail. This analysis will include the Management Concession (MC), the Management Plan (MP) and the PMS of ProRail (QlikView). In the end, S.RQ 3 analyses how the problems identified in the previous question could be alleviated. The advice provided in ProRail is based on the results of previous chapters and scientific literature over performance management.

1.5.1 What are the shared and non-shared performance areas the internal stakeholders of ProRail find important?

The performance of a railway system can have many aspects. The system should be safe, available and reliable, for example. It should also be easy to maintain and provide enough capacity to its users.

An answer to S.RQ 1 can help with providing a *"compass"* for which performance areas are more critical than others inside ProRail. The results of this question can also showcase if there are areas where there is collective agreement over their gravitas. These areas would be the direction shown on the *"compass",* guiding the research project. The expectation is that shared areas would have a much stronger coupling between the performance agreements than non-shared ones. Their *"line of reasoning"* could provide a basis to create a generalization for the stronger coupling of other areas. Therefore, this thesis will first try to identify these essential performance areas by making use of the Q-Method.

The Q-Method traces its origins in Social Science where it was first developed by William Stephenson (Stephenson, 1935), a psychologist and a professor at the University of Missouri and the University of Iowa. According to the work of Brown (1993), this methodology lays the foundation on examining subjectivity.

Matters such as the one described in this report can be subjective. With this methodology, the researcher can examine ideas, feelings, beliefs or evaluations by asking the respondents to rank several statements regarding one subject, for example, project performance (Koops , 2017; Lee, 2017). This can capture the subjectivity embedded in this whole process and express eventually what is essential to the respondents and if there are particular emerging patterns from it (Lee, 2017).

One particularity of the Q-Method is that it mixes a qualitative with a quantitative approach (Lee, 2017). The generation of statements and their ranking by the participants form the qualitative part. However, after this is done, Q-Method uses factor analysis to produce its results.

This mix of approaches can also be the main advantage of this method. Instead of just expressing what is important to them, the respondents are *"forced"* to choose between statements, making trade-offs (Koops , 2017). Moreover, Q-Method is that it can produce accurate results with a relatively small number of participants (Webler, Danielson, & Tuler, 2009).

In order for this method to be applied, the author first conducts a literature review. This review will incorporate both academic and industry sources in order to locate relevant performance areas. These areas will then be presented to several ProRail employees. They will be asked to provide short definitions about them. These definitions will then form the foundation for the next phase of Q-Method.

By using Microsoft Excel, the author intends to create a survey so that the participants can rank the performance areas mentioned above. In order to ensure there is enough plurality, the survey is sent to different departments of ProRail. The plurality of opinions is vital as the performance areas can express several disciplines inside ProRail. A reliable system, for example, concerns both the Asset and Capacity Management departments. However, is of the same importance as the safety of the system? Or individual *"schools of thought"* are created around the performance areas?

The participants are being asked to rank the performance areas in relations to their daily tasks. This is done to observe what gravity the performance area have on their daily professional lives. After this procedure, the author makes use of dedicated software to extract the results of the Q-method.

1.5.2 What is the current state of alignment between the performance agreements and what problems could misalignment create?

The MC is the document that governs the whole system and in turn, its performance at the highest level. The MP is its yearly interpretation into actions. The Performance Management System of ProRail (QlikView), attempts to break down these documents in daily operations. These three elements form the foundation of how the system's performance requirements are translated. The starting point to answer this question is the results of S.RQ 1.

The identification of shared and non-shared areas inside the sample of this research will form the foundation of this analysis. As referred to section 1.5.1, it is expected that these categories of performance areas will have different degrees of coupling between the performance agreements. Their examination will be useful in showcasing what this thesis means by "the line of reasoning". Furthermore, the results of this analysis may be able to showcase potential areas of improvement for ProRail in the way it communicates its performance requirements.

Through a review of the MC, MP and QlikView, the author intends to showcase how these documents present, structure and define the performance requirements for the performance areas resulted from the previous question. Based on the analysis of Section 1.2, the author expects that these documents will provide a direction for ProRail. Not only that but, the low-level manager of the example of that section, would be able to find a line of reasoning in the performance requirements.

This line of reasoning, which is another term for alignment in this project, should be apparent both from a top-down and bottom-up perspective. In this way, if the top-level manager wishes to scope down in a particular part of the system, or the corridor, in this case, she would be able to do so.

According to this thesis, problems arise when there is a *"broken link"* in this chain. This broken link could be that the low-level manager cannot connect the performance standards of his level to the overall goals of ProRail. If he cannot do this, then how he would know whether or not he is contributing to the organization? According to the example of Section 1.2, this could harm himself and ProRail in general.

A shielding behaviour could be cultivated, and factious results may end up inside the PMS of ProRail. This, in turn, will represent the performance of the organization wrongfully. If that is the case, the top-level manager will be presented with a distorted image of the train corridor. On paper, everything would be good, but in reality, lower levels may struggle to navigate through inconsistent or outright impractical standards.

Cases, where this line of reasoning is disrupted, are deemed problematic and form points for further analysis. To support his argument about the potential adverse nature of limited alignment, the author uses primarily scientific literature sources. These sources can be connected to possible problems identified for particular performance areas in the MP, MC and QlikView or support potentially positive results. The areas where problems regarding their alignment are found will form the foundation of S.RQ 3.

1.5.3 How can the current alignment be improved?

In order to answer the final S.RQ, the author indents to use the findings of the second one. Areas where the problematic elements described in Sub-Section 1.5.2 will form the foundation of this analysis. Furthermore, the findings of the scientific literature review will be combined in order to create a framework to promote alignment.

This framework will attempt to empower the collaboration of the three distinct organizational levels identified in Section 1.3. It will also aim to make apparent a line of reasoning behind the performance requirements of each level.

The thesis intends to present a more process-based approach to accomplish these goals. Since the performance requirements of the system regard three separate levels, it might be useful to create dedicated standards for them. On the other hand, these levels are connected. A process where the requirements of the previous level work as the foundation of the next could reinforce this connection.

Furthermore, the process-oriented approach will allow for each organizational layer to express itself in the performance standards it should abide. In this way, a top-level manager can still have an overview of the corridor while a low-level specialist can connect himself with his prescribed performance requirement. After all, these requirements will be the result of discussions with his colleagues. The chances of shielding himself against them would be much lower. At the same time, this will mean that the overview of the top-level manager would be way more truthful. Such an approach still respect the peculiarities of each level while at the same time creates an apparent connection between them and their performance standards.

2 Theoretical Perspective

Chapter 2 intends to provide the theoretical background of this thesis project. To achieve this, the author conducted a literature review on perspectives over alignment and possible approaches to improve it. Both of these subjects are analysed in Sections 2.1 and 2.2, respectively. The author makes use of both scientific literature and industry sources to support his arguments. Section 2.3 concludes the chapter.

Regarding scientific literature, the author made extensive use of the online TU Delft Library as well as the TU Delft Thesis Repository. The keywords which were used for this search were *"Performance Management", "Performance Measurement", "Railways Performance"* and *"Performance Alignment"*. The author tried to limit himself to scientific papers regarding infrastructure performance and more specifically, rail performance.

The industry sources the author uses are anecdotal knowledge obtained by meetings with ProRail managers. The managers with whom the author met during his time at ProRail were mainly from the Asset Management and Rail Technology departments. The intention was to cross-validate scientific and industry information to showcase the connection between these two domains regarding possible problems misalignment can create.

2.1 Perspectives on Alignment

Knowledge and information sharing have been linked with better operational results and higher value production for the organisations that utilise them (Tooranloo, Ayatollah, & Alboghobish, 2018). However, if an organisation operates a system in a segmented way, its different levels, which in many respects are dependent on each other, will lack the view of a *"common goal"*.

Organisational levels will try to satisfy performance requirements which may not be connected to upper organisational goals (op de Woert, 2013). Thus, instead of striving to attain its strategic objectives, the system strives to attain *"local goals"* which are not necessarily going to contribute to the bigger picture.

Many organizations adopt a *"one performance dashboard for all levels"* mentality. However, not all organisational levels use KPIs for the same purposes (Bos, 1997). Top management, for example, is oriented in long term goals regarding its strategy. Daily or weekly KPIs might not be the best tool for this level to appraise performance. Work floor personnel, on the other hand, requires indicators which provide a more frequent overview of their contributions (Eckerson, 2009).

This mixed approach might create confusion in appraising the performance of an organisation. All the information is cramped up in one place, and there is no apparent separation of it. At the same time, the system itself is structured with specific levels in mind. Several questions arise from this fact. Are all of the KPIs in the Dashboard necessary? If yes, which KPIs are oriented in specific organisational levels?

For the rail industry, a number of these problems and their results are stated in the report of McNulty (2011). This report focuses on the British railway system. According to McNulty (2011), the British railway sector does not perform as it is supposed to. This fact has unwelcoming consequences for its performance. The source of potential problems is difficult to be located, and proposed solutions lack a direction. McNulty (2011) supports that not enough effort has gone to cooperation and communication among high and low operational levels of the organisation.

McNulty (2011) also states that in such an environment, the different organisational levels have a very narrow view of what the system should accomplish. They try to optimise what is *"in front of them",* but they cannot determine if their efforts contribute to higher goals. This can result in misalignment and suboptimal performance for the organisation (McNulty, 2011; Rose & Manley, 2012). Moreover, the findings of McNutly (2011) seem to be a reality for the Dutch railway sector according to the research of op de Woert (2013).

This miscommunication has the potential to create problems for the performance of an organization. While all of its performance agreements include the same performance areas in their clauses, they might not make an effort to connect each of the organizational levels to respective and overall performance goals.

In turn, a narrow view of operations is created. The specialists and managers of this level do their best to satisfy a set of prescribed requirements, but since they are not adequately communicated, it remains unclear how their efforts contribute to the strategic goals of ProRail for example.

This can lead to the same results a rigorous command, and control approach could deliver. Shielding from the requirements and the use of personal trade-off and judgement from the operational level. While it is true that personnel in this layer has the most knowledge about the system, if they use it arbitrarily, it cannot contribute to its fullest to the organization. In cases such as "Safety" where a healthy dose of alignment exists, ProRail can extract more value out of this knowledge.

These problems, however, are not only supported by scientific literature. Meetings with several ProRail managers further validated these issues. Several ProRail managers working in Rail Technology explained the difficulties of this *"missing translation"*.

Some of them did not know what the MC or the MP stated over the general performance requirements of the system even though they knew that they had to do to satisfy a set of performance standards. However, according to them, these standards were subject to constant changes which hinder their line of view. Moreover, some of these managers could not give a definite answer of whether or not these indicators contributed to the general goals of ProRail.

This does not mean that employees of different levels do not know what to do. They are all well trained capable managers, but this *"missing connection"* makes their valuable work very localised. In the case of *"Environmental Sustainability",* this work does not seem to connect to what ProRail should achieve.

2.2 Perspectives on how to improve Alignment

What McNulty (2011) and op de Woert (2013) observed relates to how, the clear majority, of enterprises, communicate their strategic performance goals to their lower levels. The performance requirements are communicated mostly *"top-down"*. Top management will formulate a plan with strategic goals. This plan will be broken down to reach lower parts of the organisation (Wouters & Wilderom, 2008), as ProRail does with the MC.

While well-intentioned, such an approach might create reactions from the lower levels and sometimes is met with resistance. The employees on the *"work floor"* have no input in these requirements or how they should be implemented in their level of the organisation. They may even find them inaccurate or utterly unsuitable for their day to day activities (Wouters & Wilderom, 2008; Malina & Selto, 2001). Most of the time, they perceive them as control measures from the top management and lack the overview of how these measures can help the organisation (Carmona & Gronlund, 2003; Larsen , 2001).

Literature also provides the counter-argument that strict alignment will not always lead to positive results (Adler & Borys, 1996; de Bruijn , 2002). The top-down approach described in the previous paragraph is an excellent example of how total alignment with strategic goals can exist on paper but not in reality. This is the reason the author deemed it necessary to explain his view on the term *"alignment"* in Sub-Section 1.4.1. Alignment should be a line of reasoning, a connection of organizational levels and goals. Not a strict command and control structure that hurts creativity and innovation.

On the other hand, the communication of requirements can be done bottom-up. In this case, top management still drafts a strategic plan for the organisation. This is the macro – implementation level. Thing again, over the Management Concession and the Management Plan. Then at the micro-implementation level, organisational units, react to this plan. Many times they reform it according to their needs and then implement it (Berman, 1978).

However, such an approach can still entail several adverse effects. First of all, it might create conflict between top management and operational levels. In this much more open context, lower levels have more freedom to make changes to the original plan. Top management, however, has also the right to contest these changes. Since it cannot force its opinion, unproductive conflicts can be created over which performance requirements contributes to the organisation or not (Lupton, 1991).

Moreover, lower levels can always fall back to the fact that there are no concrete goals about this performance area. In their eyes, they are doing an excellent job. Top management, however, might not be satisfied.

This possibility can also be reversed. Top management might think the goals are clear, while lower levels feel there is no direction and purpose in their activities. A healthier choice would be to follow the reasoning of the other two performance areas analysed in this thesis.

2.3 Conclusions of Theoretical Perspective

The performance output of an organization seems to connect itself with how well its requirements and structure are aligned with each other. Literature and practice suggest that better communication between the organizational levels results in knowledge production and better performance management.

In terms of alignment, it seems that there exists a goldilocks zone. Too little and the organization is left without a purpose. Too much and the organization becomes cumbersome and rigid, failing to motivate employees and promote innovation. Furthermore, there is more than one way to communicate performance requirements. The two approaches found in assessed literature are the Top-Down and the Bottom-up approach.

It seems that there is also a connection between these two practices and alignment. As with the previous case, they too seem to have a goldilocks zone. Too much autocracy from top management and the lower levels will shield themselves from it providing unreliable performance data. On the other hand, if the role of top management devolves into a spectator, low levels could use their expert knowledge as an excuse to mask bad performance.

Based on the above findings, the following chapters will analyse the structure of how performance requirements are communicated in ProRail. Moreover, their alignment, as defined in this thesis, will be assessed. In the end, the author will provide advice to ProRail on any potential weaknesses this analysis may reveal.

3. Application of Q-Method

Chapter 3 will present to the reader the preparation, execution and results of the Q-method. Its analysis and results will provide an answer to the first S.RQ: "*What are the shared and non-shared performance areas the internal stakeholders of ProRail find important?*". Section 3.1 elaborates on how the author constructed the list of 17 performance areas the participants were called to rank concerning each other.

Furthermore, it elaborates on the preparation of the survey file and the choice of the software to analyze the answers. In the end, Microsoft Excel was used to create the file of the survey and PQMethod (ver. 2.3 March 2014) was the software chosen for the analysis.

Section 3.2 presents a summary of the participants' composition, along with the preliminary results of the Q-analysis conducted with PQMethod. In total, 26 participants out of four ProRail departments filled in the survey with 100% success rate. Given the guidelines for the Q-Method, this number is deemed sufficient. The resulted correlation matrix of their responses is also discussed as it provides a first view of what one can expect from the next step of the analysis.

The presentation of the three perspectives produced by the analysis is the subject of Section 3.3. The participants created three perspectives around the *"Safety of the railway system"*, *"Reliability"* (combined with high capacity and frequency) and *"Reliability"* (combined with maintainability and safety). Moreover, the analysis produced three consensus statements which are *"Environmental Sustainability", "Nuisance of the Environment"* and *"Efficient connection of freight flows"*. Last but not least, Section 3.4 concludes the analysis and provides an answer to S. RQ 1.

3.1 Preparation for the Analysis

The first stage, when implementing the Q-Method, is to create a list of statements which will be then presented to the participants of the survey. It is essential that these statements can have different meanings for a different point of views and should not represent irrefutable facts (Lee, 2017).

It is suggested that the researcher should amass these statements from a relevant to the subject at hand, literature study (Watts & Stenner, 2012). Informal interviews with parties which know the research matter can also be used to incorporate more information in order to can create the statements (Lee, 2017).

Off course, one should keep in mind that after a while, the information will repeat itself, and this should be a sign that the Q-statement forming stage is over. In either case *"a rough and ready universe of statements"* will suffice (Stephenson, 1953). Given other studies found in the literature which applied the same method for similar infrastructural purposes (Koops , 2017; Blom, 2014), a number of 15 to 25 statements should be sufficient.

Another essential factor about the statements is that they should be defined to a degree. One should note that this definition does not intend to transform them into irrefutable facts, but it is used as a common reference point for the participants (Koops , 2017). This is done for the following step of the method, which is the ranking of these statements.

If every participant receives a list of statements without any explanation, they will define them themselves in that very moment. This would have undesirable results in their final ranking. Their definitions can have as their source the assessed literature or even be the results of interviews with, knowledgeable, regarding the subject of research, individuals (Koops , 2017).

3.1.1 The Initial List

This research project starts with a literature review of scientific and industry sources. This review aims to amass several elements which will eventually form the Performance Areas of the survey. The journal papers which were reviewed had as their scope the performance of infrastructural projects in general while the industry sources were more specific about the rail sector.

The latter were mostly provided from ProRail, and due to company policy, it is not able for the author to cite them directly. Sources such as these are denoted as *"ProRail internal sources"*. Furthermore, the author used information from informal interviews with ProRail managers as well as the Concession between the Ministry of Infrastructure and ProRail (Ministerie van Infrastructuur en Milieu , 2015).

Since the Concession is a public document and directly connected to the Dutch railway system, the author would like to showcase how some of the performance areas are derived. Its second Chapter makes the first reference to the performance of the system under Article 4, Paragraph 2. There it lays out the four main performance areas the system should adhere to. These are (Ministerie van Infrastructuur en Milieu , 2015):

1. *An attractive product for passenger carriers and travellers*
2. *An attractive product for freight carriers and shippers*
3. *The quality of management and transport of the main railway infrastructure*
4. *The capacity of the main railway infrastructure for both commercial and freight operators*

Most of the Performance Areas found in the survey conducted in this thesis are derived from these for main *"missions"* the system should accomplish. For example *"Availability"* and *"Reliability"* fall under the third category. *"Physical connection of goods"* and *"Physical connection of travellers"* fall under category number one and the *"Capacity"* of the rail system under category number four.

An interesting finding from ProRail sources is that it seems to be no distinction between performance areas regarding their importance. The management Concession, for example, presents a very neutral image of the performance areas. According to the author, this lack of hierarchy reinforces the need for such a study.

It might be natural for the performance areas to be regarded as equal on paper. However, reality might present a very different aspect. While ProRail should strive to achieve all of them, to satisfy the management Concession, it would be useful to know how its personnel perceive these areas in their daily work. This knowledge could have a positive contribution to the way ProRail operates.

As mentioned in Chapter 1, operational personnel has the most *"hands-on"* experience with the system. The way these people prioritise performance areas could showcase subject which may require more of ProRail's attention. On the other hand, it may validate what the organization expects from its personnel. For example, if the company aims for a safe system, and safety ranks high amongst the other areas, it would be an indicator that ProRail communicates in an effective way of its mission.

In the end, 15 initial statements were produced. These statements formed the basis to create the final list, which was eventually presented to the respondents of the survey. Table 1 presents the initial statements after this literature study, along with their sources.

Table 1: Initial list of Performance Areas

Performance Areas	Definition	Source
Automatization	The ability to automate processes and decisions about the system so that the computers/machines of the system can make them with minimal, or no human effort	Informal interviews with ProRail managers
Availability	The ability to be able to make effective use of the infrastructure at any given moment	ProRail , 2019; Ministerie van Infrastructuur en Milieu , 2015; Leijten & Koppenjan, 2010
Connectivity	The connectivity of a train station with other forms of public transport like busses and trams. How easy it is to switch from a train from the station to a bus/tram and vice versa.	Informal interviews with ProRail managers, Steenhuisen & van Eeten, 2012; van Gestel, Koppenjan, Schrijver, van de Ven, & Veeneman, 2008
Flexibility	The amount of ease to adjust the system to new situations	Informal interviews with ProRail managers, Gunasekaran, Patel, & Tirtiroglu, 2001; Amiril, Nawawi, Takim, & Ab. Latif, 2014
Frequency	The amount of trains passing through a station at a given amount of time, usually trains/hour	Informal interviews with ProRail managers, ProRail Internal sources, Steenhuisen & van Eeten, 2012; Ministerie van Infrastructuur en Milieu , 2015
Layout of the Platforms	How much the layout of the platforms facilitate a safe and efficient passenger flow inside a train station	ProRail internal sources
Limit hindrance of the Surrounding Environment	The attempt to minimise aspects which could have undesirable results to the surrounding environment such as light, noise and substances pollution as well as oscillations	ProRail Internal Sources, Informal interviews with ProRail managers, Chen, Ao, Wang, & Li, 2018; van Gestel, Koppenjan, Schrijver, van de Ven, & Veeneman, 2008; Amiril, Nawawi, Takim, & Ab. Latif, 2014
Maintainability	The ease of maintenance regarding new and existing parts of the infrastructure	ProRail , 2019; Ministerie van Infrastructuur en Milieu , 2015

Modularity	The number of interchangeable components regarding a rail asset.	Informal interviews with ProRail managers, Arguedas, 2015; Amiril, Nawawi, Takim, & Ab. Latif, 2014
Punctuality	The measure in order to judge when a train is coming and leaving a train station on time	ProRail , 2019; Ministerie van Infrastructuur en Milieu , 2015
Reliability	The amount of confidence one has that the system can be put into effective use at any given moment	ProRail , 2019; Ministerie van Infrastructuur en Milieu , 2015; de Bruijn & Dicke, 2006; Steenhuisen & van Eeten, 2012; Veeneman, Dicke, & de Bruijne, 2009; Leijten & Koppenjan, 2010
Safety	The amount of accidents, or the lack therefore while the system is operational	ProRail , 2019; Ministerie van Infrastructuur en Milieu , 2015; Steenhuisen & van Eeten, 2012; de Bruijn & Dicke, 2006; Veeneman, Dicke, & de Bruijne, 2009; van Gestel, Koppenjan, Schrijver, van de Ven, & Veeneman, 2008; Amiril, Nawawi, Takim, & Ab. Latif, 2014; Leijten & Koppenjan, 2010
Speed	The maximum speed which a train can attain in a given location	ProRail Internal sources, Steenhuisen & van Eeten, 2012
Sustainability	The amount of reducing the production of damaging to the environment substances and use of resources by the resulted system	ProRail , 2019; Ministerie van Infrastructuur en Milieu , 2015; Steenhuisen & van Eeten, 2012; Chen, Ao, Wang, & Li, 2018; van Gestel, Koppenjan, Schrijver, van de Ven, & Veeneman, 2008; Leijten & Koppenjan, 2010
System Capacity	How many trains, often belonging to different Operators, can be operational at the same time in the system	Informal interviews with ProRail managers, Steenhuisen & van Eeten, 2012; Gunasekaran, Patel, & Tirtiroglu, 2001

3.1.2 The final Statement List

The second step of the list creation involved taking feedback from various ProRail Managers on the statements. Ten managers were asked to provide a short definition for each of them. The participants of this questionnaire worked in different departments and functions within ProRail.

Table 2: Participants of the questionnaire over Performance Areas definitions

Participant	Department
PR.1	Rail Technology
PR.2	Capacity Management
PR.3	Capacity Management
PR.4	Asset Management
PR.5	Communications and External Relations
PR.6	Capacity Distribution
PR.7	Asset Management
PR.8	Asset Management
PR.9	Project
PR.10	Project

Furthermore, the managers were also asked to provide statements which they thought were missing from the original list. This question intended to amass and evaluate additional information which the author might have missed. The given definitions were also cross-examined with the ones of Table 1 to produce the final definitions for the survey file. Through this procedure, the performance area number was raised to 29.

Regarding the additional statements provided by the respondents, it was observed that the majority of them involved notions which were *"resources"* and not performance areas themselves. For example *"Automatization of processes"*, *"Organization Integrality"* and *"Standardization of Components*" could be used to improve areas such as *"Availability", "Reliability"* and *"Maintainability".*

Most of the additional statements fell eventually under this category. From them, *"Unplanned and Planned Unavailability"* along with *"Operational Costs"* made it to the final list. The area *"Traceability of information"* was broken down to *"Information exchange between travellers"* and *"Information exchange between freight transporters".*

Furthermore *"Connectivity"* was also broken down to *"Physical connection of passenger flows"* and *"Efficient connection of freight flows"* to represent the difference between commuting and commercial operators. The final list of performance areas, along with their definitions, are presented in the following table.

Table 3: Final Q-Statement (Performance Areas) List

Performance Areas	Definition
Availability	Infrastructure availability for effective use (the proportion of time in which rail infrastructure is available)
Capacity of the rail system	The number of trains that can be operational in the track system at the same time (often with different operators)
Environmental Sustainability	The degree of sustainability: reducing harmful substances for the environment that are released during production, use of sustainable sources, recycling, etc.
Frequency	The amount of trains that pass through a station in a given time unit usually trains / hour.
Information exchange in regard to freight carriers	The efficient exchange of information between ProRail, freight carriers and shippers so that goods can be transported and loaded at the scheduled time
Information exchange in regard to travellers	The efficient exchange of information between ProRail and Passenger Carriers so that travellers can be informed in time about the condition of their journey.
Maintainability	The ease with which maintenance of existing and new rail infrastructure is possible
Nuisance for the environment	The extent to which unwanted nuisance to the environment is prevented. Think of light, sound, air pollution, vibrations.
Operational costs	The number of financial resources needed to keep rail assets and systems operational.
Efficient connection of freight flow	The extent to which goods connect train movements and buildings to other forms of transport, such as water and road infrastructure
Efficient connection of travellers flow	The extent to which train movements connect to other forms of public transport such as buses and trams.
Planned Unavailability	The unavailability of infrastructure due to planned activities, or maintenance, on the track (the proportion of time in which rail infrastructure is unavailable)
Reliability	The degree of Reliability so that the track system does what it should do.
Safety of stations	The safety of stations (platforms and others), expressed in incidents and near incidents.
Safety of the rail system	The security of the system (expressed in incidents and near incidents)
Train Speed	The maximum speed a train can reach in a specific location.
Unplanned Unavailability	The unavailability of infrastructure due to unplanned rail activities according to an unpredictable event (the proportion of time in which rail infrastructure is unavailable)

The importance of including people from different departments became apparent in the provisional stage of statement definition. The following example is used as an argument to support this notion. Participant PR.2 gave the following definition about reliability: *"The ability to make use of the infrastructure at the desired time."*. Participant PR.4 stated the following regarding this performance area: *"The track is available to run trains. Increase added value by reducing unplanned and planned unavailability."*

Both of these definitions are quite similar to each other and the original definition of the author in Table 1. However, PR.2 and PR.4 work in different departments. The fact that these three parties -the author, PR.2 and PR.4 – provided similar definitions on the same performance could mean that this definition would be more universally accepted. In this way, the respondents of the survey would have a common ground when they are called to rank *"Availability"*. A similar line of thought governs the definitions of the other performance areas.

3.1.3 Constructing the Survey File

After creating the final statement list, the author constructed the Q-Sort, which is essentially a ranking sheet. In it, there are different levels of *"agreement"* or *"importance"* ranked from -N to +N denoting the *"least agreeable/important"* and the *"most agreeable/important"* statement respectively. In between the more *"neutral"* statements are placed (Koops , 2017).

This particular *"forced"* form was used as it is the preferred form of most researchers (Stephenson, 1953 ; Brown, 1980) and was also used to similar surveys relating to the infrastructure sector (Blom, 2014; Koops , 2017). Regarding the number of participants, 30 to 40 respondents are deemed satisfactory in order for the method to produce reliable results (Webler, Danielson, & Tuler, 2009).

The author opted to create an Excel file with conditional formatting in order to amass the needed input. The initial idea was to visit the respondents personally and guide them through the procedure after giving them a small introduction of the research project and the purpose of the survey.

Due to restrictions on people movement; however, during the COVID-19 pandemic, visiting the participants was not an option. To survey as personal as possible, it was decided to create small videos for the respondents to guide them through it.

3.1.4 The Survey Outline

The survey file was broken down into three parts. The following paragraphs describe these sections while Appendix A provides visual information over the Excel file constructed by the author.

The first tab of the survey, called *"Introduce",* presents in a short video the researcher. In it, the author thanks the participants for their time. He also states that all of their data will be handled with anonymity in this research. The *"Introduction"* tab, presents in text, the purpose of the research and this survey.

In the *"Personal Information"* tab, the participants are asked to provide their department so that a unique code can be created to denote them in this project. The fourth tab of the document presents the list of the 17 performance areas along with their definitions so that the respondent can study them before ranking them. In the next tab, the participant is presented with another video. This video is used as a tutorial on how the Q-Sort should be filled.

In order to help with the filling in of the Sort and safeguard correct answers, the file uses conditional formatting in the *"Ranking of performance areas"* tab. Each of the rectangles of the Sort is connected with the list of performance areas on the screen. When the user selects one area from the list for a specific rectangle, the same area becomes green to denote to the user that they have already selected it. Even in the case where the participant selects the same area twice, the relevant rectangles will turn red, informing them that there is something wrong with their answer.

The last tab of the file also includes a short video which thanks again the respondents for their participation and provides them with the contact information of the author in case they have further questions.

3.1.5 Selecting the Participants

The survey document was initially sent to several ProRail managers with whom the author came in contact with at the start of this research project. They provided immense help by sharing it around the different company departments. This diversity would enrich and validate the analysis of the results.

If the participants were from a single department, then it would be logical to have similar priorities regarding the performance areas presented to them. However, if managers of different departments ranked similarly to the 17 areas of the survey, the importance of this ranking would be much higher.

This is the reason why the participants were asked to rank the performance areas based on their daily tasks. Through direct and e-mail contact, the respondents were asked the question: *"How would you rank these performance areas given your daily work and tasks?"* The survey wanted to showcase what them, as individuals, found to be important regarding the system's performance.

As the performance areas are quite generic, the project on which the managers worked was not taken into account. Nevertheless, contact with the A2 corridor was welcomed, and many participants were indeed involved with this specific part.

The fact that no participant rejected to participate showcases that the notion of *"not every performance area is equal"* is either not expressed or not so much though inside ProRail. In any case, the participants who came in direct contact with the author found the survey intriguing. They had a genuine curiosity over its results, and their majority received a copy of this report to examine them.

The first surveys were handed out on the 30th of March 2020. The initial deadline for the respondents was the 10th of April. Again, due to the COVID-19 measures, it was decided to give more time to the participants to fill in the survey. This is why the deadline was moved from the 10th to the 20th of April 2020. This was communicated verbally to ProRail managers with whom the author had digital meetings and was passed along the line when they forwarded the survey to their colleagues.

3.1.6 Choosing the appropriate Software

In order to examine which viewpoints exist and which performance areas are shared among the respondents, the author chose to make use of PQMethod (ver. 2.3 March 2014). Such a tool follows three necessary procedures to derive results.

First, a correlation matrix is created regarding the answers of the participants in the Q-Sort. This is done to showcase the relationships between the views of the participants. After this stage, the researcher has an overview on which participants agreed with each other and to what degree.

The second part consists of a Factor Analysis, usually with the use of Principal Components Analysis. In simple words, what this method does is to group answers which correlate highly with each other. This makes the problem easier to handle because its dimensionality is reduced. For example, Instead of 26 different Sorts, after factor analysis, only four remains because the participants mainly expressed only four views among them.

Last but not least, the factor scores of each statement are calculated. This calculation is done because not all Q-Sorts inside a factor have the same correlation with each other. Highly correlated Sorts with the factor should have more weight in defining it. The essential mathematical background of the method is described in more detail in Appendix B.

3.2 Identifying Perspectives and Common Areas

In average, the response to the survey was satisfactory. Even if the answers just fell short from 30, they still provide accurate results. It is recommended to have twice the number of participants in relation to the number of statements; however, the minimum requirement for the Q-method to work is to have at least equal number of participants with the number statement (Onwuegbuzie & Frels, 2015). Thus, the survey of this project fulfils the above requirement.

Regarding the participants themselves, they came from three different departments and one sub-division of ProRail. The departments are comprised of Asset Management, Capacity Management and Projects. The sub-division of IGP is part of AM. This particular division forms a connecting link between AM and Projects in big endeavours such as the A2 corridor.

The Asset Management department is responsible for the upkeep of the system. Under its supervision, the system remains safe, reliable and available to the public and the partners of ProRail. This is also the department with the closest relationship to external contractors as the supervision of the system's maintain acne falls under its tasks.

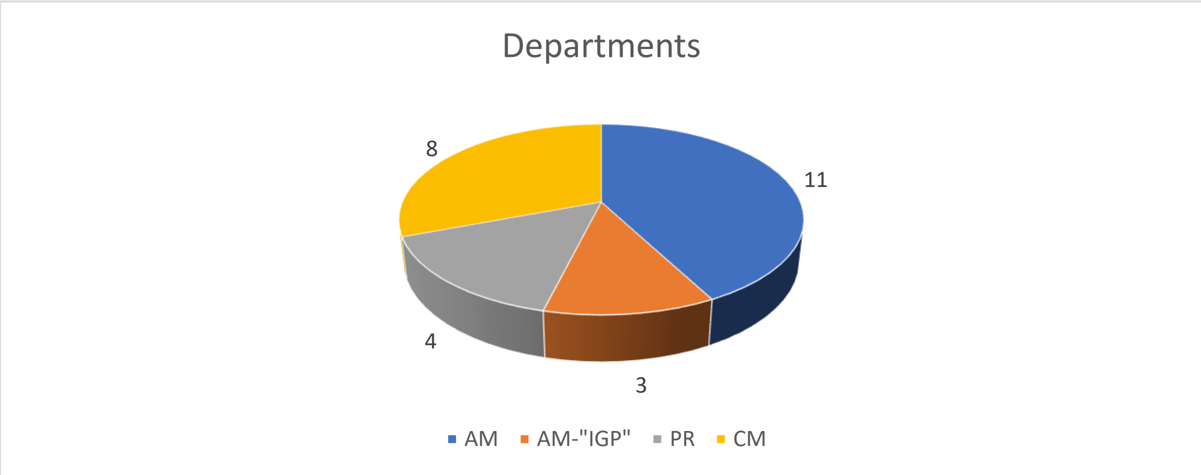
The activities of Capacity Management entail regular contacts with train operators for both freight and passenger transport. This is the department responsible for accommodating the parties mentioned above in the system when the need arises. It also monitors and adjusts the timetable of the traffic in the network according to its availability.

Last but not least Projects, as the name suggests, is responsible for the construction of new rail projects. This includes the construction or renovation of train stations with the cooperation of local and national authorities.

Most of the responsibility to fulfil the standards found in the performance agreements falls on AM and in extension, IGP. Since AM is accountable for the state of current assets, it has daily involvement in activities which influences the performance areas of Table 3. Projects such as the A2 corridor are deemed *"too big"* from ProRail to be handle independently from AM and Projects. Thus, for this particular part of the system, the IGP sub-division is highly involved in the translation, verification and validation of the corridor's requirements. It forms a connecting link between AM and Projects and should manage both of their aspects.

Last but not least, Capacity Management plays a crucial role in how and when the system can be used, i. e when and how the system is available. Its activities have a considerable amount of interplay with the ones of AM. For example, if AM cannot guarantee the reliability of the corridor, then CM could not guarantee its availability to operators and in extension, the public. Conversely, the plans of CM should not come in conflict with the way AM keeps the system *"in shape"*. The distribution of participants from the departments can be observed in Figure 3.

Figure 3: The Departments of the participants



As mentioned in Sub-Section 3.1.6, the first stage of the analysis begun by comparing the delivered Q-Sorts with one another. Some respondents may have given quite similar answers. On the other hand, some Q-Sorts are fundamentally different. It is interesting to examine these relationships to get the first picture of the viewpoints of the participants. Figure 4 presents the correlation matrix produced by the input of the survey.

Figure 4: The Correlation Matrix of the Survey

	SORTS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1	PR.IGP.1	100	77	28	28	37	77	77	47	43	22	10	8	52	43	32	28	40	50	80	25	75	60	32	43	47	20
2	PR.AM.1	77	100	28	12	28	65	62	52	43	12	-10	12	5	32	12	12	35	37	68	28	45	43	12	22	50	22
3	PR.CM.1	28	28	100	5	17	30	28	30	28	12	-25	15	15	45	28	10	40	55	3	12	25	20	35	3	45	35
4	PR.AM.2	28	12	5	100	12	0	47	28	5	43	15	47	32	68	32	45	3	12	25	45	35	60	40	55	30	5
5	PR.AM.3	37	28	17	12	100	45	60	52	85	62	32	15	30	32	60	3	57	57	47	30	62	55	28	12	60	68
6	PR.IGP.2	77	65	30	0	45	100	75	47	57	12	20	-10	35	30	22	-15	45	43	68	15	60	50	43	12	52	25
7	PR.PR.1	77	62	28	47	60	75	100	70	65	43	17	37	43	45	45	3	45	55	70	52	68	77	60	43	68	25
8	PR.AM.4	47	52	30	28	52	47	70	100	47	35	35	60	30	35	70	5	57	62	45	20	52	65	45	60	55	35
9	PR.IGP.3	43	43	28	5	85	57	65	47	100	60	17	8	15	25	43	-3	60	57	57	35	55	52	43	3	73	75
10	PR.PR.2	22	12	12	43	62	12	43	35	60	100	43	43	5	25	62	47	60	60	55	5	28	50	50	35	70	57
11	PR.AM.5	10	-10	-25	15	32	20	17	35	17	43	100	22	15	5	43	25	20	28	32	-43	22	25	17	52	25	20
12	PR.AM.6	8	12	15	47	15	-10	37	60	8	43	22	100	15	17	57	28	17	32	5	12	-3	28	28	68	22	8
13	PR.CV.1	52	5	15	32	30	35	43	30	15	5	15	15	100	40	55	32	30	22	28	22	75	43	25	50	3	25
14	PR.CM.2	43	32	45	68	32	30	45	35	25	25	5	17	40	100	32	32	12	30	20	30	55	60	28	28	25	43
15	PR.CM.3	32	12	28	32	60	22	45	70	43	62	43	57	55	32	100	32	73	65	37	12	52	50	52	70	50	55
16	PR.CV.2	28	12	10	45	3	-15	3	5	-3	47	25	28	32	32	32	100	22	17	37	-25	30	20	-5	45	15	32
17	PR.AM.7	40	35	40	3	57	45	45	57	60	60	20	17	30	12	73	22	100	77	57	8	55	55	60	30	75	62
18	PR.AM.8	50	37	55	12	57	43	55	62	57	60	28	32	22	30	65	17	77	100	45	5	52	68	60	40	73	52
19	PR.AM.9	80	68	3	25	47	68	70	45	57	55	32	5	28	20	37	37	57	45	100	15	62	55	43	37	68	35
20	PR.CM.4	25	28	12	45	30	15	52	20	35	5	-43	12	22	30	12	-25	8	5	15	100	35	35	37	10	32	8
21	PR.AM.10	75	45	25	35	62	60	68	52	55	28	22	-3	75	55	52	30	55	52	62	35	100	75	35	40	47	50
22	PR.PR.3	60	43	20	60	55	50	77	65	52	50	25	28	43	60	50	20	55	68	55	35	75	100	60	43	60	37
23	PR.PR.4	32	12	35	40	28	43	60	45	43	50	17	28	25	28	52	-5	60	60	43	37	35	60	100	40	68	28
24	PR.CM.5	43	22	3	55	12	12	43	60	3	35	52	68	50	28	70	45	30	40	37	10	40	43	40	100	30	10
25	PR.AM.11	47	50	45	30	60	52	68	55	73	70	25	22	3	25	50	15	75	73	68	32	47	60	68	30	100	47
26	PR.PR.5	20	22	35	5	68	25	25	35	75	57	20	8	25	43	55	32	62	52	35	8	50	37	28	10	47	100

In the above figure, 100 denotes perfect agreement while -100 complete disagreement. To give an example participant PR.IGP.1 response correlates highly with the responses of participants PR.AM.1, PR.IGP.2, PR.PR.1 and PR.AM.9. Without conducting a Principal Components Analysis, it is safe to assume that these 5 participants might belong in the same viewpoint. On the other hand, it is highly unlikely that PR.IGP.1 will be placed in the same cluster with PR.AM.5 and PR.AM.6 given their weak correlation of 10 and 8 respectively.

It is also worthy to note that participants from the same department are not always in agreement with their colleagues. PR.AM.11 has a stronger correlation with PR.PR.2 than PR.AM.2 and PR.AM.4. One would expect the Q-Sorts of participants from the same department to correlate highly with each other, but apparently, this is not always the case.

However, in order to produce the viewpoints of the participants, a more in-depth analysis is needed. Principal Components Analysis is the tool to achieve that. What this will eventually produce is to showcase how many different Q-Sorts are evident.

The Sorts which are more highly correlated with each other will form one Component. In this way, they will form clusters based on the agreement or disagreement of the participants as showcased in Figure 3. By using factor analysis techniques such as PCA, one tries to define the amount of these factors.

To be able to interpret the final components, one needs to implement the last step by calculating their scores. The factor scores represent the weighted average score of a statement based on the scores it got in each Q-Sort corresponding with a particular PCA component. They are a measure to denote that a particular statement is more important than others. The weighted average is used in this case since not all Q-Sorts have the same correlation with a Principal Component.

3.3 The Perspectives of the Participants

After inserting all of the Q-Sorts in PQMethod, the author performed a PCA analysis on them. In the end, the 26 answers formed 8 Components, or Factors, based on their correlation in Figure 3. However, out of these 8 Components, one can only use 3 to express the views of the participants. This is based on the Scree plot of the data found in Appendix B.

Based on the conducted analysis, the first perspective revolves around the *"Safety of the rail system"* while the second and the third around *"Reliability"*. It was strange at first that the analysis produced two different components with the same performance area as their focus.

However, as it will become evident in the analysis, these two perspectives are not the same, albeit very similar. The second perspective finds a combination of "*Reliability"* and *"Capacity of the rail system"* significant, while the third combines "*Reliability" with "Safety of the rail system"* and *"Maintainability"*. This result is interesting as it showcased the importance of distinguishing statements. These statements can be useful when two perspectives, such as these are produced as they indicate what makes them different.

The three perspectives are going to be analyzed in sub-sections 3.3.1, 3.3.2 and 3.3.3, respectively. Last but not least, the analysis produced three statements which did not define any of the resulted Q-Sorts. These consensus statements will be discussed in subsection 3.3.4.

3.3.1 Perspective 1: A Safe System

The first component of the analysis ranked the *"Safety of the rail system"* as the most critical performance area. In total, 8 participants loaded heavily on that Sort, meaning that they share this particular point of view. Figure 5 provides information about the departments of these participants, while Figure 6 presents the Q-Sort of this view along with the Factor Scores of each performance area.

Figure 5: Departments of the participants of Perspective 1

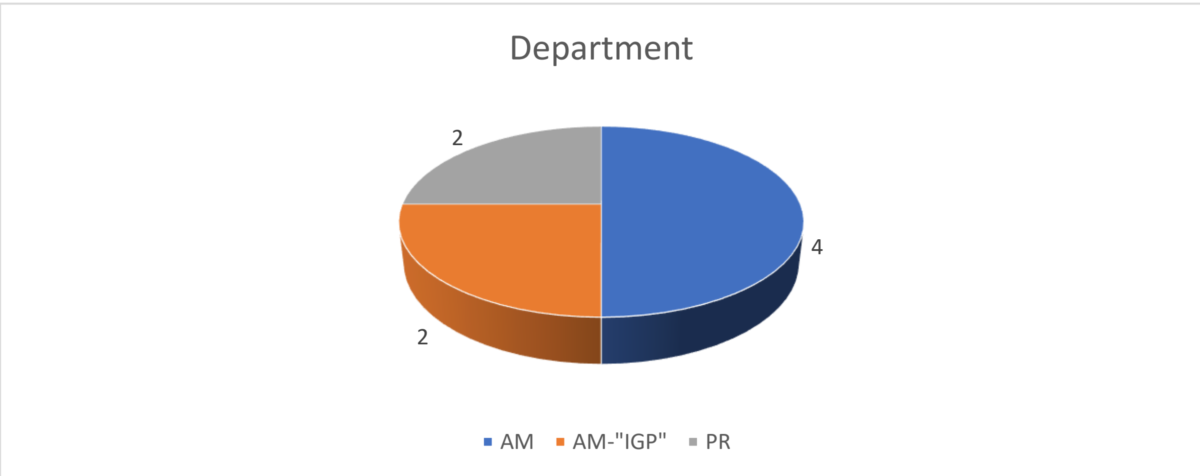


Figure 6: Q-Sort of Perspective 1 along with Factor Scores

-3	-2	-1	0	1	2	3
Train Speed (-2,227)	Planned unavailability (-0,593)	Enviromental sustainability (-0,348)	Unplanned unavailability (-0,023)	Reliability (1,064)	Safety of stations (1,344)	Safety of the rail system (2,173)
	Frequency (-0,960)	Information exchange in regard to travelers (-0,425)	Maintainability (-0,057)	Capacity of the rail system (0.229)	Availability (1,103)	
		Nuisance for the enviroment (-0,558)	Physical connection of freight flow (-0,228)	Operational Costs (0,070)		
			Physical connection of travellers flow (-0,248)			
			Information exchange in regard to greight carriers (-0,318)			

The combined Q-sort of this component provides plenty of information. First of all, it seems there is a clear prioritization regarding the *"Safety of the rail system"*. Its score sets it apart from the following two performance areas of *"Safety of stations"* and *"Availability"*. However, these two performance areas have a similar score with each other and *"Reliability"* meaning that they are of similar importance for the respondents which loaded heavily on that view.

It should be stated here that Figure 6 does not intend to say that *"Safety of the rail system"* is the only area that these participants care about. All of the performance areas are important for a well-performing railway system. What it wants to showcase is that for the participants who formed this particular view *"Safety of the rail system"* has more gravity on their way of thinking and the way they are conducting their jobs regarding the system. The same can be said for the other two perspectives.

According to Figure 4, most of the participants of this perspective came from the Asset Management department of ProRail. Since they are responsible for monitoring and adjusting the state of the system in is deemed logical that *"Safety of the rail system"* defined this view. It would be easier to effectively manage the assets of the system if there was not an accident every other day.

The gravity of this performance area is also evident in the list of its Distinguishing Statements. It is interesting to observe that both the highest and lowest scored areas on the perspective were also the ones that defined it the most from the other two.

The participants which loaded heavily on this view do not find the prioritization of *"Train Speed"* to be an essential element. This area ranked low also in the other two perspectives, but the first view is more extreme on that matter since its score is the lowest here.

Table 4: Distinguishing Statements of Perspective 1

Performance area	Perspective 1 Score	Perspective 2 Score	Perspective 3 Score
Safety of the rail system	2,17	1.03	1,57
Reliability	1.06	1,72	1,71
Unplanned unavailability	-0,02	-0,70	0,81
Maintainability	-0,06	-0,75	0,92
Information exchange in regard to freight carriers	-0,32	-1,23	-1,65
Train Speed	-2,23	0,01	-0,44

Perspective one is also quite more positive regarding the matters of *"Unplanned unavailability", "Maintainability"* and *"Information exchange in regard to freight carriers"*. Although *"Reliability"* did rank high, it is evident that the other two perspective places more attention to this area. To conclude, Perspective 1 was clear about the views of its participants on the matter of rail performance setting its safety apart from the other areas.

3.3.2 Perspective 2: A Reliable High Frequency System providing enough Capacity

The other view of the survey ranked the performance area *"Reliability"* as the most crucial area amongst the 17 presented to the participants. This view was formed primarily out of 6 participants. As with the first perspective, their characteristics and combined Q-Sort are presented in Figures 7 and 8.

Figure 7: Departments of the participants of perspective 2

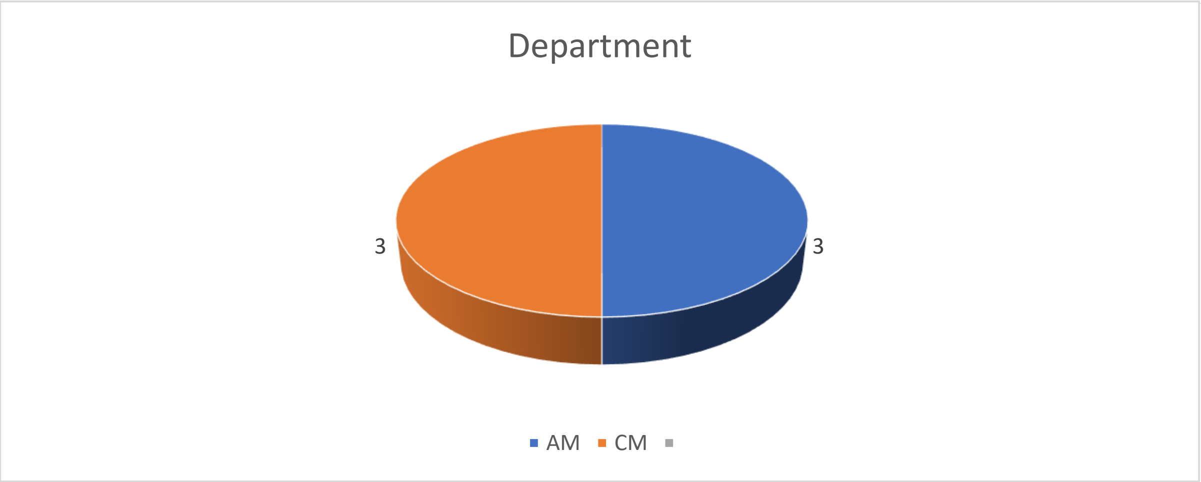


Figure 8: Q-Sort of Perspective 2 along with Factor Scores

-3	-2	-1	0	1	2	3
Operational costs (-1,737)	Information exchange in regard to travellers (-0,943)	Unplanned unavailability (-0,703)	Physical connection of travellers flow (0,533)	Safety of the rail system (1,025)	Frequency (1,369)	Reliability (1,721)
	Information exchange in regard to freight carriers (-1,234)	Maintainability (-0,752)	Train Speed (0,014)	Safety of stations (0,840)	Capacity of the rail system (1,083)	
		Nuisance of the enviroment (-0,890)	Physical connection of freight flow (-0147)	Availability (0,583)		
			Planned unavailability (-0,296)			
			Enviromental Sustainability (-0,466)			

This view is not so clearly defined as the first one. *"Reliability"* is the most critical performance area according to the respondents which loaded on this perspective. However, it did not score much higher than *"Frequency"* and *"Capacity of the rail system"*. Even if visually, these three statements are placed on different positions on the Sort, based on their scores, they seem to have similar importance for this perspective.

Given the distribution of the departments in this view, this is a logical outcome. All of the participants which loaded on this Q-Sort came from the AM and CM departments. The relatively small differences between the first three performance areas of this view express the wishes of these departments. A reliable system which provides high-frequency services with enough capacity to accommodate carriers.

It is thus no surprise that *"Frequency"* and *"Capacity of the rail system"* along with the *"Physical connection of travellers flow"* distinguished this view as one can observe in Table 5.

Table 5: Distinguishing Statements of Perspective 2

Performance area	Perspective 1 Score	Perspective 2 Score	Perspective 3 Score
Frequency	-0,96	1,37	-0,80
Capacity of the rail system	0,23	1,08	0,23
Safety of the rail system	2,17	1,03	1,57
Availability	1,10	0,58	1,44
Physical connection of travelers flow	-0,25	0,53	-0,44
Unplanned unavailability	-0,02	-0,70	0,81
Maintainability	-0,06	-0,75	0,92
Operational costs	0,07	-1,74	0,03

Another fact derived from Table 5 is that perspective two does not seem to care much about the operational costs of the system. One could say that the participants of this perspective would be more lenient to higher costs if this would result in the betterment of the *"Reliability"*, *"Frequency"* and *"Capacity of the rail system"*.

3.3.3 Perspective 3: A Reliable System which can be Maintained with Safety

The third perspective has the peculiarity of being quite similar to the second as both ranked the performance area of *"Reliability"* on the top. As with the other two perspectives, Figures 9 and 10 provide information about the respondents and the Q-Sort of perspective 3. In total, 9 participants loaded heavily on this view, and even though their most important performance area was the same with perspective two, there are significant differences between the two.

Figure 9: Departments of the participants of perspective 3

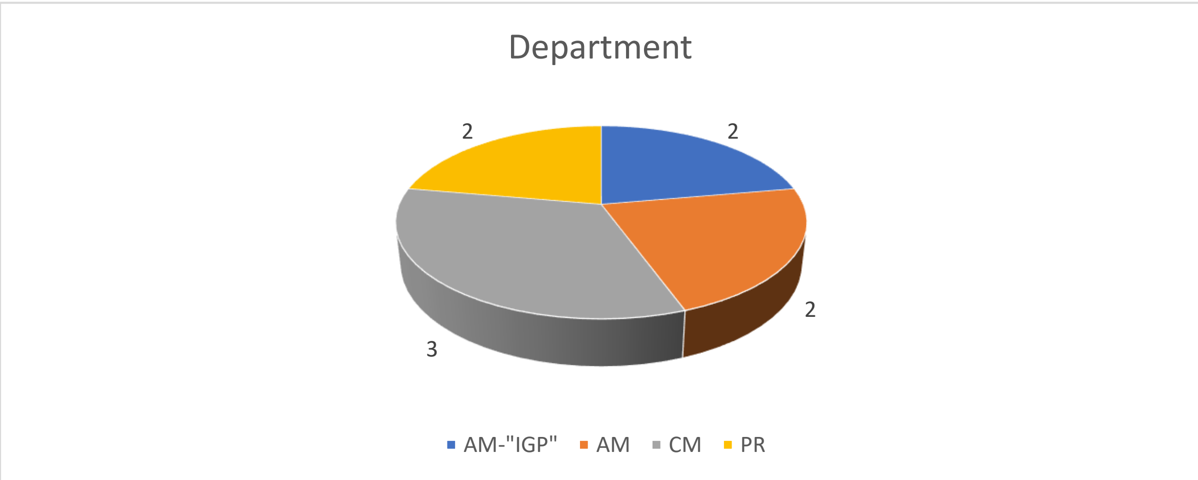


Figure 10: Q-Sort of Perspective 3 along with Factor Scores

-3	-2	-1	0	1	2	3
Information exchange in regard to freight carriers (-1,648)	Frequency (-0,805)	Nuisance of the enviroment (-0,658)	Capacity of the rail system (0,232)	Maintainability (0,920)	Safety of the rail system (1,575)	Reliability (1,710)
	Information exchange in regard to travellers (-1,187)	Psysical connection of freight flow (-0,665)	Operational costs (0,034)	Unplanned unavailability (0,809)	Availability (1,443)	
		Enviromental sustainability (-0,787)	Safety of stations (-0,427)	Planned unavailability (0,340)		
			Train Speed (-0,442)			
			Psysical connection of travellers flow (-0,444)			

Similarly to perspective 2, perspective three is not clearly defined just by looking at *"Reliability"*. The following two performance areas have somewhat similar scores, so the participants which loaded on this perspective make no distinct separation between the importance of *"Reliability"*, *"Safety of the rail system"* and *"Availability"*.

What sets this perspective apart from the second view the most is the performance areas of *"Safety of the rail system"*, *"Maintainability"* and *"Unplanned unavailability"* evident by Table 6.

Table 6: Distinguishing Statements of Perspective 3

Performance area	Perspective 1 Score	Perspective 2 Score	Perspective 3 Score
Safety of the rail system	2,17	1,03	1,57
Maintainability	-0,06	-0,75	0,92
Unplanned unavailability	-0,02	-0,70	0,81
Planned unavailability	-0,59	-0,30	0,34
Safety of stations	1,34	0,84	-0,43

This view aims for a reliable system which can be maintained safely while still being available to the users. This is indirectly stressed by the higher importance of *"Unplanned unavailability"* and *"Planned unavailability"* compared to the other two perspectives. For these participants, it would be essential to have a sound maintenance schedule and be able to cope quickly with unforeseen events while ensuring the safety of the system.

3.3.4 Consensus Statements

The consensus statements are the performance areas which did not contribute to the creation of any of the perspectives above. This means that all of the participants shared the same view on them. It is thus essential to discuss them as both the agreement about their usefulness or not, regarding the system can provide valuable insight.

If the participants agreed that a number of these areas are important, indicated by a positive score, they could help enrich the three perspectives by providing complementary points of interest. If the respondents agreed on their *"uselessness"* however, it may be a sign that they could be overlooked, to a degree, compared to other more critical areas.

On the other hand, it may turn out the consensus statements are neutral in the eyes of the respondents. In that case, they should not form priorities nor be neglected, given that the more essential performance areas are taken care of. The following table presents the consensus statements of this thesis project.

Table 7: Consensus Statements

Performance area	Perspective 1 Score	Perspective 2 Score	Perspective 3 Score
Environmental sustainability	-0,35	-0,47	-0,79
Efficient connection of freight flows	-0,23	-0,15	-0,66
Nuisance for the environment	-0,56	-0,89	-0,66

Generally speaking, a score greater than one indicates a high significance. Scores between -1 and 1 indicate neutral statements and scores less than one indicate low significance statements (Blom, 2014).

There seems to be little to no consensus amongst the perspectives over the importance of the performance areas. One could argue that there is a partial consensus about *"Reliability"* for perspective two and three, but this would not be entirely correct. *"Reliability"* set apart these perspectives from the first. Furthermore, these two perspectives were further distinguished from each other through the performance areas of Tables 5 and 6. An actual common statement would not have contributed to the creation or distinction of any perspective.

The lack of more consensus statements is surprising as the author would expect that there would be some critical common areas regarding performance amongst the people of the same organization. This survey produced only the three consensus statements of *"Environmental Sustainability"*, *"Efficient connection of freight flows"* and *"Nuisance for the environment"*.

Looking at their scores, one can deduce that the participants regard them as neutral. Their importance is *"in the middle"* of the spectrum, meaning that they will still gravitate more on the performance areas which defined the perspective. These three consensus statements would be a welcoming by-product for the participants instead of a complementary priority to the defining statements of the perspectives.

This thesis expected that *"Environmental Sustainability"* and *"Efficient connection of freight flows*" would be consensus areas since they both express main aspects of ProRail's mission. However, it did not expect them to score in the neutral zone. This is especially true for *"Environmental Sustainability"* as its importance is proliferating for Dutch society in general.

As for the area *"Nuisance for the environment"* the result seems fairly logical. Nobody wants ProRail to be a nuisance for the environment, but new projects must be constructed, and maintenance works to be done. *"Nuisance for the environment"* should be avoided when possible but it should not impede the safety or the Reliability of the system for example. This is the only consensus statement where its score was what the author expected to be.

Furthermore, the author also expected *"Physical connection of traveller flows*" and *"Operational Costs"* to be in Table 7 with scores higher than 1. Strangely, this is not the case. However, the argument can be made here that if the performance areas which created the perspectives are satisfied, these two statements can be satisfied with more ease.

A safe, reliable system which offers enough capacity and frequency would be able to provide more options regarding the connectivity of the travellers without compromising their security. These options may translate in higher operational costs, but one could argue that the value of such a system negates them. To conclude, the analysis produced three common performance values with a neutral character for the participants.

3.4 Conclusions and Limitations

The survey conducted in this research project started with the creation of a set of the performance area, and it intended to provide an answer to S.RQ1: "*What are the shared and non-shared performance areas the internal stakeholders of ProRail find important?*"**.**

The participants of the survey formed three perspectives. The first one regarded the *"Safety of the rail system"* as the most important performance area while the other two ranked *"Reliability"* in the first place. Even though at face value, these three perspectives may seem self- explanatory the survey showcased remarkable results regarding its samples.

First of all, it would be wrong to state that *"Safety of the rail system"* and *"Reliability"* are the only important performance areas. What this means is that these two particular performance areas have more influence on how the participants of the sample prioritize matters and conduct their functions. The formed the two primary *"schools of thought"* amongst the participants of the survey.

Another important finding was that even though perspective two and three are distinguished from each other, they are not entirely different. *"Reliability"* does not form a clear consensus statement, but its two perspectives agree over its importance. One could say that this performance area is *"partially"* common since its core expresses a vast majority of the respondents.

Regarding consensus, the participants provided a neutral view on the areas of "*Environmental Sustainability"*, *"Efficient connection of freight flows"* and *"Nuisance for the environment".* Their neutral character does not mean they should be neglected. On the contrary, they form an important cluster of areas to be analysed further in the report. Instead of representing distinct philosophies, they express the entirety of the sample with the same potency.

These findings have crucial implications for the rest of the research. First of all the Q-Method served its original *"compass"* purpose. The areas which defined the perspectives and the ones where consensus was reached are the two directions to follow. Based on these results, the author forms the following hypothesis.

Since the participants where split between *"Safety of the rail system"* and *"Reliability",* reliable coupling of their performance requirements is expected in the performance agreements of Section 1.1. The same is also hypothesised for the consensus statements. Instead of forming two different directions, they bring the participants together in agreement.

As for the rest *"less important"* areas a hypothesis is made that they might are incorporated in other performance areas which act as umbrella terms. This is based on the fact that even though they were found in literature, they are not explicitly stated in the MC.

To conclude, S.RQ 2: "*What is the current state of alignment between the Management Concession, Plan and Performance Management System and what potential problems can misalignment create?"* will continue the analysis by scoping down the performance requirements of the following performance areas:

1. *"Safety of the rail system."*
2. *"Reliability"*
3. "*Environmental Sustainability"*
4. *"Efficient connection of freight flows."*
5. *"Nuisance for the environment"*.

The analysis will also examine if the rest of the performance areas found in the list of Table 3 are expressed in the performance agreements of ProRail.

It should be noted at this point, that this survey is not without its limitations, and future research could broaden its scope. A similar survey can also include external parties such as train operators or rail contractors. Their input might give useful information to redefine or even validate the clusters or consensus areas of this report.

3.5 Discussion of the Q-Method results

The results of the Q-Method can be indicative of how ProRail personnel operates in its daily work life. The, essentially two, perspectives formed around performance are quite interesting. One could argue that the importance of a safe and reliable system is no surprise.

After all, the mission of ProRail itself states that the organization strives for these two aspects. However, the results indicated that ProRail succeeds in embedding their importance to the daily work ethic of its personnel. It is one thing to say that something is important and another thing for it to actually is.

The three perspectives formed, is a strong indication that the personnel of ProRail understands and respects its mission and share its values. So even if it is not a big surprise that these two areas formed the schools of thought of the survey, it is encouraging to observe this connection.

The common performance areas, on the other hand, indicate what might become urgent matters in the future. Sustainable development is of great importance right now, especially in the Netherlands, which is a leading nation on it. The system is safe and reliable, but this must not come at the expense of the environment. Currently, ProRail put much effort into transforming its system with friendliness to the environment in mind. An example of this is the Delft – Zuid Station, now known as Delft Campus.

ProRail went into much effort to transform a small old station in South-Holland, into a self-sustaining, modern part of the system. The station produces a great deal of the needed power by solar panels contributing to the vision of a sustainable network. This transformation requires much effort from all the members of the organization. It is welcoming to see that this effort is shared among them.

Along similar lines, rail transport of goods is much more environmentally friendly than air or road transport. Furthermore, it could be as much, if not more efficient, as it is much more direct. The second common performance area of *"Better connection of freight flows"* expresses these aspects. ProRail has an extensive and successful passenger network.

Although its freight network is extensive, some revisions could be made to attract more businesses. Again this effort will require the cooperation of many organizational departments. The indication that a better connection in the freight network is common among ProRail's personnel is a positive basis for this endeavour.

Last but not least there is a common area of *"Nuisance of the surrounding environment".* The Netherlands is a small country where space is hugely valued. Its exploitation should be done most efficiently. By carefully planning how and where the network will expand, its nuisance can be limited. The fact that this area was common for the sample of the survey may indicate that ProRail, in general, focuses its efforts in finding the best solutions for the expansion and maintenance of its system.

4 Performance Requirements and Current Alignment

Chapter 4 will elaborate more on the performance indicators connected to the performance areas of Chapter 3. The Q-Method conducted in the previous Chapter serves as a *"compass"* for this thesis. The factor score of each statement provides a hierarchy for them. Statements that scored higher seem to be more critical. The ones with low scores, albeit necessary for a well-performing system, do not seem to be the focus of ProRail

Of particular importance are two kinds of performance areas. The first category involves performance areas that defined the three clusters produced by the Q-Method. These are *"Safety"* and *"Reliability"*. The second category involves common performance areas. Instead of creating a specific perspective, the importance of those areas was universal for all participants. The shared performance areas produced by Q-Method are, *"Environmental Sustainability" "Efficient connection of Freight flows"* and *"Nuisance for the Environment"*.

Given the importance of these areas, Chapter 4 will attempt to analyse their performance indicators as they are stipulated in the MC, MP, and the PMS of ProRail, otherwise known as QlikView. This analysis intends to assess the current alignment of the selected performance areas in between the three sources mentioned above and can be found in Section 4.1.

The way alignment is assessed is based on the aforementioned *"line of reasoning"* between the performance requirements of the chosen performance area. The agreements should have enough cohesion with each other so that someone would be able to follow a specific requirement in all of them.

This requirement does not have necessarily to be stipulated with the exact same words or measured with the exact same procedures. What is welcomed though is for it to remain consistent with the general objectives of ProRail and translate those into concrete goals which, when achieved makes this objective possible

Last but not least, Section 4.3 concludes the Chapter by summarizing its results. It provides an answer to both parts of S.RQ 2 (a) "*What is the current state of alignment between the Management Concession, Plan and Performance Management System?"* and *(b)"What potential problems can misalignment create?"*. This answer is used to proceed to Chapter 4 to provide final advice.

4.1 Current State of Alignment

The focus of Section 4.1 is to assess the current state of alignment for the performance areas selected based on the Q-Method results. This is being done by analysing the performance indicators of the areas in three different sources: the MC, MP, and QlikView, the PMS of ProRail.

The author hypothesised beforehand that the shared performance areas would have been the ones with the most well-aligned indicators. *"Safety"* and *"Reliability"* are essential but not shared and express distinct *"schools of thought"* inside ProRail. However, this was not the case. *"Efficient connection of Freight flows"* was an exception but only because it forms a performance indicator of *"Reliability"*.

After analysing the MC, MP, and QlikView, it is concluded that *"Safety"* and *"Reliability"* are aligned in all three levels. The reader can follow their performance indicators from top to bottom and vice versa. Their break down is consistent and can be summed up to judge if the organisational objectives are met. There is a healthy balance in these areas. Their requirements are not too generic, so they give direction to ProRail.

At the same time, the formulation of these requirements leaves room for interpretation for lower levels. This is important as lower performance requirements are connected to daily tasks and respect the professionalism of specialists and low-level managers. Safety, for example, begins by providing several general goals in the MC. These goals are branched out and analysed further in the MP and the end, they form distinct safety categories in QlikView. This tree structure minimises broken links as all of its "branches" stem from common roots. Sub-Sections 4.1.1 and 4.1.2 provide more details on this analysis.

The other two common performance areas seem to lack this line of reasoning in their break down, the deeper someone goes in the organisational levels. Their trackability and connection to higher or lower indicators are lacking.

Sometimes it seems that performance indicators in QlikView sprout out of nothing while having little to no connection in the Management Concession or Plan. Furthermore, the way *"Environmental Sustainability"* and *"Nuisance for the surrounding Environment"* are presented in both documents, and ProRail's software seems, connected. Their indicators try to tackle the broader area of a sustainable rail system.

Some of them seem to repeat themselves or try to measure the same notions, which create confusion for the reader. This is why they are both analysed in Sub-Section 4.1.3 and given the name *"Sustainability"*.

4.1.1 Safety in the MC, MP, and QlikView

The Management Concession

The Management Concession of the Dutch Railway system was signed in 2015 between ProRail and the Ministry of infrastructure and governs the way the system should be maintained and perform until 2025. The first mention of the performance area of *"Safety"* is being done in Article 4, Paragraph 2, Section C (ii). The MC states that: "*The safety of the system includes the safety of all parties making use of the system as well as the safety of the rail system itself."* The Management Concession analyses the notion of *"Safety"* in more detail in Appendix 1. There it offers information indicators about *"Safety"* as one can observe in Table 8.

Table 8: Performance and Information Indicators of performance area *"Safety"* (Ministerie van Infrastructuur en Milieu , 2015) (Translated from Dutch)

Performance Area	Information Indicator	Performance Indicator	Bottom value	Target Value
Safety	Number of collisions with level crossing users	-	-	-
	Number of train to train collisions	-	-	-
	Number of derailments	-	-	-
	Number of Signal Passed At Danger passages	-	-	-
	Number of SPAD passages where danger reached	-	-	-
	Number of occupational safety incidents	-	-	-
	Number of environmental violations (determined by an authorised person)	-	-	-

The indicators provided in this Table are deemed helpful because they do not constrain the notion of *"Safety"*. They instead open up new branches were *"Safety"* can grow. This is in line with the first mention of the performance area in Article 4. The *"Number of Train to Train collisions"* for example represents an aspect for the safety of the system itself. *"Number of collisions with level crossing users"* represents both the safety of the passengers and the general public safety near the tracks. In contrast, the *"Number of occupational safety incidents"* covers the safety of maintenance personnel, for example.

All these indicators are branched out of this single sentence of Article 4, Para. 2, Section 3 (b). The only exception is the last indicator which does not seem to belong in this domain but rather in sustainability. This indicator is the only one which *"is lost"* in the MP and QlikView.

Another observation for the MC is that it does not provide any performance indicators. This may seem strange at first, but there is a logic behind this choice. As mentioned above the MC is signed between ProRail and the Ministry of Infrastructure and Environment. More specifically, the top management of ProRail is involved in this procedure. A performance indicator is accompanied by bottom and target values.

To put it very simply, one should be alarmed if the result is below the bottom value while at the same time, he should strive to attain the target value of the indicator. While such a structure can give purpose to lower organisational levels, it can result in adverse effects. The stipulation of performance indicators with bottom and target values in this point can be perceived as forceful and even disrespectful by mid and low levels.

Safety specialists, for example, may feel threatened or even disrespected if top management solidifies by itself how they should conduct their work (Malina & Selto, 2001). This can lead to a *"numbers game"*. Lower levels could find a way to *"fool"* the system by providing *"pretty"* numbers without thinking of the bigger picture (Carmona & Gronlund, 2003). Quick solutions which are used only to keep top management happy can hurt the organisation (Wouters & Wilderom, 2008).

On the other hand, by keeping the interpretation and definition of Information Indicators open for lower levels top management respect their professionalism and knowledge (Wouters & Wilderom, 2008; de Bruijn , 2002). In this way, the chances of recognising the performance indicators and the measurements themselves are much higher and prevent short-sighted solution to keep top management happy (Wouters & Wilderom, 2008).

Another finding connected to the performance areas presented in Chapter 2 is that *"Safety"* is used as an umbrella term. In Section 2.4, the author hypothesised that low ranking performance areas might be incorporated under an umbrella term.

"Safety" seems to follow this format. Two of the 17 performance areas of Chapter 2 are "*Safety of the railway system"* and *"Safety of Stations".* In the MC and the other performance agreements both of these areas are elements of the umbrella term *"Safety".* in other performance areas which act as umbrella terms. This is based on the fact that even though they were found in literature, they are not explicitly stated in the MC.

The Management Plan

The Management Plan is the annual report of ProRail on the railway system regarding its past and future performance and the most significant incidents of the previous year. From a first glance, it follows a different structure by the MC. However, this is logical as the one is a much more formal legal document and the other a technical report.

In the MP, the performance area of *"Safety"* is addressed in Chapter 4. There ProRail elaborates on the five domains where it wishes to steer its focus regarding safety. Under every field, the MP provides an overview of the general performance of ProRail the previous year and what projects are being initiated to improve the situation further. The five domains are (ProRail , 2019):

1. *Better safety qualification for its external partners and itself.*
2. *Better suicide prevention on the rail and general societal safety.*
3. *Improving the safety of STS (light signalling) train intersections.*
4. *Improving the safety of level intersection with road traffic.*
5. *Improving the safety of passengers in stations when they change platforms to board another train.*

All of the above domains are derived from the Information Indicators of Appendix 1 in the MC. The first domain makes the information indicator *"Number of occupational safety incidents"* more specific. By upgrading the safety qualification of ProRail's personnel and its external partners, the *"work-floor"* is less prone to accidents, and a culture of safety is developed.

Level crossings are the most easily accessible parts of the system, ruling out station platforms. Unfortunately, they become often the sites of suicide incidents and severe traffic accidents. Furthermore, many accidents occur when a passenger needs to change trains in a station.

The information indicator of "*Number of collisions with level crossing users"* is evolved in the MP to include not only the safety of the level crossings but also the safety of the stations and general society. This is represented by domains two five and four.

Examples like this one showcase the importance of freedom of interpretation. If the MC provided unchangeable performance indicators, this branching out would have been impossible. The current way the MC and MP deal with safety encourages ProRail to include its many aspects in the performance of its system.

Domain three, on the other hand, is a direct outcome of the information indicator *"Number of Signal Passed At Danger passages"*. Off course, there is nothing wrong to translate or paraphrase an information indicator in lower levels directly. Neither it is hurtful to combine indicators. In this stage of performance requirements forming, the situation is still fluid and solid definitions and indicators are not advised (Eckerson, 2009).

The PMS (QlikView)

QlikView is the Performance Management System of ProRail and provides the KPIs which govern the operations of the organisation. *"Safety"* forms one of its dashboards. This is the first instance where the user can observe specific KPIs as it concerns more the operational level of the organisation. However, the system is capable of offering a broad view of the system's safety while still giving the option to zoom into specific regions.

Here the information indicators produced by the MC and the MP are solidified into three main categories:

1. *Travel with Safety (Veilig Reizen)*
2. *Work with Safety (Veilig Werken)*
3. *Live with Safety (Veilig Leven)*

Two more categories exist in the Safety Dashboard in the form of "Overarching (KPIs)" and "Management Plan". The second one is of particular interest as its KPIs are directly connected to the MC and MP. This link can indicate how well ProRail is performing on its strategic goals.

The three main categories in the "Safety" dashboard have their own KPIs. Many times a KPI can have one or more sub-KPIs. Generally, the Dashboard creates a sense of a *"tree"*. The MC laid down the roots, the MP formed the stem and then QlikView the branches. One could say that the sub-KPIs represent extensions of these branches.

Even if they are a small part of the "tree", one can still pick one and find his way back to the roots. The following figure visualises the previous metaphor with an example.

Figure 11: KPI "Collision Train with Train" in QlikView

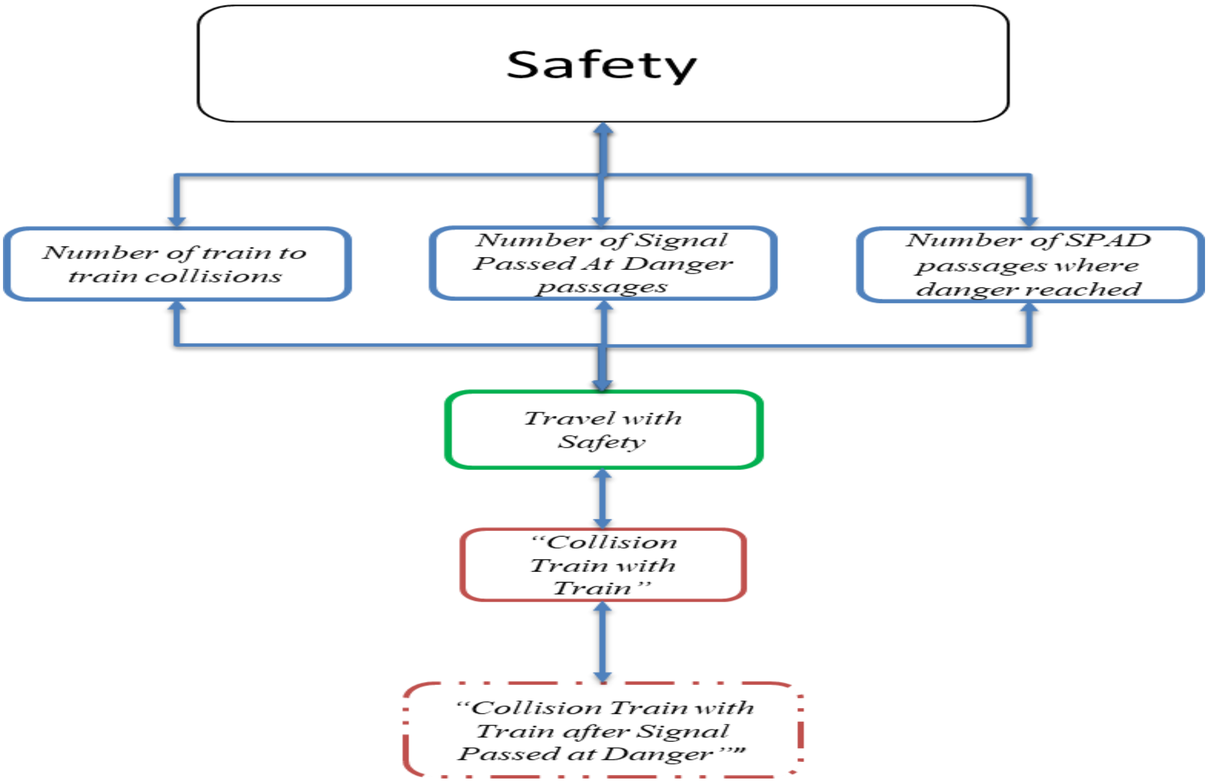
KPI's Veiligheid

Domein	KPI's	Jaar 2019 Aantal	Norm 2019	Jaar 2020 t/m jul Aantal	2
Veilig Reizen	Botsing trein-trein	1		0	
	Botsing trein-trein na STS	0		0	

As mentioned before the user can select to observe the KPIs of a specific Administrative region or Contract area. QlikView also offers the option of *"Geographical Safety",* which provides a visualisation about how the system and in extension the A2 corridor performs on safety. This Dashboard, however, is limited to KPIs directly connected to the MP.

For the example of Figure 11, the author selected the KPIs regarding "Safety" for the category "Travel with Safety". One of the KPIs of this category is *"Collision Train with Train"*. In turn, this KPI has the sub-KPI *"Collision Train with Train after Signal Passed at Danger".* In the case of *"Safety,"* it is entirely possible for someone to pick this sub-KPI and trace it back to the MC. The following figure presents to the reader this procedure while at the same time it visualises this *"tree of performance".*

Figure 12: Tracing the KPIs of *"Safety"* to the MC



The blue rectangles represent the Information indicators of the MC. After they are further analysed in the MP, these three elements form parts of the category *"Travel with Safety".* One KPI that can measure the safety of the travelling experience is *"Collision Train with Train".* A KPI which can further specify what collision *"Collision Train with Train" means is "Collision Train with Train after Signal Passed at Danger".* This figure can be read both top-down and bottom-up.

Both directions follow a line of reasoning and contribute to one another. It should be noted that this is a minimal example, but the same traceability also holds for the other KPIs of QlikView. One can note that in this example, three different information indicators from the MC result in the same sub-KPI in the QlikView. This can be entirely possible and even sought out by performance management teams.

The role of a PMS is not to fill the organisation with KPIs for every single detail. Organisations with an abidance of KPIs report sub-optimal performance and adverse behaviours from personnel regarding the measurements (Eckerson, 2009; Wouters & Wilderom, 2008).

The goal of a PMS should be to quantify and make apparent the processes which lead to performance with the use of Performance Indicators (Evers, Overkamp, & Wilderom, 2009). If an organisation can find one performance indicator which provides information about more than one tactical or strategic goals, then this can be seen as an advantage and not as a shortcoming (Eckerson, 2009).

Conclusions over Safety

The process of creating this Dashboard follows most of the strategies presented by de Bruijn (2002) to create a useful PMS. By defining a small number of fundamental indicators in the MC ProRail, and in extension, the Ministry, create room for interpretation. Lower organisational levels still have the freedom to develop and adjust KPIs according to their needs.

It is far less likely for such a practice to be perceived as a threat by lower organisational levels. Top management provides them with a foundation and a set of *"basic rules"*. In turn, they have the freedom to build on them based on their knowledge. This open *"enabling"* procedure creates more trust and respect on the PMS and its application (Wilderom, Streatfield, & Wouters, 2009).

The fact that the area of safety is broken down to sub-areas with their own KPIs and sub-KPIs indicate a welcoming attitude towards definition plurality (de Bruijn , 2002). Passengers might express safety with a safe journey. For a maintenance worker, it may represent a safe working environment. The way the Dashboard is structured respects many different parties dependent on ProRail, both internal and external. In this way, the results can also be interpreted in different ways serving different purposes (de Bruijn , 2002).

The separate category of KPIs regarding the MP is also a welcoming addition. The other KPIs can be used to assess the operational performance of the organisation. The KPIs connected to the MP can be used to determine the strategic performance of ProRail. According to de Bruijn (2002), a PMS with agreements about where and how its KPIs will be used results in less shielding towards it and creates an open, trusting environment.

The performance of safety creates a robust *"tree"* of KPIs. One can follow them from top to bottom and vice versa and understand how they contribute to the strategic goals of ProRail. This is a prime example that alignment of performance indicators does not require them to be the same at every level.

The author would like to think about alignment as a process of reasoning. Why is a KPI in the Dashboard? Does it contribute to the overall objectives ProRail has for this performance area? Can somebody go back and forth the performance agreements of ProRail and scope down its origin? Regarding the Safety Dashboard, the answer is yes.

4.1.2 Reliability in the MC, MP and QlikView

The Management Concession

As with *"Safety"*, the first mention of *"Reliability"* in the Management Concession is being made in Article 4, Paragraph 2, Section C (i). According to the MC, the *"Reliability"* of the system includes *"…the reliability of the main railway infrastructure and traffic management, its availability, the malfunction sensitivity and the number of major disturbances and their duration."* The performance area is further broken down in Appendix 1. In contrast with *"Safety"*, the MC provides Performance indicators for *"Reliability"* along with bottom and target values.

Table 9: Performance and Information Indicators of performance area *"Reliability"* (Ministerie van Infrastructuur en Milieu , 2015) (Translated from Dutch)

Performance Area	Information Indicator	Performance Indicator	Bottom value	Target Value
Reliability	Number of freight trains on time at the border with its main track	Punctuality <3 min total passenger traffic	87,0%	90,0%
	The requested timetable versus the realised timetable (freight transport)	Traveller punctuality <5 min Main Railway Network (joint KPI with NS)	90,0%	92,3%
	The requested route versus realised route (freight transport)	Punctuality of regional series (<3 min)	93,0%	94,0%
	Number of freight paths that connecting to the international network	Punctuality <3 min High-Speed Line	79,5%	82,0%
	Train paths provided to freight transport following the schedule	Punctuality freight traffic	80,0%	82,0%
	Request response times for freight paths inside agreed standard time	Train paths provided	97,5%	98,2%
	Number of overload statements	Routes of Interest (joint KPI with NS)	93,7%	95,6%
	Number of TAOs* resulted from third parties.	Number of influenceable TAOs (technique and processes)	5900	5200
	Number of TAOs resulted from weather conditions.	Customer nuisance as a result of malfunctions	-	-
	Failed trains	-	-	-
	Realised connections on nodes	-	-	-
	Average recovery time of TAOs	-	-	-

*TAO: Train Service Affecting Irregularity

This Table is a first stage operationalisation of the sentence found in Article 4. Its first six Information Indicators represent the Reliability of the system itself and sound traffic management. The following six indicators provide information over availability as well as the number of malfunctions and their repair time.

From these information indicators, the MC forms the first performance indicators for the area of *"Reliability"*. The indicators measure the Reliability of the system in terms of punctuality, including how many requested routes were realised. Furthermore, indicators about the systems unavailability provide crucial information over malfunctions and the time it took to rectify them.

This format is another validation of the "umbrella" hypothesis made in the conclusions of the Q-Method. It makes evident that the performance areas of *"Reliability, "Availability" and "Unavailability",* are interrelated. The *"umbrella"* term ProRail uses to express them is *"Reliability".*

Given the analysis of *"Safety",* one could argue that the establishment of performance indicators this early in the process might hurt its realisation. If performance indicators about *"Safety"* would have been perceived as a threat by lower levels, what makes *"Reliability"* different? While this argument seems valid at first glance, this is not the case.

The MC provides notes on both its information and performance indicators. These notes explain that this Table is not *"set in stone"*. The performance indicators of this Table have a provisional nature. They are subject to change from the lower organisational levels, should they feel that they do not represent the performance area of *"Reliability"* adequately. Furthermore, the information and performance indicators regarding freight traffic are to be further developed with the help of the freight sector.

The fact that *"Safety"* did not have any performance indicators does not mean that every performance area must abide by this format. After all, freedom of interpretation is not reserved only for low organisational levels. Neither have these levels a monopoly on meaning giving (de Bruijn , 2002).

Different performance areas might require different approaches. *"Safety"* follows a much more bottom-up approach. Top management sets only several basic rules, and then lower levels use their specialised knowledge to develop and solidify them (Palumbo, Maynard-Moody, & Wright, 1984). *"Reliability"* on the other hand has a higher dose of the top-down approach in it. In this approach, top management is the main actor. The plan it drafts is almost an irrefutable truth, and few to none objections can be made by lower levels (Lupton, 1991; Matland, 1995)

Since both the information and performance indicators have a provisional nature, *"Reliability"* follows a mix of both approaches. Interim targets can be set, and as long they are open to change lower levels will not perceive them as threats (Eckerson, 2009; Wouters & Wilderom, 2008). They can either accept them or adjust them. Even though there is less room for manoeuvring, the reliability requirements are not forced upon the rest of the organisation. The only difference is that their changes and objections should fall along the lines of the prescribed requirements.

The Management Plan

In the MP, Chapter 2 provides an extensive review of the manner ProRail was able to satisfy the performance indicators regarding *"Reliability"*. Furthermore, it elaborates on its plans on how to keep this adequate performance. Regarding the indicators themselves, they are further analysed. Definitions are given along with measurement systems.

The performance indicators remain mostly the same as the ones in the MC. The only ones which were reduced are *"Passenger punctuality Main Railway Network < 5 minutes"* and *"Passenger punctuality High-Speed Line < 3 minutes"*.

This is an example of what was described in the previous paragraph. Lower levels, in this case, the top and mid-management of ProRail may have realised that these indicators were redundant, and their information was described accurately by the other ones. Given the way "Reliability" is communicated, they have the freedom to merge or redact these provisional KPIs altogether.

For the performance area of *"Reliability",* the MP build on the MC rather than branching out, like with *"Safety".* The information about this particular area regards more future ProRail projects to safeguarded than the creation of "footholds" for the production of more KPIs. In contrast with *"Safety"*, the only thing the MP does for the performance indicators of *"Reliability"* is to define and measure them.

The alignment, in this case, is much more apparent even from this stage. Instead of following a line of reasoning, *"Reliability"* uses mainly the same metrics to define if the strategic goals of ProRail are met or not.

This is another indication that not all performance areas should be tackled in the same way. Some are *"softer",* having many aspects of being measured and require more creativity in their indicators. Some are sharper from the start. They need a small number of measurements which are suited for all organisational levels.

A positive observation so far is the following. Even though "Reliability" falls under the second category, as described in the above paragraph, it is still not *"forced"* on lower levels. The author argues that this is one of the reasons ProRail performs adequately on "Reliability". Personnel does not perceive these indicators as a threat nor as an *"insult"* to their professionalism. Thus it is much more likely to truly strive to achieve long term goals, rather than to implement a fast solution for a short term satisfaction of top management (Wouters & Wilderom, 2008; de Bruijn , 2002; Malina & Selto, 2001).

The PMS (QlikView)

The area of Reliability is not presented directly by QlikView. Instead, there exist three options. "Passenger Transport", "Freight transport" and "Nuisance". The third option expresses the availability of the system in terms of *"Customer Annoyance", "Malfunctions"* and *"Function Recovery Time."*

The other two options use *"Punctuality"* as the primary measurement of *"Reliability".* In the case of Passenger transport also the *"Failure of Trains"* is used along with *"Passenger Punctuality".* The freight sector uses *"Punctuality"* and "*Transit Time*" as its main KPI categories. Furthermore, the common performance area of "*Efficient connection of freight flows"* is expressed with the *"Transit Time"* performance indicator in the Freight Transport dashboard.

This means that ProRail not only measures its performance regarding this sector by punctuality. The amount of time spent when moving goods from one point to another is also taken into account. The inclusion of this indicator is positive Since this was equally important for the respondents of the survey in Chapter 5.

All of these dashboards build on what ProRail is expected to deliver on *"Reliability"*. The Passenger and Freight Transport dashboards along with their KPIs are connected to *"…the reliability of the main railway infrastructure and traffic management…".* The Dashboard of Nuisance is connected to the last part of the sentence *"…its availability, the malfunction sensitivity and the number of major disturbances and their duration.".* ProRail successfully operationalises the aspects of *"Reliability"* which were laid down in its previous agreements, in its PMS.

Each of these choices presents to the user an even more detailed version of them. For example, the *"Punctuality"* tab in the Passenger Transport category displays the punctuality of trains given 3 minutes of slack. In it, the user can get information about different operators, train line groups and periods as well as detailed representation of how punctuality is distributed for each month of the year. This information remains consistent from the MC until the general overview of the PMS.

To zoom into the system, the user can use the "Geographic punctuality" tab. While useful it only provides information for the KPI *"Punctuality < 3 min"*. Nevertheless, the user can observe the train punctuality in the areas which (s)he wishes. For example, along the A2 corridor, the performance is according to the standards.

A striking difference in safety is the representation of KPIs. Instead of a list, Passenger and Freight transport dashboards make use of figures which can be adjusted depending on the choices of the user on time or operator for example. This indicates the difference between performance areas. While a list of KPIs with bottom and target values may be enough to describe safety, it may be lacking for Reliability.

Safety incidents are being dealt with as individual disturbances of the system. However, Reliability is much more continuous. It is *"always there".* Safety issues, on the other hand, are far in between, given that there is an efficient safety culture. So, *"Reliability"* requires a different approach to be measured and presented.

The lack of bottom values in the figures representing Reliability KPIs may indicate an openness towards interpretation. This can enrich the PMS and make personnel more friendly to its use (de Bruijn, 2002) but at the same time, both the MC and MP presents bottom and target values. These values can be displayed in the system overview since they are already decided. Otherwise, this difference may create confusion. Since the values are in the other two documents, they should have been in the PMS too.

Nevertheless, the same connection in the different levels of *"Safety"* can also be made with *"Reliability".* In this case, it is even easier to make this connection as the changes in indicators between the MC, MP, and QlikView are minimal.

Conclusions over Reliability

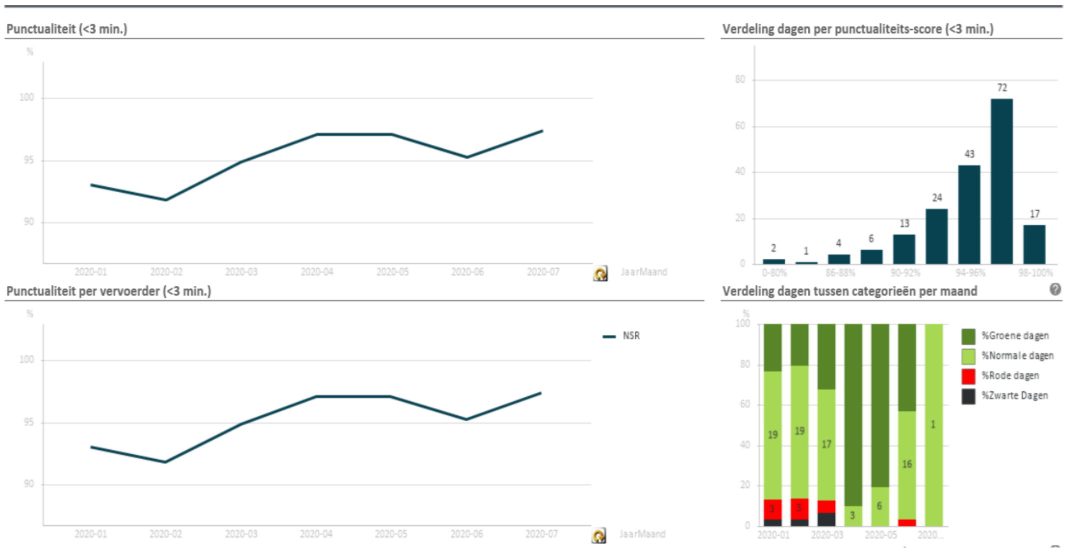
"Reliability" provides sound reasoning on why its KPIs are there and how they contribute to the strategy of ProRail. In this case, their alignment is more evident as they remain mostly unchanged throughout the levels.

This performance area also indicates the different approaches one could take and still achieve alignment. There is no *"tree of Reliability"* as with *"Safety"*. However, the information remains connected and can be traced back to the MC and the strategic goals of ProRail. An example of this fact is the "*Punctuality <3 min total passenger traffic"*.

The MC defines it as a KPI. The MP elaborates more on it by providing a measurement system to assess it. In the end, QlikView uses this system and provides more detailed information about the KPI. In its Dashboard, the user can observe, for example, how punctuality is distributed on a defined amount of time.

The system also presents different categories regarding punctuality on a monthly or daily basis. The categories regard green, regular, red and black days. Each of these represents good, regular, bad and very bad days in a month regarding the Reliability of the system or parts of it. The following figure regards the operations of NS in the region of Amsterdam. In this case, the two graphs on the right can be considered sub-KPIs which feed the main KPI on the left. In extend, this KPI is directly connected with the ones in the MP and the MC.

Figure 13: Detailed representation of the KPI *"Punctuality < 3 minutes"* in QlikView



To conclude *"Reliability"* is another example of an aligned performance area. It showcases a different approach than *"Safety"* which can still deliver, consistent and connected KPIs with the strategic goals of ProRail. The fact that this difference exists reinforces the idea that to provide alignment, one does not necessarily have to follow the same "rules" for every subject. Freedom of meaning giving and interpretation should exist (de Bruijn , 2002), and help to deliver results such as in the case of both *"Reliability"* and *"Safety"*.

4.1.3 Sustainability in the MC, MP and QlikView

The Management Concession

The performance areas of *"Sustainability"* is first covered in Article 4, Paragraph 2, Section C (iii). The Management Concession states the following over this performance area: *"(the) performance area (of) sustainability, includes at least local environmental impacts and emissions of greenhouse gases resulting from the implementation of the concession and the use of the main railway and involves the efficient use of responsibly sourced raw materials, spatial planning quality and the preservation of biodiversity in the areas of ProRail activity."*

The above definition includes both the common performance areas of *"Environmental Sustainability"* and *"Nuisance for the surrounding environment".* It is positive that the first definition of *"Sustainability"*, as understood by ProRail, includes both of these elements which proved to be equally important for ProRail's personnel in their line of work. Given the structure of both *"Safety"* and *"Reliability,"* the author hypothesised that this performance area would follow a similar line of thought. If that was the case, the author expected the Management Concession to provide a table with at least Information indicators, covering the aspects of *"Sustainability"* as they are described in Article 4. This expectation was more definite about this performance area as its elements were of equal importance for the respondents of the survey in Chapter 4.

However, the MC seems to fail to provide more information over what is expected from ProRail ion this matter. In Appendix 1, only one information indicator is provided for *"Sustainability"*. This information indicator is *"CO2 footprint".* Although it can be useful in only describes one facet of the performance area as it is explained above. The aspects of spatial planning quality or the use of responsibly sourced raw materials are wholly neglected.

The other two performance areas, covered in this Section, built on their initial definitions. The Sections of Article 4 provided the first "tools" and Appendix 1 dissected the original definition in district elements. Both the MP and QlikView followed this format. "Sustainability" however seems to abandon this logic. Given this finding, the author hypotheses' that the alignment of this particular area will not be as strong as the one of *"Safety"* or "*Reliability".*

Both the information and performance indicators of the previous cases provided enough material to develop and broaden the performance areas. The singe information indicator of "Sustainability" could be used as a foundation for its environmental aspect. However, the remaining aspects are left out of this process.

The Management Plan

The area of sustainability is covered in the third Chapter of the Management Plan. In contrast with *"Reliability,"* no performance indicators or additional information indicators are given. The way the Chapter is built is more akin to "Safety". The MP presents four categories where sustainable development is expected from ProRail. These categories are:

1. *Mobility*
2. *Energy*
3. *Materials*
4. *Nature*

The first two categories involve future projects of ProRail to boost the number of passenger and freight companies that use rail instead of the road and air transport. The second involves initiatives for more efficient energy use and production. These two elements could be connected with the information indicator of the MC.

Generally speaking, rail transport is much less taxing for the environment than other modes. Furthermore, both sustainable energy sources and more efficient use of energy are "greener", environmentally friendly practices.

Under the Materials category, the MP elaborates on projects which aim to the adaption of a circular economic model regarding the materials used ProRail's projects to minimise the adverse effect of their production on the environment. The Nature category involves projects which aim at a balance with the surrounding nature of the railway system. These include passages for local fauna and ground materials which do not hurt the surrounding flora.

Similar measures and guidelines can also be found in the *"Explanatory Notes to the Management Concession 2015 – 2025"* in the MC. While the two documents are well connected in this regard, they make little effort to give a direction in the way ProRail can define whether or not it satisfies these environmental aspects. The MP does not attempt to produce information or performance indicators out of this Chapter for the area of "Sustainability". Appendix 4 presents the same single information indicator which can be found in the MC.

Although as stressed before it is important not to *"force"* performance standards on lower levels, some direction is advised (Eckerson, 2009). "Safety" can be a prime example. Its information indicators are still quite general in the MC. The MP provides more concrete action on how ProRail intends to tackle the matter. In the end, QlikView provides reliable KPIs which covers all its aspects. The way "Sustainability" is unfolding so far in the analysis might not be the most helpful to determine if and when ProRail satisfies this performance area.

The PMS (QlikView)

In QlikView, there are two dashboards connected with *"Sustainability".* The first one is called *"Environment".* This Dashboard presents KPIs connected with environmental violations and environmental reports done by ProRail. Although the user can zoom into Administrative regions, there are no data for contract areas. In contrast with the above subsections, it seems that this Dashboard does not go all the way down to the operational level.

Furthermore, its KPIs are not connected to the MP or MC. They provide an overview of how and if ProRail respects the environment, but this type of measurement has not been clearly defined in upper levels. So far, there is one clearly defined goal, and that is the CO2 footprint of the organisation. This list could be connected to the fourth category of sustainable development in the MP. However, there are still no strategic guidelines to determine whether or not these KPIs are indeed useful for ProRail.

The other Dashboard about environmental sustainability is called "*Sustainability*". In it, the user can find three categories directly connected to the MP. They provide useful information over energy usage and production, protection of the surrounding nature and the reduction of material usage impact on the environment. The format used in the presentation of the KPIs is akin to the one of *"Reliability".*

For example, graphs with the current and projected energy usage are provided. Furthermore, each of these smaller dashboards provides a geographical representation of the system where the user can observe smaller parts of it. While helpful, these dashboards suffer from the same problem with the previous one. They cannot be traced back and connected to strategic goals set in the MC. Their connection is limited to the MP.

They could contribute to the general goals of ProRail regarding sustainability but then again, how could someone know? This question was not necessary in the cases of *"Safety"* of *"Reliability".* Moreover, the fact that some KPIs do not seem always to continue to lower organisational levels makes the alignment of this area lacking compared to the other two analysed in the previous sub-sections.

Conclusions over Sustainability

"Environmental Sustainability" was proved to be a common performance area. Based on this fact, the author expected to find a much more reliable connection between the MC, MP and QlikView regarding its performance indicators. The current way this performance area is built lacks the feel of a *"tree of requirements"* or a direct connection with strategic objectives.

It is not to say that the KPIs for this area are not useful. They might as well contribute to a very sustainable system. However, would they help ProRail's goals? Moreover, what are these goals? One could say that they are explained in the MP. While this is not entirely wrong, chapter 3 of the MP regards more future projects and initiatives of ProRail and its partners for a more sustainable system. It does not set goals, or built upon goals set in the MC in any way.

The missing links in the case of *"Sustainability"* are the lack of strategic goals and the disconnection of performance requirements between the analysed performance agreements. In hindsight, this may be a logical conclusion. Since there is no initial direction, the goals of this performance area are re-iterated in each agreement. In the end, its KPIs, while indicative of the daily situation, may not be suitable to assess its overall state.

The production of the current KPIs is indeed connected to these initiatives and projects, but how they help the overall system is still unclear. This is in contrast with *"Safety"* and *"Reliability"* where their KPIs can be connected with both future ProRail initiatives and strategic goals.

4.2 Conclusions on Current Alignment

Chapter 4 analysed further the results of the Q-Method. The analysis focused on the performance areas that defined the three perspectives of Chapter 3. Moreover, common performance areas were analysed. The scope of the analysis was to examine how aligned these areas are between three sources. The Management Concession, the Management Plan and the PMS of ProRail. The reader should treat the term *"alignment"* in the way it was defined in the first chapter of this project.

In the case of the performance areas described in Section 4.1, ProRail seems to adopt a combination of the top-down and bottom-up approaches for *"Safety"* and *"Reliability"*. Top management still has control over goals and how to achieve them. Lower levels, however, still have the freedom to build on what they received. They are not forced to follow to the letter what top management thought as there is room for interpretation. As mentioned in Chapter 2, this fact is quite positive in the building of a successful PMS.

The results of Section 4.1 showcase that, ProRail has a healthy level of alignment. This is especially true for the performance areas which defined the three perspectives of Chapter 3. Both *"Safety"* and *"Reliability"* are deemed aligned, as they both follow an unbroken line of reasoning. This line can be followed from top to bottom and vice versa. Another important finding is that there are several approaches to achieve this.

In the case of "*Safety*", a *"performance indicators tree"* is build. Goals are set in both the MC and MP by high and middle management. When it comes to QlikView, these goals are clearly and consistently broken down in KPIs with bottom and target values. Each one of these KPIs contributes to the mission of ProRail for a safe system.

On the other hand *"Reliability"* follows a much more traditional aspect. There is less deviation in its performance indicators between the different levels. However, the PMS offers a much richer picture with suitable KPIs and breaking down options. Another important fact is that this format is not forced to lower levels. The MC clearly states that its performance indicators are provisional and subject to change. The choice of meaning giving and interpretation is there. Whether or not they are going to be used is another matter.

For the common performance areas, the Chapter draws the following conclusions. *"Efficient connection of freight flows"* forms one of the KPIs of *"Reliability"*. It is used in the Freight Transport Dashboard with the name *"Transit Time"*. The KPI measures the amount of time spent when moving goods from one point to another and thus expresses how reliable the moving of freight is in the system. As with the other indicators of *"Reliability"* it can be traced back to the MC.

The performance areas of *"Environmental Sustainability"* and *"Nuisance for the surrounding Environment"* are the exception in this otherwise aligned system. Their analysis in the MC is lacking, and so does the creation of their information indicators. The MP elaborates more on their aspects but does not provide any goals for them. The elaboration involves future initiatives and programs to boost these areas. Even though this part of the MP can be used as inspiration for more information indicators, no such attempt is made.

QlikView provides two distinct Dashboards to describe these areas of "Environmental Sustainability" and *"Nuisance for the surrounding environment"*. Their performance indicators seem to be disconnected from the other two documents. The line of reasoning of *"Safety"* and "Reliability" is not present in this case. Moreover, they try to describe aspects of the same performance area, and it might be sound to merge them.

Coupling this Chapter back to S.RQ 2 "*What is the current state of alignment between the Management Concession, Plan and Performance Management System and what potential problems can misalignment create?"* the thesis can provide the following answer.

The current state of alignment in ProRail performance indicators is quite good and can provide a direction to all of its levels. However, two of the performance areas which were shared amongst its staff were found to be problematic. This finding is in contrast with the hypothesis in the conclusions of Chapter 3. The author expected the common areas of the Q-Method to have strong couplings between them. While this was the case of the areas which formed the perspectives of Chapter 3, the same cannot be said about two out of three consensus areas.

The degree of the located weaknesses is not such that the operations of ProRail will be hindered in the immediate future. However, caution is advised. For this reason, Chapter 5 intends to provide advice to ProRail on how it could promote alignment in its performance requirements. Since *"Sustainability"* was found lacking compared to the other areas, it will be used as the centre of the advice. With this procedure, the thesis intents to provide an answer to its final S.RQ: "*How can the current alignment be improved?"*

5 Improving current Alignment

Chapter 4 analysed the shared and non-shared performance areas, resulting from Q-Method. This analysis showcased that *"Sustainability"* is less aligned than the areas of *"Safety"* and *"Reliability"* lacks, in terms of its alignment, compared to the other areas. This particular aspect of the system proved to lack a general direction in the form of strategic goals. Moreover, its performance requirements lack the breadth and depth of the ones of the other two performance areas.

The requirements of *"Sustainability"* tend to cover more the environmental aspect of the area. However, based on the analysed performance agreements, the system should also be sustainable regarding its space planning and the biodiversity of the country, for example. While these areas are mentioned in the PMS, they are not so well thought out.

In contrast, all of the four safety categories outlined in the MP are covered in the PMS with precise and well-explained performance indicators. Chapter 5 intends to provide advice to ProRail, on how to improve on this subject. This advice provides an answer to the final S.RQ "*How can the current alignment be improved?".*

Section 5.1 showcases the general idea of the advice. Through the analysis of Chapter 4, the author realised that performance requirements appear for three distinct levels. At the Strategic level, the requirements express the overall goals of the organisation. The Tactical level represents interim goals and is oriented towards mid-level management. Last but not least, the Operational requirements express the daily workings of the organisation and its short term goals.

Currently, these three distinct levels are intertwined in the PMS of ProRail. However, they represent different data for different purposes and audiences. This thesis suggests an explicit representation of these levels with three separate dashboards.

Nevertheless, the contents of these dashboards are connected. In order to manage their interfaces, a process-oriented approach is suggested in Sections 5.2, 5.3 and 5.4. In these sections, the author presents three different discussion tables. These tables will be dedicated to each dashboard and will include specific rules and participants.

Their interaction is expected to create only necessary KPIs for each level and to align the area of *"Sustainability"*. This alignment is accomplished by providing this area with the structure *"Safety"* uses. It is expected that a process-oriented procedure, along with a *"branching-out"* of sustainability requirements, will improve the current alignment.

It should be noted that the current structure of *"Sustainability"* does not constitute a pressing matter for ProRail. The organization can still operate at an excellent level. With this being said, the author argues that a different, more process-based approach, could benefit the organization by enriching the performance requirements with the local knowledge of each level. Given that *"Sustainability"* was found to be less connected than the other two performance areas showcased in Chapter 4, it is chosen to showcase the proposed advice.

Section 5.5 elaborates on the conclusions regarding the advice. The Section also provides suggestion on how this framework could be implemented in the system along with current practices.

5.1 Three Dashboards with One Goal

In the current situation, the three levels mentioned above are implicitly represented in the PMS. One can observe the general performance of the system, regarding *"Sustainability"*. This is the Strategic level. Through the options of QlikView, one can also find the performance of administrative regions. This is the Tactical level. Last but not least, the performance of specific contract areas can be found. This is the Operational level.

Although the current approach can provide very satisfactory results, this chapter would like to provide a different way to relate and communicate performance agreements. Perhaps a different type of alignment might benefit ProRail and its operations. This type of alignment wishes to strengthen the coupling of the agreements with each other. At the same time, it creates a transparent and participative environment for their stipulation.

After all *"healthy"* alignment for this thesis is not *total* alignment. On the contrary, the author argues that total alignment can lead to a cumbersome and ineffective organization. On the other hand, creating a basic set of rules and goals over a specific performance area might form the foundation to produce this healthy alignment. They can be used as a frame. Inside this frame, the different organizational levels add their knowledge and expertise to produce more *"enabling"* performance requirements. The author wishes to present an alternative which can, should serious problems arise, be used as a pilot.

The proposed separation wishes to provide more clarity to ProRail. First of all, it will offer a clear separation of strategic, tactical and operational objectives. This separation is done in three levels to represent the three different goals of an organization. The Strategic level, for example, contains long term goals more akin to strategy. The Operational level contains short-term goals which may need to be fulfilled the next month, which are generally more precise and technical. The Tactical level is their connecting link representing mid-term goals combining the elements of the other two dashboards.

Secondly, it has the potential to hold on significant KPIs and discard unnecessary information from the system (Eckerson, 2009; Bisbe & Otley, 2004). The requirements produced by each Table will have a predetermined term. In their next revision, the relevant parties can decide whether to keep or discard a number of them resulting in metrics which benefit the most each level. This will provide to ProRail a cleaner overview of its objectives in all levels. Moreover, it will reduce the number of resources and time needed to monitor its performance.

Through such a process, the way ProRail personnel agrees on how to measure performance becomes more transparent across the levels. Furthermore, the display of these metrics becomes cleaner, with users being able to examine the level they wish to directly.

Nevertheless, the three levels remain connected to each other. General strategy cannot be implemented without tactics and operations. On the other hand, lower levels are left without a purpose if top management does not have any goals. In order to manifest, and even reinforce, this symbiotic relationship, a process-oriented approach is suggested.

This suggestion is based on the work of de Bruijn (2002). Most of the criticism of performance measurements stems from the fact that they measure outputs (products). This approach, however, fails to take into account the throughput (production process) which resulted in this output. Instead of focusing purely on numbers and calculations, the suggested framework is oriented to discussion, freedom of interpretation and respect for the professionalism of each level.

This thesis suggests the creation of three separate dashboards. *"Sustainability"* can be used as a pilot performance area, since its alignment, was found to be somewhat lacking according to the definition this thesis uses for the term. The Amsterdam – Eindhoven corridor can be used as a testbed for this approach, as referred to Chapter 1. These tables will represent the parties connected to the dashboards and will serve a double purpose. They will provide performance indicators for each level through discussions, and they will also be responsible for their appraisal and if necessary change.

In order to achieve these goals, some basic process rules must be defined. The following generalised rules intend to provide direction to the discussion tables and frame their proceedings. The four basic rules proposed by this thesis are the following:

1. In order for a performance area to be *"aligned"* one should be able to follow its KPIs through the three Dashboards/Levels. This should be done in both directions.
2. There is freedom of interpretation over which measures can contribute to the fulfilment of a performance area. Having overall the same KPIs, between levels, does not necessarily lead to *"alignment"*. Some performance areas may require more *"creativity"* than others.
3. Discussion tables should be comprised of people directly connected to the level they represent. Their knowledge should be respected and represented in the KPIs of each level.
4. Decisions made in each table will have a pre-agreed valid term. Constant changes will not provide enough time for the proposed indicators to showcase positive or negative outcomes. The terms can be different for each level.

The first rule intends to establish what can be considered a healthy alignment. Instead of choosing to represent the traditional sense of the word, the proposed advice opts for the *"line of reasoning"* as explained in previous chapters. Alignment does not mean that the *"requirements are the same".* It has instead the meaning of the *"requirements are connected and derived from each other".*

The second process rule builds on the first by solidifying a technical version of the *"freedom of speech".* It provides space, especially for the low levels, for building upon the high-level requirements. It also establishes that no two performance areas are the same, and each one might need a different approach in its proceedings. This plurality of opinions has the potential to enrich the procedure and produce beneficial results.

The third rule intents to respect the knowledge and authority of each organizational level. Instead of having a more top-down oriented approach, the proposed advice chooses a more horizontal structure. Each table includes parties directly connected to the organizational level it represents. Therefore a top-level manager does not have a direct place in the *"Operational-level Table"*. His or her input is indirectly present and further developed upon by people with far more knowledge and experience at that level. The same holds vice versa.

The fourth and final process rule makes sure that no decision, at no level, is absolute. This rule will provide a sense of safety in the participants. It is highly unlikely that everyone will agree on everything every time. Thus, by making the decisions contestable the process provides the opportunity for different opinions to be heard. At the same time, the rule also provides a predefined duration to test if the decided requirements contribute or not, positively to ProRail.

It should be noted here that these rules and the process approach in general needs a particular set of parameters to work. First and foremost, the participating parties must feel safe and respected in the discussion. Second, there is a need for culture change, primarily if the organization used to have a more top-down structure.

People are generally unwilling to move away from a familiar structure. Long-lasting norms provide a safety net for everyone. Attempts to innovate or renovative will be met with resistance (Bisbe & Otley, 2004). This is why change should be implemented gradually. This will allow people to adapt to it and smooth out the created resistance (Rotmans & Loorbach, 2009).

While the rules try to provide both of these conditions, it should be noted that change is always a complicated procedure with many hidden dangers. In the best-case scenario, the participants feel safe and respected and indeed have a cultural change in their work ethics. Nonetheless, two possibilities can hinder such an approach.

In the first instance, top management tries its best to promote a more horizontal culture and to establish that freedom of interpretation is guaranteed in the process. Workshops and corporate events are being made, promoting a new way of thinking. However this *"whole new world"* is strange, especially to low-level personnel. A great deal of scepticism may be created in their ranks which can lead to resistance despite the good intentions of the new approach.

On the other hand, such changes can create a more vindictive atmosphere. As mentioned this mix of top-down and bottom-up structure can empower specialists and low-level managers. This newfound power can be used to shield their possible shortcomings from the higher-ups. They are the specialists, and they know best. Moreover, since there is freedom of interpretation, they can mask their arguments behind the produced performance indicators.

The above instances show that change, although needed for an organization to evolve, is not without its struggles. Even if it is not possible to completely rule out these adverse outcomes, one can safeguard against them by incremental steps towards change. Based on the results of these steps, one can shorten or widen his *"stride"*.

This thesis would like to make the argument that change is just like biological evolution. It takes a lot of *"experimentation"* and failures along the way, but the result can be a fascinating organism. Patience, caution and small steps are advised. For that reason, the thesis insists for ProRail to limit itself on Sustainability and the Amsterdam - Eindhoven Corridor in the case it implements such an approach.

To represent the different nature of each discussion table, these four rule will be adapted to their needs. The following Section will analyse each table/dashboard separately. This analysis will include the nature of KPIs, each table will be responsible for producing, and the interplay between the levels to provide a well-aligned performance area.

5.2 The Strategic Dashboard

The role of a Strategic Dashboard is to enable top management to implement its strategy and manage the general performance of the system. Out of all three dashboards, this is the one with the most extended valid term. It is advised that strategic performance indicators should have a lifespan of at least six years (Eckerson, 2009). Frequent changes will deprive the organisation of its purpose. However, if no attempt of change is made, the organisation runs the risk of stagnation (Bisbe & Otley, 2004).

The KPIs of this level should be limited in number. They should cover the fundamental aspects of an individual performance area without restricting the room to manoeuvre for lower-level dashboards (Eckerson, 2009; Rotmans & Loorbach, 2009). In the following sub-sections, the thesis provides a framework on how to define these KPIs and the Strategic discussion table.

5.2.1 Definition of Strategic KPIs

The best source to define strategic KPIs is to use the MC. It is the document were the strategic goals of ProRail, and the Ministry are laid down. Regarding *"Sustainability",* its definition in Article 4, provides a testbed for strategic KPIs production. In essence, the system should:

1. Reduce emissions of greenhouse gases
2. Promote the use of responsibly sourced raw materials
3. Promote spatial planning quality
4. Protect and preserve biodiversity in the areas of ProRail activity.

The above four points can be discussion subjects on the agenda of the Strategic table. They represent the strategic objectives of ProRail regarding the sustainability of its system. Based on them, the organisation can produce strategic performance metrics to determine the accomplishment of these objectives. In order to visualise this process, the author would like to present simple, possible examples of the outcome of each discussion table. Off course, reality will be much more complicated, but the purpose of the examples is to showcase the logic behind the suggested framework.

After the strategic discussions are concluded, the following elements could serve as strategic KPIs:

1. Environmental Footprint
2. Sustainable working practices
3. Protection of the surrounding environment

These three metrics are a possible representation of the goals set in Article 4. The third metric can serve as a combination of the third and fourth goal. Furthermore, it is not necessary at this level to have purely quantitative KPIs (Eckerson, 2009). One can use a gauge system which will display whether or not the objectives are satisfied based on lower-level metrics. After all top management would be more interested in the general overview of sustainability and not exact metrics, which would also be more challenging to understand. Sub-Section 4.2.2 elaborates on how such a process table can be set for the Strategic level.

5.2.2 Adapted Process Rules for the "Strategic Table."

The Strategic table regards the top-management of ProRail and the representatives of the Ministry. These will be the two main parties of the discussion. Since the talks involve areas such as "Sustainability" where a certain degree of specialisation is needed, the talks can include external specialists for assistance. In this way, the table would be comprised of parties directly connected to the strategic level of ProRail, respecting the third rule of the process.

The freedom of interpretation in this stage is quite relaxed. The performance indicators produced by this table should cover the main objectives of ProRail while at the same time provide room for lower levels to adjust them to their needs. Ambiguity in their definitions is welcomed as it could promote creativity. This practice is also an indirect sign of respect for the professionalism of lower levels. Even though top management still needs some command and control over the organisation, it is not wise to challenge the local knowledge of its specialists (Wouters & Wilderom, 2008; Malina & Selto, 2001).

Regarding the alignment of the indicators, the strategic table can discuss the overall alignment of previous years. There are no higher-level indicators from the ones produced for the Strategic Dashboard to search for connections. Instead, a point in the agenda could be an assessment on how well aligned a performance area is, compared to the last discussion round.

As for how frequent these discussion rounds should be, a term of at least six years is advised. Generally, this amount of time is deemed suitable to conclude the effectiveness of the strategic KPIs and if necessary, change the "route" of the organisation (Eckerson, 2009).

The result of this discussion table should be summarised in a report with its proceedings and decisions. Representatives from the top management of ProRail would be then responsible for communicating the results to the next discussion table. In this way, ProRail will inform its personnel over its objectives and lay down the foundation for the next round of discussions in the Tactical level.

5.3 The Tactical Dashboard

The role of the Tactical Dashboard is to assist middle management with monitoring and optimising the performance of the areas under their supervision. This dashboard is the intermediate step between long term and short term strategy, and its metrics usually reflect both of these aspects (Eckerson, 2009).

The KPIs of *"Sustainability"* at this level should make clear its mission and success factors. It is advised that these interim goals include both quantitive and qualitative metrics (Rotmans & Loorbach, 2009). The qualitative metrics could connect better this dashboard to the Strategic level, where there is still a higher level of abstraction.

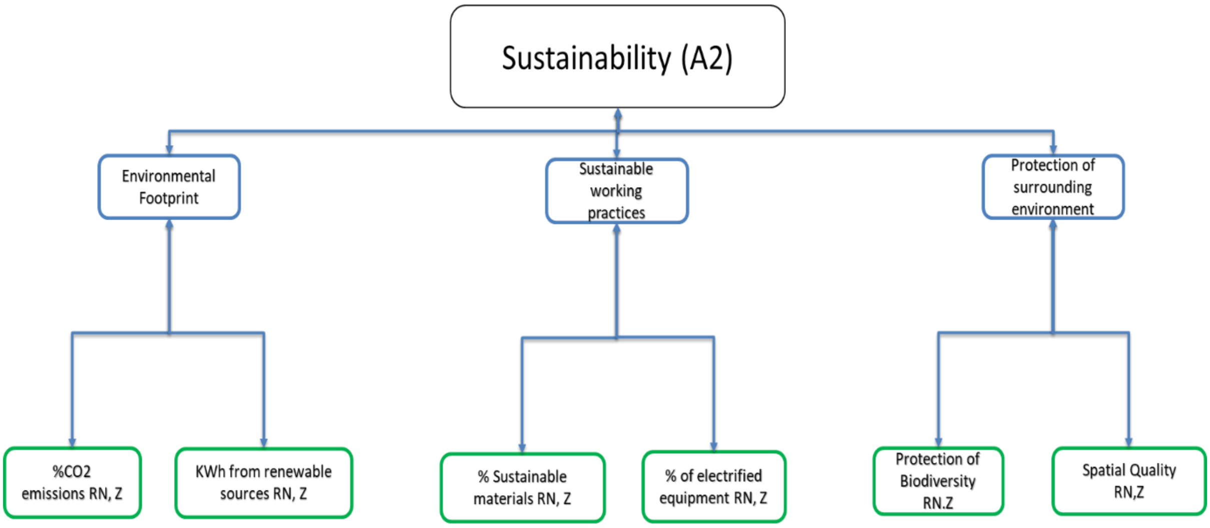
The quantitive metrics could form a connection with the Operational Dashboard, where its content begins to be much more specific (Eckerson, 2009; Rotmans & Loorbach, 2009). In the sub-sections below, the thesis provides the framework of Tactical KPIs definition. Sub-section 5.3.2 provides information over the composition and the adapted process rules of the Tactical discussion table.

5.3.1 Definition of Tactical KPIs

To define Tactical KPIs, it is advised to use the MP and the results of the previous discussion table as cornerstones. More specifically for *"Sustainability",* the MP provides information in its third Chapter over the future actions of ProRail on the matter. Based on the and the Strategic KPIs, the participants can define the metrics of this intermediate step.

As mentioned in sub-section 5.1.3, the MP defines four categories where sustainable development is expected from ProRail. In the example of the previous sub-section, the imaginary Strategic discussion table produced three KPIs. A possible combination of these two elements could result in the Tactical metrics of Figure 14, represented with a green colour.

Figure 14: Performance indicator Tree representing the Strategic and Tactical levels.



Even in this simple example, one can observe the connection between Strategic and Tactical KPIs. The latter category not only is derived from the higher level but also respects the four categories of sustainable development in the MP.

Two possible ways to measure the Environmental Footprint of activities could be the percentage of CO2 emissions and the KWh of energy derived from renewable sources. The first metric is a direct cascading of the sustainability information indicator in both the MC and the MP. The second one is derived from the second category of sustainable development of the MP (Energy). Another example is the Tactical KPIs connected to the protection of the surrounding environment. Safeguarding the biodiversity in areas of ProRail activity, and ensure their overall spatial quality, fall under the fourth sustainable development category (Nature).

The Tactical KPIs of the example can be qualitative, such as *"Protection of Biodiversity"* and quantitative, such as *"% of CO2 emissions"*. They represent the long-term (Strategic) goals of ProRail regarding "Sustainability" while at the same time can be further branched out to determine short term (Operational) goals.

5.3.2 Adapted Process Rules for the "Tactical Table"

The composition of the Tactical Table should include the top-management representatives of the Strategic table and representatives of ProRail's administrative regions. It is advised to include middle management representatives knowledgeable for the performance area under question. In this way, the need for external specialists is eliminated. While their presence is welcomed in Strategic discussions, it may antagonise lower ProRail levels and is thus discouraged.

The room of interpretation of this table starts to limit itself compared to the previous one. While freedom still exists, it is constraint by the context of the previous discussion. Furthermore, as mentioned in Section 4.3, Tactical KPIs should reflect both long term and short term goals. They should still be coupled to the broad, Strategic KPIs, but constraint enough to produce specific operational metrics.

This is the reason why the Tactical level should reflect the findings of both the Strategic and Operational dashboard in their discussion. The findings of this dialogue and the produced metrics could then be used as the cornerstones of the Operational Dashboard.

5.4 The Operational Dashboard

The final dashboard regards the Operational level of ProRail. This kind of dashboard enables front-line personnel to control processes and daily tasks regarding the system's performance. The data populating this level have the most detail in them and should be specific and sharp (Eckerson, 2009).

Although not obligatory the use of at least target values is advised. One could also use bottom values, but as explained in previous chapters, these may be regarded as control measures from higher levels (de Bruijn , 2002; Wouters & Wilderom, 2008). Target values, on the other hand, can provide a clear goal to pursue, for the operational personnel. Without the fear of *"punishment"*, if the bottom value is not achieved, they can focus their efforts to the best possible result (Wilderom, Stertefeld , & Wouters, 2009).

The KPIs are mostly quantitative and represent short-term goals, often measured daily. Given that the structure of Sub-Sections 4.3.1 and 4.3.2 is followed, the metrics of this dashboard should be able to "scale up" to the Tactical and in extent Strategic KPIs. The following subsections continue the "Sustainability" example given in this chapter also for the Operational level.

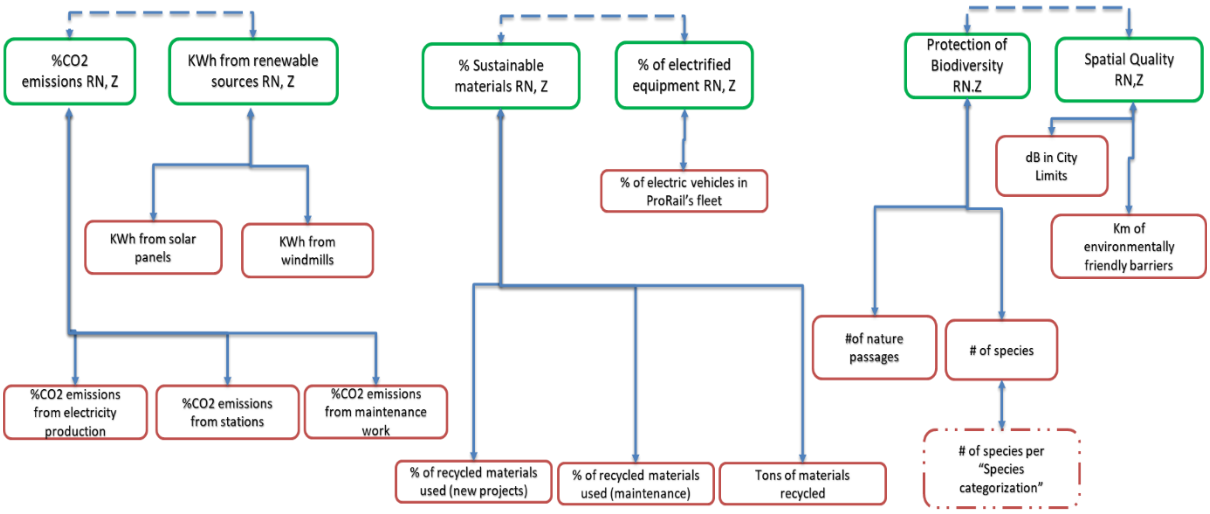
5.4.1 Definition of Operational KPIs

For operational KPIs definition, it is advised to make use of the results from the previous discussion table. As explained in Sub-Section 4.3.1, the Tactical KPIs should express both long and short term goals. Thus, they can serve as *"inspiration"* for lower-level personnel. Given the freedom of expression this approach entails, the produced KPIs have a higher chance to be connected to their daily tasks and professionalism.

In turn, this will minimize the chance of engaging in a *"numbers game"* just to satisfy a series of quotas. The efforts put in attaining the target values of these KPIs would be much more honest and truthful. At the same time since they will be derivatives of Tactical KPIs, they could be coupled with higher levels.

The fact that the definition of operational metrics should be sharper does not limit the freedom of interpretation of the level. However, their formulation should not be ambiguous and should follow the SMART principle (Eckerson, 2009; McAdam, Hazlett, & Galbraith, 2014). This means that operational KPIs should be: Specific, Measurable, Attainable, Relevant and Time-bound. These requirements are not an obligation the Strategic or Tactical KPIs should fulfil. The short term nature of the operational level, however, demands sharper definitions which should abide by that principle. The following Figure builds upon the example of *"Sustainability"* presented in this chapter. It provides a possible set of operational KPIs directly connected the results of the previous table.

Figure 15: Performance indicator Tree representing the Tactical and Operational levels.



As mentioned in Sub-Section 5.3.1, two possible ways to measure the Environmental Footprint of activities could be the percentage of CO2 emissions and the KWh of energy derived from renewable sources. The CO2 emissions in the vicinity of the A2 corridor can entail emissions from electricity production, overall emissions from stations and emissions from maintenance work. On the other hand, the KWhs from renewable energy sources can be the product of solar panels or windmills.

Concerning the Tactical KPIs the operational metric are Specific (solar panels, electricity production emissions), Measurable (percentages), Attainable (can be measured in a multitude of ways), Relevant (they contribute in determining the sustainability of the corridor regarding CO2 emissions and energy production from renewable sources) and Time-bound (they can be measured and assessed in a predefined period).

Measures such as these can provide a detailed overview of how ProRail performs in the short term regarding its sustainability goals. Furthermore, they are derivatives of the Tactical KPIs. Their *"feed"* into the system will provide insight for the Tactical level too. Last but not least, the Tactical (green) KPIs of Figure 13 are themselves derived from the Strategic KPIs of Sub-Section 4.2.1. In such a way, the alignment of *"Sustainability"* becomes much stronger while at the same time, this approach minimizes frictions and misunderstandings between the organizational levels of ProRail.

5.4.2 Adapted Process Rules for the “Operational Table” and Process Rules

Following the previous discussion rounds, the Operational table should start by including the representatives of the Tactical level. These parties would know the discussions with top management, and their feedback would be crucial along with the proceedings of the last discussion round.

Off course since this discussion table is focused on the operational level, low-level managers and specialist should be included to represent it. These parties can be drafted from the departments and sub-divisions analysed in Section 3.2. Their daily efforts and valuable work are directly connected to system performance. Their input would be crucial in the formation of sturdy operational KPIs.

Another possible addition to this discussion table would be the Contractors responsible for the maintenance of the system. They too have extensive knowledge on how the system works and how it could come to a better state. The operational personnel of ProRail is also in constant contact with them for their daily activities. One could say that there is a partnership between them, but this would be half true.

While the staff themselves might indeed see each other as partners, the same cannot be said about the higher-ups of their respective organizations. The private parties ProRail works with are still competitive with each other and towards ProRail. Moreover, they are quite different organizations.

ProRail is motivated by public accountability. Its actions should serve the Dutch public and society. Private companies, however, have as their core values, profits and market share. By including their representatives in these talks, ProRail risks giving huge leverage over future negotiations of PBM Contracts. Nevertheless, their interactions with operational personnel can form points on the agenda of the Operational table. For the above reason, however, direct inclusion of these parties in the negotiations is not advised.

As explained in the previous section, the room of interpretation in this level limits itself considerably. This is because operational KPIs should fall under the Tactical KPI categories formed in the previous table. This fact, however, should not limit the creativity of operational personnel in the conception of operational KPIs. The most significant difference with the other two levels is that quantitive KPIs are preferred, and their formulation should follow the SMART principle.

5.5 Conclusions on the Proposed Advice and General Application

Chapter 5 proposes a process-based framework to promote alignment as it is defined in this thesis. The use of this framework makes a clear separation between the Strategic, Tactical, and Operational level.

With this distinction, the framework makes more apparent the different character of each level regarding the system's performance. The Strategic level aims for the future and the long term success of the organization. The Tactical level is the connecting link to operations and balances short and long term goals. In the end, the Operational level supervises the daily application of the performance agreements.

In this approach, KPIs are tailored for each level and function as a coupling between their requirements. They are tailored because they are produced after deliberation between parties directly connected with each level. They are coupled because KPIs of lower levels are derived from their higher counterparts.

Given the results of Chapter 4, the proposed framework could be implemented for the performance area of *"Sustainability"* as its testbed one could use the A2 corridor. This part of the system forms an important link and has many teams of different disciplines working on it. Furthermore, there will be changes in the schedule of the line with the new PHS (High-frequency train transport) program.

The top management layers of ProRail can work closely with the HR-Department to start promoting this different way of thinking. This could be done by organizing workshops to introduce the different levels to this approach and familiarize them with its workings. The ICT department can be involved later in the procedure when HR and Management begin organizing the discussion tables. Since the Management Concession is still in effect until 2025, the Strategic Table talks would not be possible. However, the proposed advice can still be implemented in the Tactical and Operational levels. Through their cooperation, HR and ICT can form the main organizers and moderators of the tables and their results.

More trains can translate in more people, more chances for something to go wrong, or to malfunction and more chances to increase the burden to the environment. These circumstances could work as a Petri dish for such an approach to be tested.

Off course this advice is not tailored to function only for *"Sustainability"* and only for the A2 corridor. These two elements might create the starting point of a possible *"pilot"* program, as explained above. The idea of disseminating performance requirements into distinct levels while at the same time connecting them through a process-based approach can work for any performance area but especially for shared ones.

Given the importance of a performance area that is shared among the organization, it will create better foundations to discuss it. Moreover, the participants will be more inclined to participate. An improvement on how to communicate the requirements of such an area will benefit all of them, making their personal and colleague's efforts all the more valuable.

Nevertheless, the basic principles remain the same: Create dedicated metrics to represent each level, connect these metrics between them, and provide room to manoeuvre for the people of the organization. Appendix C presents a more generalised version of the *"Sustainability"* example.

However, one should not forget that change comes with risks. The suggested framework offers the advantages described above, but it might deliver some adverse results. First of all, the empowering of lower levels does not always have positive results. Power games will be in play.

More particularly, professionals at lower levels will strengthen their position. It would be easier for them to hide adverse outcomes regarding system performance or dismiss any suggestions from the levels above using defensive reasoning. They are the ones with specific knowledge over a subject, and thus they should know better than high-level managers. Fallacies like that could become a reality by using such an approach.

Despite these dangers, the author is positive that such an approach can have welcoming results. The Dutch are generally horizontally oriented people (Hofdstede , 1983). This means that they can operate better when there is less hierarchy in their work environment.

The proposed solution does not eliminate the vertical elements of ProRail. However, this "re-approach" on the matter of alignment is done in a more horizontal, democratic way. Decisions are contestable the knowledge of the specialists is taken advantage to the fullest, at least theoretically. This way of looking at alignment is, according to this thesis, much closer to the Dutch mindset than a purely top-down approach.

6 General Conclusions and Reflections

The intend of this report was to provide an answer to the main research question "*How to improve the current alignment of Performance Indicators in the Management Concession, Management Plan and Performance Management System of ProRail?*". To be able to do that, the MRQ is broken down in four Sub-Research Questions. The following four sections summarise the methods used for answering these questions and their results. The fifth section provides these thesis conclusions and answers to the Main Research Question.

6.1 Conclusions on shared and non-shared Performance Areas among internal stakeholders

In order to answer S.RQ1: *What are the shared and non-shared performance areas, the internal stakeholders of ProRail find important?* The author made use of the Q-Method. This question intended to function as a "compass" to scope down important performance areas for further analysis.

The qualitative part of the method was conducted through a literature study to produce several Performance Areas for the participants to rank. In the end, 17 Performance Areas were identified. The survey was performed with the use of an Excel file. In total, 26 participants of different organizational ProRail departments provided their answers. The survey had a 100% success rate regarding its correct completion by the participants.

Three perspectives became evident after the data were analyzed by PQMethod (ver.2.35 March 2014). The first perspective regards the *"Safety of the rail system"* as the most important performance area making a clear separation from the other 16. Perspectives 2 and 3, both rank *"Reliability"* at the top. However, the second view gravitated more towards a system which safeguarded frequency and capacity, while perspective three combined *"Reliability"* with *"Maintainability"* and *"Safety of the rail system"*.

The participants produced three consensus areas. These performance areas did not contribute to the formation of the perspectives, and so they are deemed equally important for the respondents. These areas are *"Environmental sustainability", "Efficient connection of freight flows"* and *"Nuisance for the environment"*. Regarding the importance of these areas for the participants, it is concluded that they have a neutral character. This means that the areas mentioned above are "*complementary"* to the formed perspectives. Given the importance of these performance areas. The scope of this examination was to identify their state of alignment in ProRail's performance agreements.

6.2 Conclusions on current alignment and potential problems

To provide an answer to S.RQ 2 "*What is the current state of alignment between the Management Concession, Plan and Performance Management System and what potential problems can misalignment create?"* the author examined the performance agreements of ProRail regarding the results of S.RQ 1. This examination had as its scope the formulation and structure of performance requirements for the performance areas of: *"Reliability", "Safety"* and *"Sustainability"*.

The alignment or lack thereof, of these areas, were judged based on this thesis' definition about the term. For this thesis, an aligned area is an area where a logical connection can be made between its performance requirements and the organizational levels of ProRail.

The first two performance areas of *"Reliability",* and *"Safety of the rail system"* were found to fall under this definition. *"Safety"* in particular, uses a tree-like structure for its performance requirements. These requirements are presented in all of the performance agreements. The deeper one goes into the organizational levels, the more detailed and specific they become. In the end, one can follow the reasoning of its performance requirements from top to bottom and vice versa.

"Reliability" uses a much more concrete structure where there is little change in its performance indicators from top to bottom. Nevertheless, alignment, as defined in this report, still exists between the levels and the performance metrics of this area. Furthermore, the common performance area of *"Efficient connection of freight flows"* is encompassed inside *"Reliability"* as a performance indicator. This fact validated the hypothesis of the author in Chapter 2 that low-ranking performance areas would be under the "umbrella" of the ones which defined the survey.

Regarding the common areas of *"Environmental sustainability",* and *"Nuisance for the environment"* the author located an alignment problem in their structuring. First of all, given the definition of the MC about sustainable development, they both fall under the same category. This is the reason why they are both analysed under the more general term *"Sustainability".* Regarding their performance requirements, they are not on par with the ones of *"Safety"* nor *"Reliability"*.

Although all three of the analysed performance agreements reference this area in their clauses, the building of its indicators lacks a logical order. If someone examines an indicator in QlikView, he cannot trace it back to a concrete strategic goal of the organization.

These findings indicated that the current alignment in ProRail's performance agreements is present on a sufficient degree. However, problems were indeed located. Although these omissions do not threaten the operational excellence of ProRail directly, it would be useful to examine how they could be rectified.

6.3 Conclusions on the improvement of the current alignment

The third and final research question of this project was S.QR 3: "*How can the current alignment be improved?"*. To provide an answer to this question, the author engaged in a literature review regarding performance management and the effective use of a PMS.

The results of this review pointed out some issues which could potentially create a misalignment in performance requirements and levels. These problems include the lack of communication between the organizational levels and the lack of distinction of requirements dedicated to these levels. Moreover, the way the top-down way used to cascade performance requirements may lead to a detached work-floor where personnel only pay lip service to standards set by higher management.

The current alignment can be improved by using a process-based approach which distinguishes the performance requirements according to their level. Thus, three separate dashboards and process tables are created. The Strategic Dashboard/Table, The Tactical Dashboard/Table and the Operational Dashboard/Table.

The way this approach can strengthen the line of reasoning between performance requirements lies in the fact that this separation empowers each level to create metrics which suit their purpose. On the other hand, the connection of the tables between them creates a context for the next level requirements to be produced. It also alleviates the disconnection of the work floor concerning the goals of the organization. This approach makes an apparent connection between the contribution of low-level personnel to the strategic goals of ProRail regarding a specific performance area.

6.4 Conclusions on the Main Research Question

This thesis started with an examination over which performance areas are shared and which represent dissect schools of thought, inside ProRail. Based on these results, it set out to examine the degree of alignment between these performance areas the agreements of ProRail. These agreements included the Management Concession, Plan and the PMS of ProRail.

This analysis showcased a high level of alignment between these three agreements but also revealed several problematic aspects in the formulation and structure of performance requirements. Having all this as a basis, a literature review was conducted on performance management and PMSs, which revealed a framework.

To answer its main research question, "*How to improve the current alignment of Performance Indicators in the Management Concession, Management Plan and Performance Management System of ProRail?"*, this thesis proposes a process-oriented framework which decouples the different organizational levels (Strategic, Tactical, Operational), while at the same time couples their performance requirements.

In this manner, ProRail can have a clear overview of its performance at all levels. Moreover, it enhances the involvement of low-level personnel which is highly connected with the real-life performance of the system. This makes the information about the state of its performance much more reliable. An engaged operational level has far fewer chances to shield itself from performance standards and engage in a numbers game. In turn, this process will bring out the performance metrics, which are truly important for ProRail. This will improve the value offered by ProRail as well as the time and effort going into the system's performance management.

In general, ProRail succeeds to communicate its performance requirements inside its organization. However, one should not forget that there is always room for improvement. With its mix of top-down and bottom-up elements and its more open nature, the proposed framework intends to help with this task.

6.5 General Reflections

Analysing how an organization attempts to align its performance in order to achieve its goals was a fascinating experience. After analysing opinions from the industry and scientific sources, the author concluded that there is no one right answer. There is no *"holy grail"*, if the reader wills, in the world of performance management.

Even in this document, the author presented what approach, in his opinion, can bring forth more alignment. This opinion is based mostly in scientific literature, but it is one of many found. For better or worse, managing performance and especially trying to invoke organizational alignment is not exactly hard science.

This finding can be seen both as a weakness and a strength. It is a weakness because a Manager has an overload of information and opinions on how to manage and align performance. On the other hand, if something does not work out, there are always plenty of options.

However, this flexibility seems to exist only in the theoretical world. In practice, the author noticed that such changes would take years to be implemented in general. To be implemented correctly, maybe even decades. The *"change tax"* would be much more significant.

Thus the inability of rather the unwillingness to change from some people or organizations can be excused. Nevertheless, small incremental steps can be applied. Change does not have to be on a large scale to have a, hopefully, positive effect.

The most valuable lesson the author obtained from this procedure was the validation of the notion that practice is vastly different from theory. Even though on paper every method, framework or general advice may seem perfectly sane and useful, in practice, people are going to implement it. Moreover, people are not so predictable as one might think.

Given all of the above, the author wishes to close this report by proposing future areas of research inspired by his time completing this thesis project. Change Management can form an exciting area of research regarding performance. How does change affect the performance of the organization, and what can be done to minimise adverse effects?

Combined with this or even as standalone research, a behavioural analysis would shed more light on how the people of the organization are perceiving alignment and performance. How connected do the members of the organization feel to its goals? Do they perceive these goals as realistic and connected to their respective tasks and professions? What do they think about the communication of performance requirements and how consistent they find them to be?

A future researcher could also examine other views on performance management and alignment. As said before the author presents one possible pathway which is not a panacea. More options do exist. An interesting approach would be to examine how self – managing teams and organizational structure can improve performance and alignment. This is the opposite opinion from the one the author presents in his work where little to no KPIs are used in bringing forth performance.

In the end, the world of construction management is an interesting one. While there are plenty of elements where only one right answer exists, the author finds that many times soft and multi-faceted elements of it are being neglected or passed over. To conclude, the author believes that the hard elements of management are necessary for both practical and theoretical structure. However, for the implementation of management plan and frameworks, the analysis of soft or not so strictly defined elements seems to be more critical. It is these elements the author wishes to bring forth and advice future research upon them.

References

Adler, P. S., & Borys, B. (1996). Two types of bureaucracy: Enabling and coercive. *Administrative Science Quarterly, 41*, 61-89.

Agostino, D., Steenhuisen, B., Arnaboldi, M., & de Bruijn, H. (2014). PMS development in local public transport :Comparing Milan and Amsterdam. *Transport Policy 33,* 26-32.

Banasick . (2019). KADE: A desktop application for Q methodology. *Journal of Open source Software, 4(36),* 1360.

Berman, P. (1978). The Study of Macro- and Micro- Implementation. *Public Policy*, 157-184.

Bisbe, J., & Otley, D. (2004). The effects of the interactive use of management control systems on product innovation. *Accounting, Organizations and Society 29*, 709–737.

Blom, R. (2014). *EMBRACING CHANGE: THE ROAD TO IMPROVEMENT? A study into if and how a combination of Lean and Agile could help coping with complexity and uncertainty in the front-end development of an infrastructure project.* The Hauge: Delft University of Technology, Antea Group.

Bos, M. G. (1997). Performance indicators for irrigation and drainage. *Irrigation and Drainage Systems 11*, 19–137.

Brown , S. R. (1993). A primer on Q Methodology. Operant Subjectivity. In S. R. Brown, *A primer on Q Methodology. Operant Subjectivity* (pp. 99-138).

Brown, S. R. (1980). *Political subjectivity: Applications of Q methodology in political science.* New Haven, CT: Yale University Press.

Carmona, S., & Gronlund, A. (2003). Measures vs actions: The balanced scorecard in Swedish law enforcement. *International Journal of Operations & Production Management, 23(11)*, 1475–1496.

Cattell, R. B. (1966). The scree test for the number of factors. *Multiv. Behav. Res 1* , 245–276.

CBS. (2009). *Nederland heeft drukste spoor van de EU.* Den Haag: Centraal Bureau voor de Statistiek.

Chen, W. R. (2008). Determinants of Firms' Backward- and Forward-Looking R&D Search Behavior. *Organization Science 19(4),* 609-622.

Cohen, J. W. (1988). *Statistical power analysis for the behavioural sciences.* Hillsdale, NJ: Lawrence Erlbaum Associates.

de Bruijn , H. (2002). Performnace Meassurement in the Public Sector: Strategies to cope with the risks of performance measurements. *IJPSM 15,7*, 578-594.

Eckerson, W. W. (2009). *Performance management strategies: How to Create and Deploy Effective Metrics.* TDWI.

Evers, F., Overkamp, I., & Wilderom, C. (2009). Continue prestatieverbetering via geregisseerd zelfmanagement . *Holland Management Review, vol. 127*, 2-9.

Gavetti, , G., & Levinthal, D. (2000). Looking forward and looking backward: Cognitive and experiential search. *Admin. Sci. Quart. 45(1),* 113–137.

Hofdstede , G. (1983). National cultures in four dimensions: a research-based theory of cultural differences. *Int Stud Manag Organ 13(1 - 2),* 46-74.

Jankulović, A., & Škorić, V. (2013). Performance management system implementation in a Southeast European transitional country. *Journal of East European Management Studies, Vol. 18, No. 2*, 173-190.

Jolliffe, I. T. (2002). *Principal Components Analysis Second Edition* . USA: Springer .

Koops , L. (2017). *Creating public value Optimizing cooperation Between public and private Partners in infrastructure Projects.* Delft: TU Delft.

Larsen , B. (2001). Measurement is better than 1,000 opinions is it? *Managerial Auditing Journal Vol.16*, 63-68.

Lee, B. S. (2017). THE FUNDAMENTALS OF Q METHODOLOGY. *The fundamentals of Q methodology. Journal of Research Methodology, 2(2),* 57-95.

Leeuw, F. L. (1996). Performance auditing new public management and performance improvements: questions and answers. *Acounting, Auditing Accountability Journal Vol. 9 No. 2*, 92-102.

Levinthal, D., & March, J. G. (1993). The myopia of learning. *Strategic Management Journal 14*, 95-112.

Lupton, T. (1991). Organisational Change: "Top-down" or "Bottom-up" Management? *PERSONNEL REVIEW 20,3*, 4-10.

Malina, M., & Selto, F. H. (2001). Communicating and controlling strategy: An empirical study of the effectiveness of the balanced scorecard. *Journal of Management Accounting Research, 13*, 47–90.

Matland, R. E. (1995). Synthesizing the Implementation Literature: The Ambiguity-Conflict Model of Policy Implementation. *n. Journal of Public Administration Research and Theory*, 145-174.

McAdam, R., Hazlett, S.-A., & Galbraith, B. (2014). The role of performance measurement models in multi level alignment. *International Journal of Operations & Production Management 34 (9)*, 1153-1183.

McNulty, R. (2011). *Realising the potential of GB Rail* . London : Depertment of Transport .

Millar, J., Demaid, A., & Quintas, P. (1997). Trans-organizational innovation: a framework for research. *Technology Analysis & Strategic Management 9 (4)*, 399-418.

Ministerie van Infrastructuur en Milieu . (2015). *Beheerconcessie 2015-2025.* Den Haag : Ministerie van Infrastructuur en Milieu .

Ministry of Foreign Affairs. (2000). *Towards a result-oriented accountability.* The Hauge : Ministry BZK.

Neely, A., Bourne, M., Mills, J., Platts, k., & Richards, H. (2002). *Getting the measure of your business. (1st Edition).* Cambridge University Press.

Onwuegbuzie, A. J., & Frels, R. K. (2015). Using Q Methodology in the Literature Review Process: A Mixed Research Approach. *Journal of Educational Issues Vol. 1, No. 2,* 2377-2263.

op de Woert, W. T. (2013). *Intra-organizational conflicting interests in infrastructure projects A study at ProRail and other network operators.* Delft, Netherlands : TU Delft .

Osborne , D., & Gaebler , T. (1992). *Reinventing Goverment* . Reading : Penguin .

Pallant, J. (2012). *SPSS Survival Manual: A Step-by-Step Guide to Data Analysis using SPSS version 15 (3rd ed.).* New York : NY: Open University Press.

Palumbo, D. I., Maynard-Moody, S., & Wright, P. (1984). Measuring Degrees of Successful Implementation. *Evaluation Review* , 45-74.

Pollitt, C. (1993). *Managerialism and the Public Services: Cuts or Cultural Change in the 1990s?* Oxford: Blackwell.

ProRail . (2019). *Beheerplan 2020-2021: Ontwikkelingen spoormobiliteit,en duurzaamheid centraal.* Utrecht : ProRail .

ProRail . (2020 c). *Ongewenste gebeurtenissen op het gebied van duurzaamheid, veilig reizen, veilig leven en veilig werken (aantal in de afgelopen 30 dagen).* Retrieved from https://prestaties.prorail.nl/veiligheid/cDU177_Veiligheid-en-duurzaamheid.aspx.

ProRail . (2020). *Wie zijn we*. Retrieved from https://www.prorail.nl/omwonenden/wie-zijn-we.

ProRail. (2019). *Beheerplan 2020-2021.* Utrecht : ProRail .

ProRail. (2020 b). *Prestaties gericht op het laten rijden van reizigerstreinen.* Retrieved from https://prestaties.prorail.nl/reizigersvervoer/cDU174_Reizigersvervoer.aspx.

RailMaps. (2020). *Productie Railmaps*. Retrieved from http://www.railmaps.nl/viewer/?viewer=RailMaps_Intern.Railmaps_Intern&project=853e2729d0f74e209feb1a68761d6749#.

Rose, T., & Manley, K. (2012). Adoption of innovative products on Australian road infrastructure projects. *Construction Management and Economics 30*, 277-298.

Rotmans, J., & Loorbach, D. (2009). Complexity and Transition Management. *JIEC*, 1-13.

Sharratt , M., & Usoro, A. (2003). Understanding knowledge-sharing in online communities of practice. *Electron J Knowl Manag 1(2)*, 187-196.

Smith , P. (1993). Outcome related performance indicators and organazational control in the public sector. *British Journal of Management Vol 4* , 135-151.

Steenhuisen, B., & van Eeten, M. (2012). Patterns of Coping With Inconsistent Demands in Public Service Delivery. *Administration & Society 45(9)*, 1130–1157.

Stephenson, W. (1935). Technique of factor analysis. *Nature*, 136-297.

Tooranloo, H. S., Ayatollah, A. S., & Alboghobish, S. (2018). Evaluating knowledge management failure factors using intuitionistic fuzzy FMEA approach. *Knowl Inf Syst 57*, 183-205.

Unahabhokha, C., Platts, K., & Kim, H. T. (2007). Predictive performance measurement system A fuzzy expert system approach. *Benchmarking: An International Journal 14(1)*, 77-91.

Verdonk , I. (2009). *Meten is weten: Het ontwikkelen van een enabling Performance Management Systeem voor Te Woon bij woningcorporatie ProWonen.* Twente, NL: University of Twente .

Verster, P., & Cuffe, P. (2011). Changing a national railway's engineering approach to Safety – doing it the Lean Manufacturing way. *International Railway Safety Conference* . Melbourne.

Watts, S., & Stenner, P. (2012). *Doing Q methodological research: Theory, method and interpretation.* Los Angeles: Sage.

Webler, T., Danielson, S., & Tuler, S. (2009). *Using Q Method to Reveal Social Perspectives in Environmental Research.* Greenfield MA: Social and Environmental Research Institute.

Wiewiora , A., Trigunarsyah , B., Murphy , G. D., & Liang , C. (2009). Barriers to effective knowledge transfer in project-based organisations. *International conference on global innovation* (pp. 220-230). UK: Loughborough University.

Wilderom, C., Stertefeld , T., & Wouters, M. (2009). *Prestatiemeting op de werkvloer van Grolsch: een participatieve aanpak.* KLUWER MANAGEMENT.

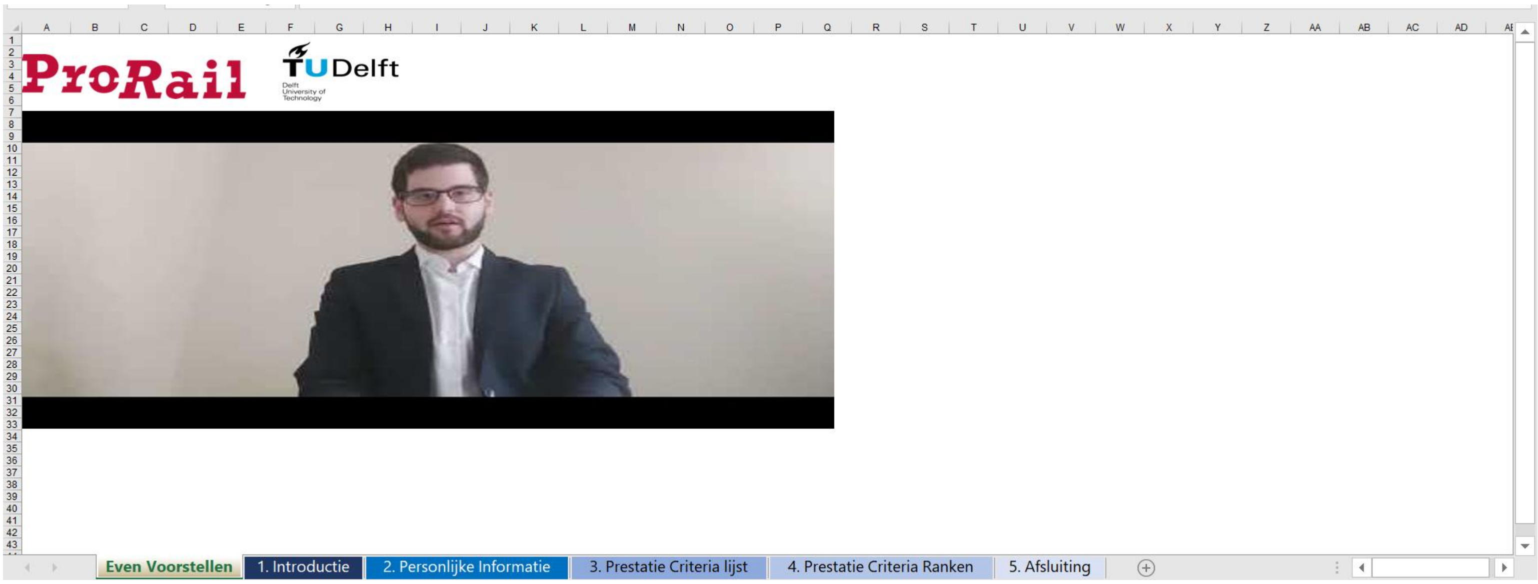
Wong , C. A., & Cummings , G. G. (2009). The influence of authentic leadership behaviors on trust and work outcomes of health care staff. *J Leadersh Stud 3(2)*, 6-23.

Wouters, M., & Wilderom, C. (2008). Developing performance-measurement systems as enabling formalization: A longitudinal field study of a logistics department. *Accounting, Organizations and Society 33* , 488–516.

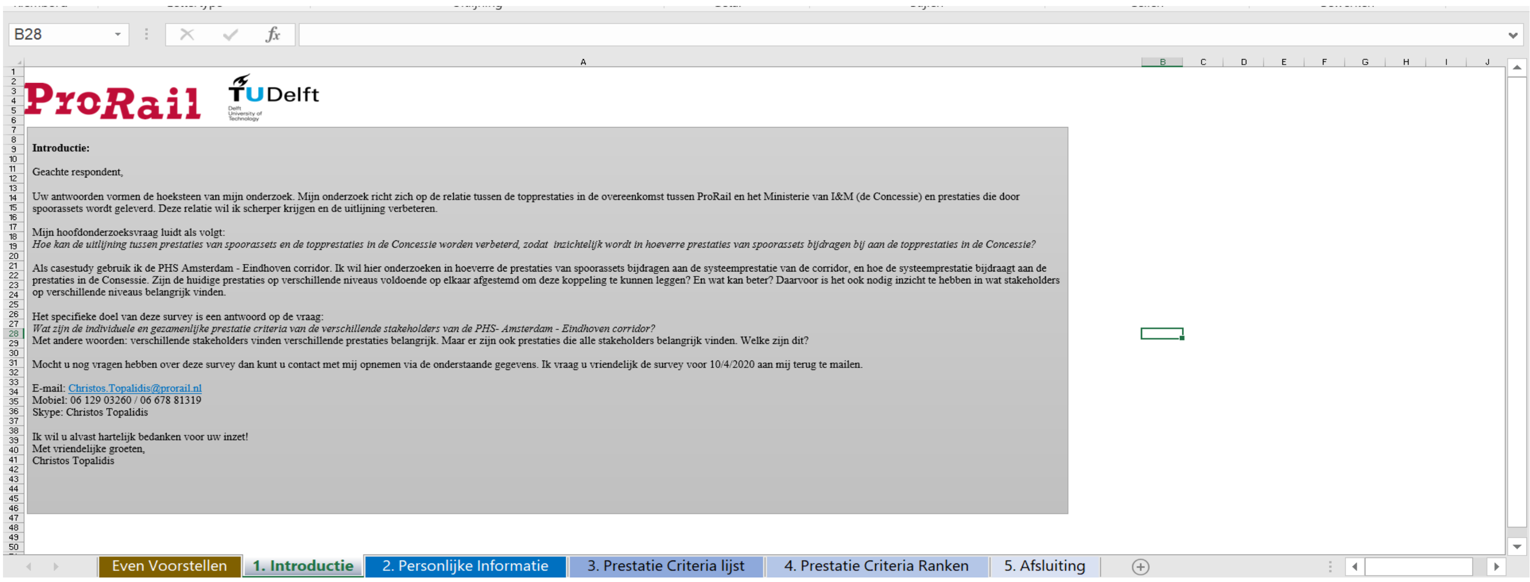
Yeo RK,, R. K., Svensson, G., Ahmad , N., & Daghfous , A. (2010). Knowledge sharing through inter-organizational knowledge networks: challenges and opportunities in the United Arab Emirates. *Eur Bus Rev 22(2)*, 153-174.

Appendix A: Steps of the Q-Method Survey file

1. Step 1: The author introduces himself to the participants with the use of a short video. The confidentiality of the provided answers is also stated.



2. Step 2: With the use of text, the participant is introduced to the research subject and the question this survey intends to answer. The contact information of the author is also presented.



Introductie:

Geachte respondent,

Uw antwoorden vormen de hoeksteen van mijn onderzoek. Mijn onderzoek richt zich op de relatie tussen de topprestaties in de overeenkomst tussen ProRail en het Ministerie van I&M (de Concessie) en prestaties die door spoorassets wordt geleverd. Deze relatie wil ik scherper krijgen en de uitlijning verbeteren.

Mijn hoofdonderzoeksvraag luidt als volgt:
Hoe kan de uitlijning tussen prestaties van spoorassets en de topprestaties in de Concessie worden verbeterd, zodat inzichtelijk wordt in hoeverre prestaties van spoorassets bijdragen bij aan de topprestaties in de Concessie?

Als casestudy gebruik ik de PHS Amsterdam - Eindhoven corridor. Ik wil hier onderzoeken in hoeverre de prestaties van spoorassets bijdragen aan de systeemprestatie van de corridor, en hoe de systeemprestatie bijdraagt aan de prestaties in de Consessie. Zijn de huidige prestaties op verschillende niveaus voldoende op elkaar afgestemd om deze koppeling te kunnen leggen? En wat kan beter? Daarvoor is het ook nodig inzicht te hebben in wat stakeholders op verschillende niveaus belangrijk vinden.

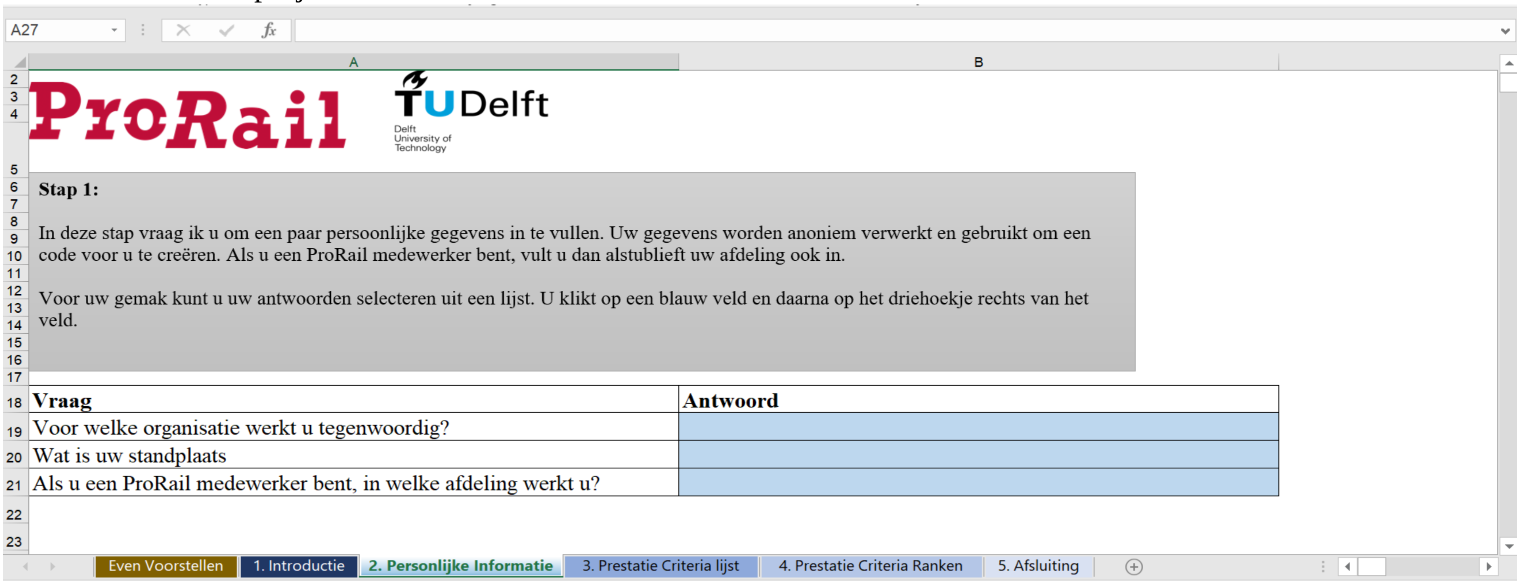
Het specifieke doel van deze survey is een antwoord op de vraag:
Wat zijn de individuele en gezamenlijke prestatie criteria van de verschillende stakeholders van de PHS- Amsterdam - Eindhoven corridor?
Met andere woorden: verschillende stakeholders vinden verschillende prestaties belangrijk. Maar er zijn ook prestaties die alle stakeholders belangrijk vinden. Welke zijn dit?

Mocht u nog vragen hebben over deze survey dan kunt u contact met mij opnemen via de onderstaande gegevens. Ik vraag u vriendelijk de survey voor 10/4/2020 aan mij terug te mailen.

E-mail: Christos.Topalidis@prorail.nl
Mobiel: 06 129 03260 / 06 678 81319
Skype: Christos Topalidis

Ik wil u alvast hartelijk bedanken voor uw inzet!
Met vriendelijke groeten,
Christos Topalidis

3. Step 3: In this tab, the participants are asked to provide basic personal information. This is done to create a code for them to denote them in public sections of this research project.



A27

ProRail TU Delft Delft University of Technology

Stap 1:

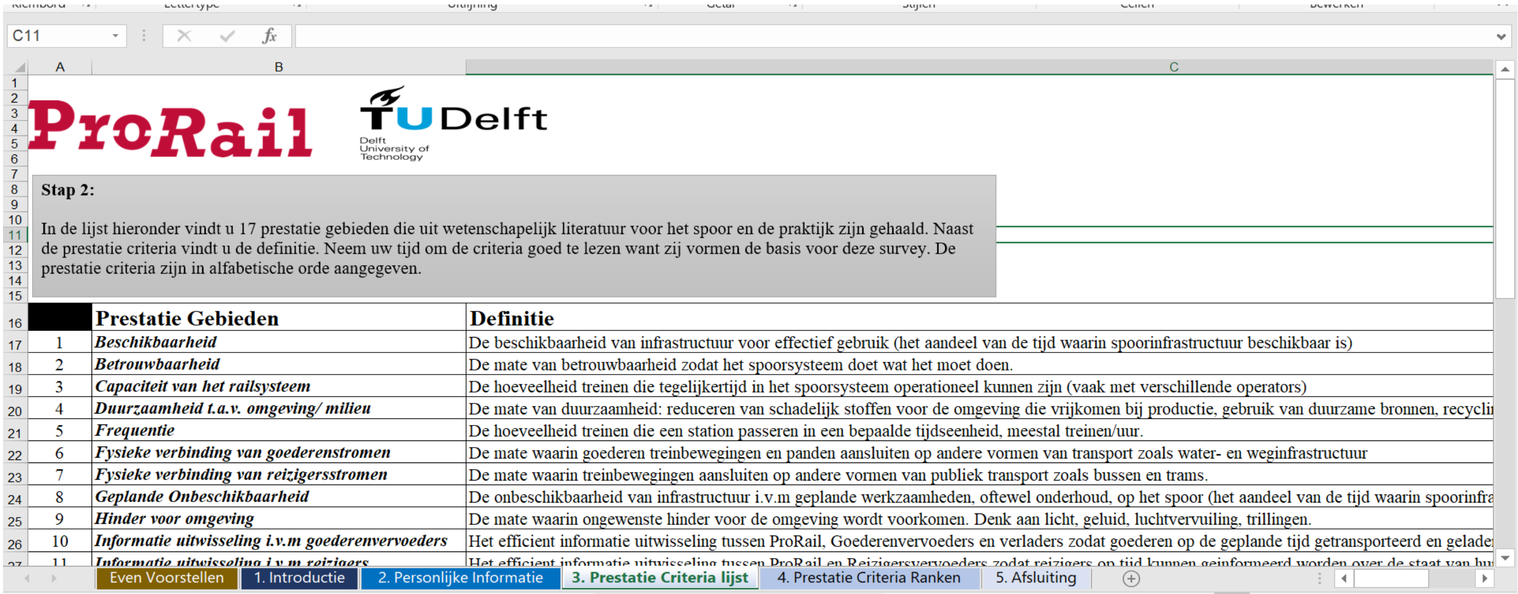
In deze stap vraag ik u om een paar persoonlijke gegevens in te vullen. Uw gegevens worden anoniem verwerkt en gebruikt om een code voor u te creëren. Als u een ProRail medewerker bent, vult u dan alstublieft uw afdeling ook in.

Voor uw gemak kunt u uw antwoorden selecteren uit een lijst. U klikt op een blauw veld en daarna op het driehoekje rechts van het veld.

Vraag	Antwoord
Voor welke organisatie werkt u tegenwoordig?	
Wat is uw standplaats	
Als u een ProRail medewerker bent, in welke afdeling werkt u?	

Even Voorstellen | 1. Introductie | 2. Personlijke Informatie | 3. Prestatie Criteria lijst | 4. Prestatie Criteria Ranken | 5. Afsluiting

4. Step 4: Here, the 17 Performance Areas, along with their definitions are presented to the participants.



C11

ProRail TU Delft Delft University of Technology

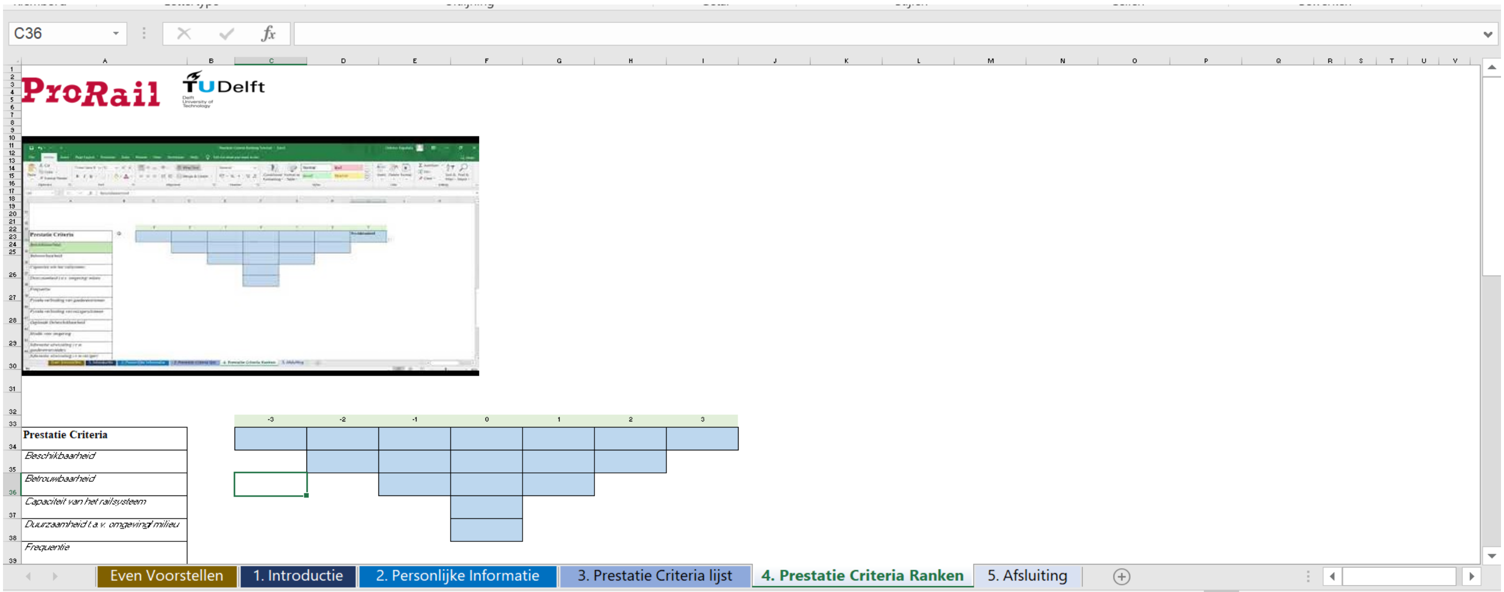
Stap 2:

In de lijst hieronder vindt u 17 prestatie gebieden die uit wetenschapelijk literatuur voor het spoor en de praktijk zijn gehaald. Naast de prestatie criteria vindt u de definitie. Neem uw tijd om de criteria goed te lezen want zij vormen de basis voor deze survey. De prestatie criteria zijn in alfabetische orde aangegeven.

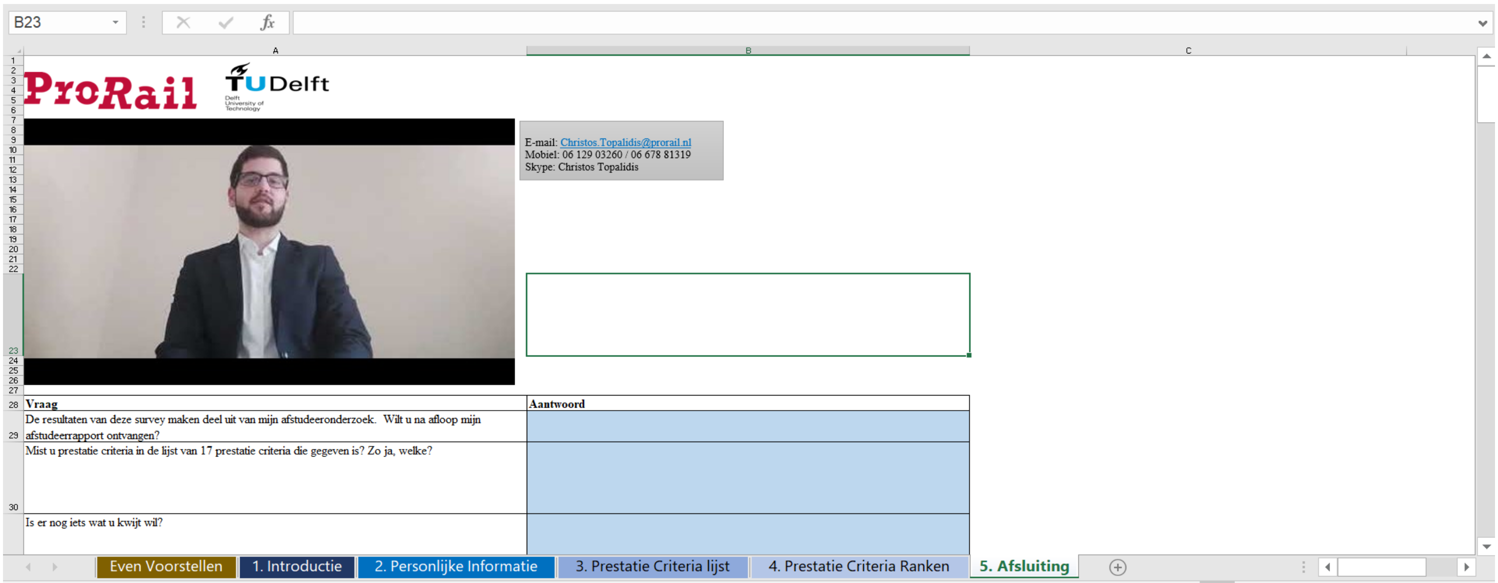
	Prestatie Gebieden	Definitie
1	*Beschikbaarheid*	De beschikbaarheid van infrastructuur voor effectief gebruik (het aandeel van de tijd waarin spoorinfrastructuur beschikbaar is)
2	*Betrouwbaarheid*	De mate van betrouwbaarheid zodat het spoorsysteem doet wat het moet doen.
3	*Capaciteit van het railsysteem*	De hoeveelheid treinen die tegelijkertijd in het spoorsysteem operationeel kunnen zijn (vaak met verschillende operators)
4	*Duurzaamheid t.a.v. omgeving/ milieu*	De mate van duurzaamheid: reduceren van schadelijk stoffen voor de omgeving die vrijkomen bij productie, gebruik van duurzame bronnen, recycli
5	*Frequentie*	De hoeveelheid treinen die een station passeren in een bepaalde tijdseenheid, meestal treinen/uur.
6	*Fysieke verbinding van goederenstromen*	De mate waarin goederen treinbewegingen en panden aansluiten op andere vormen van transport zoals water- en weginfrastructuur
7	*Fysieke verbinding van reizigersstromen*	De mate waarin treinbewegingen aansluiten op andere vormen van publiek transport zoals bussen en trams.
8	*Geplande Onbeschikbaarheid*	De onbeschikbaarheid van infrastructuur i.v.m geplande werkzaamheden, oftewel onderhoud, op het spoor (het aandeel van de tijd waarin spoorinfra
9	*Hinder voor omgeving*	De mate waarin ongewenste hinder voor de omgeving wordt voorkomen. Denk aan licht, geluid, luchtvervuiling, trillingen.
10	*Informatie uitwisseling i.v.m goederenvervoeders*	Het efficient informatie uitwisseling tussen ProRail, Goederenvervoeders en verladers zodat goederen op de geplande tijd getransporteerd en gelade
11	*Informatie uitwisseling i.v.m reizigers*	Het efficient informatie uitwisseling tussen ProRail en Reizigersvervoeders zodat reizigers op tijd kunnen geinformeerd worden over de staat van hu

Even Voorstellen | 1. Introductie | 2. Personlijke Informatie | 3. Prestatie Criteria lijst | 4. Prestatie Criteria Ranken | 5. Afsluiting

5. Step 5: This is the tab where the participants rank the 17 performance areas with each other by making use of the Q-Sort. For their ease, they are guided by a tutorial video on how to fill in the Q-Sort



6. Step 6: In this last tab, the participants are asked some general questions, and the author thanks them with the use of a short video to conclude the survey.



Appendix B: Mathematical Background of Q-Method

The Correlation Matrix

The correlations of Figure 3 are calculated based on the following equation:

$$r = 1 - \frac{\sum D^2}{\sum S_{r1}{}^2 + \sum S_{r2}{}^2} \quad \text{(Equation 1)}$$

In the above equation, $\boldsymbol{D}$ denotes the difference between the first and second respondent in the scoring of a statement. The term $\sum \mathbf{D^2}$, expresses the summation of the root square of this difference for all assessed statements. The terms $\boldsymbol{S_{r1}}$ and $\boldsymbol{S_{r2}}$ express the score of the first and second respondent respectively on one particular statement and in turn $\sum \boldsymbol{S_{r1}}^{\mathbf{2}}$, $\sum \boldsymbol{S_{r2}}^{\mathbf{2}}$ express the summation of the root square of all statement scores. This procedure is followed for all possible participant pairs.

After all the r's are calculated, they are put into a matrix. The correlation matrix, such as the one in Figure 4. To define if the amount of correlation between a specific pair of Q-Sorts is substantial, the standard error is also calculated with the use of the following formula.

$$SE = \frac{1}{\sqrt{n}} \quad \text{(Equation 2)}$$

The term n is denoting the number of the conducted Q-Sorts, and the number of correlations inside the matrix is $\mathbf{n^2}$. Correlations are deemed substantial when their absolute value is 2 to 2.5 times greater than SE (Brown, 1993). Since the SE of this survey is 0.19 substantial correlations are correlation above 0,38 to 0,48 (38 and 48 as denoted in Figure 3).

Factor Scores

The factor scores represent the weighted average score of a statement based on the scores it got in each Q-Sort corresponding with a component produced by Principal Component Analysis. The weighted average is used in this case since not all Q-Sorts have the same correlation with a Factor. This weight is calculated with the use of the following equation.

$$w = \frac{f}{(1-f^2)}$$, where f is the Factor (Component) loading on the Q-Sort (Equation 3)

Multiplying the weights with the scoring of a specific statement of the Q-Sort will result in the final score of that statement. This can be done for all statements and Sorts associated with a component by using the following formula.

$$FS_x = \sum(w_{ri} * S_{x,ri}) \quad \text{(Equation 4)}$$

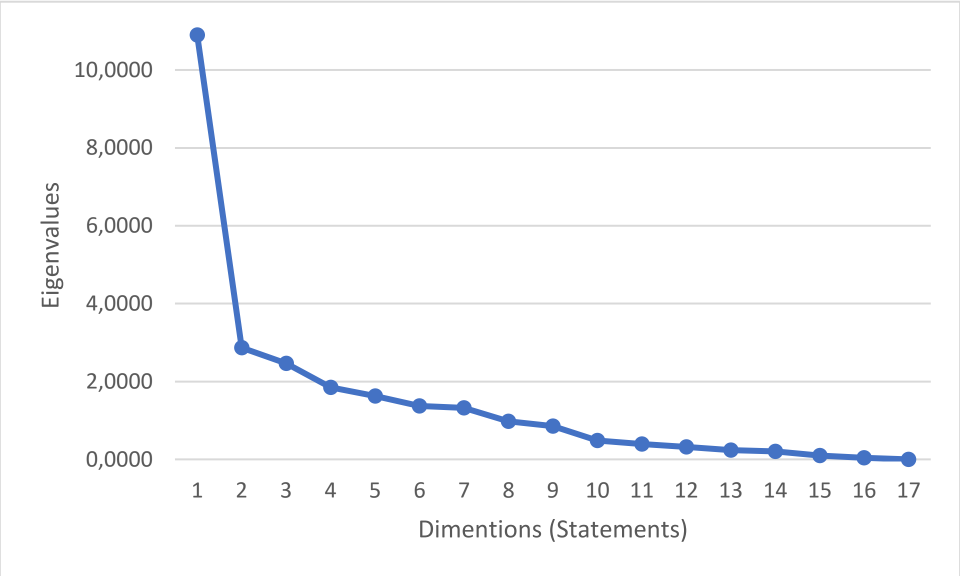
In the above formula the term $\boldsymbol{S_{x,ri}}$ denotes the scoring assigned to statement *x* by respondent *i*.

The Scree Plot

The Scree plot of the data showcases the eigenvalues of each statement with the statements themselves. The point where an *"elbow"* is created provides a sufficient number of components to describe the given problem (Jolliffe, 2002; Cattell, 1966).

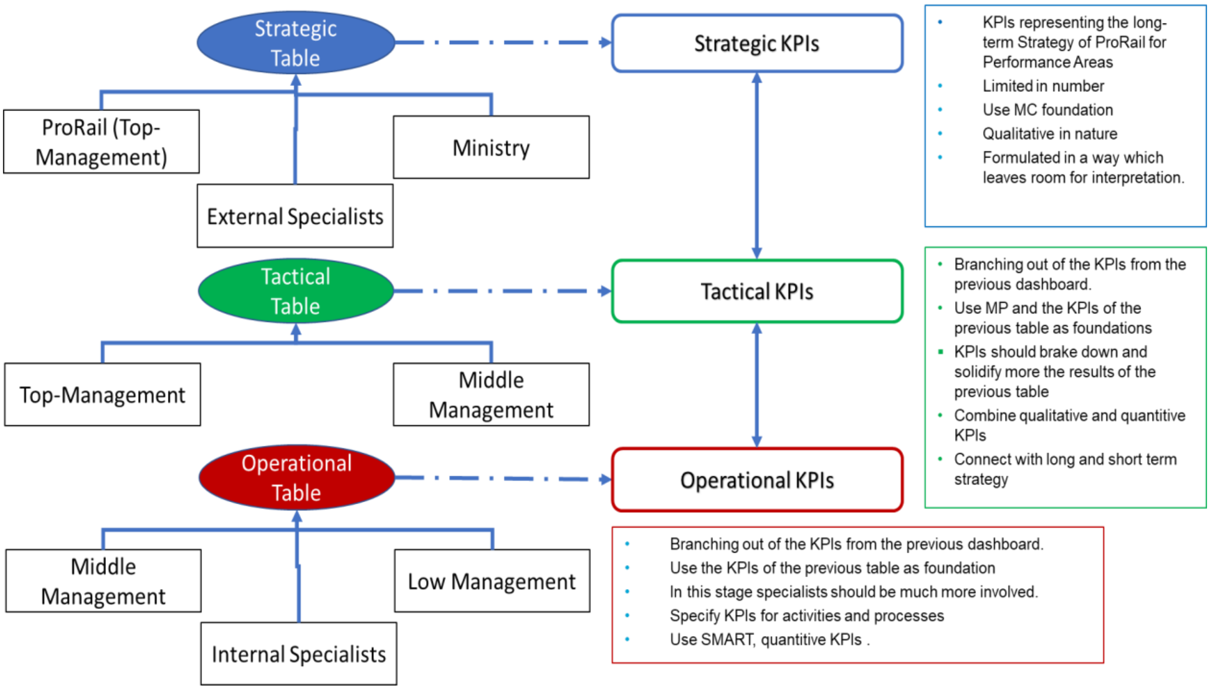
In simpler terms, the amount of data up until that *"elbow"* can accurately describe the sample as the data after the *"elbow"* are mostly just noise. As one can see in the figure below this *"elbow"* is created at statement 3, and thus three factors are deemed enough to describe the problem.

Figure 16: The Scree Plot of the data



Appendix C: Generalization of the proposed Advice

Figure 17: General application of the proposed framework



The figure above describes the general concept behind the framework presented in Chapter 4. In the example of the chapter "Sustainability" was used to elaborate on the procedure. In reality, any performance area can be the beginning of the discussions in the Strategic Table.

This discussion will form a set of Strategic KPIs. The dashed arrow represents the product of this. These KPIs will then be the starting point of the Tactical table agenda. In turn, the process of the Tactical table will produce the KPIs of the Tactical dashboard. At the end of the chain, internal specialist low and middle management will produce the final set of Operational KPIs

The two-headed arrows between the set of metrics denote that they are connected. This means that a top-level manager can trace a strategic objective to its operational metrics. Conversely a low-level manager or specialist can observe how their efforts in achieving operational goals contribute to the strategy of ProRail.