Interpreting the influencing factors within the decision making process between two train safety systems at ProRail

An explorative study

MASTER THESIS

Author: A.W. Zandstra (1536788)

MSc Management of Technology

Graduation Committee:

Chairman: Prof. Mr. Dr. J.A. de Bruijn
Professor, Section Policy, Organisation, Law & Gaming

First supervisor: Dr. Ir. S.A. Meijer
Assistant Professor, Section Policy, Organisation, Law & Gaming

Second supervisor: Dr. E. Sjoer
Assistant Professor, Section Technology, Strategy and Entrepreneurship

Company supervisor: Ing. M. van der Werff
Manager Expert Group Interlocking of the department TB at ProRail

MSc Management of Technology

Faculty of Technology, Policy and Management

Delft University of Technology

June, 2011

Abstract

This thesis explores the decision making process about the implementation of a new train safety system at ProRail. ProRail is responsible for the entire rail infrastructure of the Netherlands and faces tasks such as maintaining, optimising and replacing the infrastructure. One of ProRail's current projects concerns aged train safety systems and they must be replaced before 2018, because the economic and technical life-cycle will come to an end. A general choice between two families of train safety systems has to be established. In addition, reliability and safety may diminish if the aged train safety systems are not replaced on time. One of ProRail's incentives is to maintain maximum availability and safety of the railway infrastructure for transport companies, therefore this project can be considered as a very important project. The endurance of the decision making process constitutes ten years and is still ongoing. Therefore, we are intrigued to find out why the endurance of this process is relatively long and what factors contribute towards this issue, this research will help to answer this challenging question.

To answer this explorative research question, two rounds of interviews were performed. The first round of semi-structured pre-interviews included three participants at various hierarchical levels. These pre-interviews were conducted to acquire background information about the decision making process. With the help of 'discourse analysis' most important features influencing the decision making process were found. The second round of semi-structured interviews is an extension of the first round of pre-interviews. In that case seventeen interviews were performed of all functional groups and hierarchical levels within ProRail that are involved in the decision making process. This round focused upon the factors that were gained during the first round of pre-interviews. Again discourse analysis was used as an analytical tool in order to establish key-points that have an effect upon the decision making process. Furthermore, a comprehensive literature study was conducted about five theories, namely principal-agent theory, contingency theory, resource dependency theory, transaction cost economics and social network theory. These theories were used in order to give meaning towards the results.

This exploratory study adds perspective towards the decision making process at ProRail. The results from discourse analysis ascertained that organisational structure, communication, group decision making, inconsistency and culture influence the speed of the decision making process. It is worth mentioning that these key-points have a reinforcing effect upon one another. Furthermore, culture can be regarded as an independent variable influencing the decision making process.

This explorative study adds new and improved perspectives on scientific and managerial aspects. Still, this study also bears with some limitations. Due to the small sample size, the most likely categories influencing the decision making process are far from generalization. Another important note, the study did not analyse external parties that are involved in the decision making process. However, the explorative nature of this study does supply a first large building block on this topic, which will have an informative character towards ProRail.

Keywords: *decision making process, discourse analysis, social network theory, contingency theory, group decision making, company culture, communication.*

Acknowledgements

While this thesis project started a year ago the topic of research was not specified yet. It took some time before a clear research question was realised. It lasted a bit longer than expected, however I had the freedom to follow my own interests. Therefore, I experienced this project as joyful and most of all it was a great learning experience.

For the pleasure I experienced in this process, I am indebted to a large amount of people and therefore I would like to express my gratitude. My first special gratitude goes to Sebastiaan Meijer for supporting me in this journey. It was a delight to work with him, I was guided in a pleasant way and he always seemed to understand and manage my 'appelmoes' narratives. Of course I am also indebted to Maarten van der Werff, guiding me in an enjoyable way and allowing me to exploit my personal interests. Thank you for being flexible and helpful in the final stage of my graduation, in order to meet my time schedule. Of course I would also like to thank Ellen Sjoer for the precise, clear and useful comments that were made during the past year. Also I am indebted to Hans de Bruijn who always had some interesting viewpoints and comments about this subject.

I would also like to thank Job van Beek and Henri van Houten for their time and reflection on my thesis in order to improve my "nuanced" writing skills. Furthermore, I would like to thank the employees of the TB department. Thank you all for the hospitality and allowing me to work in the various working places that I occupied. In addition, discussions during the coffee or lunch-break were pleasant and it also induced great inputs and inspiring ideas. In addition, I would like to thanks Hanny van Zutphen en Ronald Vissers for guiding me at the start of this research while Maarten was not yet available. Besides, I would like to thank all secretaries at ProRail and at the faculty for their friendly and helpful manner when I was managing to schedule an appointment with four busy committee-members.

Of course I am grateful to all the people that participated in this research. I would like to thank all the interviewees for their time, interesting viewpoints, honesty and cooperation. Due to their enthusiasm it has been a great joy to conduct these interviews.

Last but not least, my special thanks goes to Luc who always motivated and stimulated me in difficult times and for helping to express my visualisations. And of course I am indebted to my dear parents. Thanks for supporting me during my bachelor and master, I really enjoyed this carefree period.

Delft, June 2011

A.W. Zandstra

Table of contents

Table of figures

Table of tables

Glossary

AEA Technology	A global consulting firm
ATB	Automatische-Trein-Beinvloeding
ATB-EG	Automatische-Trein-Beinvloeding Eerste Generatie
ATB-NG	Automatische-Trein-Beinvloeding Nieuwe Generatie
BB21	Beheers- en Beveiligingssystemen 21e eeuw
Betuwelijn	Train track of 125 kilometres from Rotterdam towards the German boarder
B-relais	A relay with a safety function in a railway safety system
COTS	Commercial Off The Shelf
DACAB	Design Authority and Change Advisory Board
Discourse analyses	A type of analysis which focuses on main keywords mentioned in interviews
EBP-system	Electronische Bedien Post (Electronical operating system for directing trains)
EBS-system	Electronische Beveiliging Siemens, an interlocking system
ERMTS	European Rail Traffic Management System; European system introducing interoperability of signalling systems on the train track.
Grounded theory	A systematic methodology to emphasize generation of a theory from data that were conducted in the research
Group PRM	Group Project Management
Hanzelijn	New railway between Lelystad and Zwolle
HSL-Zuid	Hoge snelheidslijn zuid; a 125 kilometer long high speed railway line between the Netherlands and Belgium
INESS	Integrated European Signalling System; A successor of the Euro-Interlocking project. The goal is to contributes to the standardisation of European signalling infrastructure
KEMA	Business and technical consultancy firm
KM	Kwaliteits Management
Mistral	A strategy with regard to train safety specified in a document called MISTRAL(i.e. Migratie Treinbeveiliging Intergraal)
MT AM	Management Team Asset Management
MT Directors	Management Team of Directors
MT IS	Management Team Infra Systemen
MT TB	Management Team Trein Beveiliging
NS	Nederlandse Spoorwegen (i.e. the Dutch Railways)
NVVP	National Transportation and Traffic Plan
NX	eNtrance-eXit (i.e. interlocking system)
PDCA	Plan-Do-Check-Act cycle
ProRail	Dutch organisation that is responsible for the railway infrastructure to maintain, improve and optimise the network in a safe way
RS	Rail systemen
SMO	Systems meet operation
Life-cycle	The cycle of a product from “invention” till elimination.
TL A&V	Team Leider Architectuur en Validatie
TL EG	Team leider expert groep
VMJB	Veiligheid, Milieu & Juridisch Beheer
VPI	Vital Processor Interlocking, an interlocking system
VPT	Vervoer Per Trein (i.e. transport by train)

1. Background information

Before the research questions and the purpose of this thesis are being addressed, it is important to impart background information. First of all, this research is performed at ProRail, therefore it is essential to include background information about the company. Second, the decision that will be evaluated in this research is concerned about new and conventional train safety systems. Background knowledge about this subject is necessary in order to get a grip towards the research question presented in chapter two. Third, this research focuses on the decision making process, therefore a short overview will be shown about the organisational and decision making structure within ProRail.

1.1 Company background

In this section the general background of ProRail will be highlighted, the organisational history of the company and their ambitions.

1.1.1 General

ProRail is the rail infrastructure manager of the Netherlands. Formally ProRail is a subsidiary of Railinfratrust BV (RIT). This company is owned by the Dutch government that legally owns the majority of the railway system. Though, ProRail is the economic owner of the rail infrastructure of the Netherlands.

ProRail is responsible for the railway system in the Netherlands, including the construction, maintenance, management and safety and subsystems for train detection, train protection (ATB) and outside elements like signals, level crossings, etc. They have more than 4000 employees which ensure that 1.2 million passengers and 100,000 tons of goods arrive at their destination every day. This is established with the help of more than 6,000 trains and around 6,830 kilometres of train track. Therefore, it is an important infrastructure network in the Netherlands. Moreover the Dutch railway system is the second busiest railway system of the world and busiest considering Europe.

ProRail is working on accessibility of the Netherlands by providing an optimal rail network. Dividing space on the train track, controlling all train traffic, building and managing stations and constructing new train track. Furthermore, ProRail maintains current elements (e.g. points, track bridges, catenary and level crossings).

Above the facts presented in the previous paragraph, ProRail is working with both the government and train operators to improve utilization of the rail network. They are trying to create more space on the train track in order to increase the amount of running trains. As a result more travellers and goods can be transported. Their goal is to increase the annual transportation of people with five percent until 2020. ‘Ruimte op de rails’ (e.g. space on the traintrack) is a project in order to realize this goal. It encompasses the fact that every ten minutes a passenger train will ride at major infrastructural points. In addition, a ‘green wave’ for freight will also encourage realising this goal. Moreover ProRail is working with regional government and municipalities identifying their needs in terms of rail and station facilities.[1]

[1] *www.prorail.nl*

1.1.2 History

NS Railinfratrust BV was founded in the reorganisation of 1995 as a holding for the Dutch Railways of three organisations, namely NS Railinfrabeheer, Railned and Traffic Control. These organisations are directed by the Minister of Transport. In 2003 these three parties are working together under the trade-name ProRail. At January the first 2005 these three subsidiaries merged toward ProRail B.V. Though, the minister remains responsible for the main railway infrastructure.

ProRail has five members in the management team replacing the board of directors since April the first of 2009. Figure 1 illustrates how this process looks like.

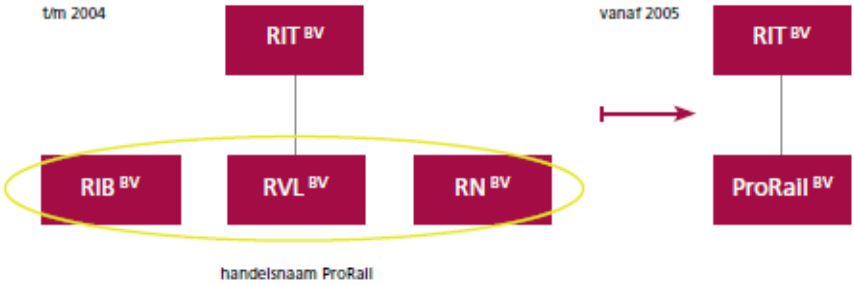

Figure 1 – The process of the development of ProRail.

1.1.3 Ambition

ProRail has several ambitions which can be divided in five bullets that function as guiding principles in this company.

- *Operational excellence;* ProRail continuously wants to improve the daily performance of the train track and at stations.
- *High frequency traffic;* ProRail strives for a better use of train track in order to increase the capacity of major lines in the future with 50 percent.
- *More possibilities for freight;* more space, flexibility and additional services to freight is another ambition.
- *Regional customization;* ProRail is reacting and anticipating towards the needs of regional carriers and governments.
- *Public interest, business served;* ProRail acts as a good steward of the capital which represents the train track.[2]

1.2 History of train safety systems

The main signalling equipment of the railway system in the Netherlands consists of the relay based interlocking and subsystems for train detection, train protection (ATB) and outside elements like signals, level crossings, and etcetera. The life-cycle of B-relays (a safety component in a railway safety system) is coming to an end, therefore they have to be replaced and therefore the Netherlands must prepare a countrywide modernization of the signalling infrastructure of the railway infrastructure. Another upcoming challenge entails the fact that legislative demands (promotes market operation) of the EU must be fulfilled and enable the expected growth of railway traffic.

[2] www.prorail.nl

This section will elaborate upon the history of relay technology, automatic train protection and electronic interlocking. Furthermore, the reason why conventional train safety systems need to be replaced is discussed. In addition, little background will be given about Mistral, BB21 and the department TB.

1.2.1 History relay technology

After the Second World War the relay based generation of interlocking was introduced on the railway network of the Netherlands. The impulse to replace classical (mechanical) signalling systems with relay technology was the Marshall Plan. This also explains the reason why the signalling infrastructure in the Netherlands is both technically and functionally strongly oriented towards American systems.

Over time the standard signalling equipment of the NS (Nederlandse Spoorwegen, i.e. Dutch Railways) became the NX (eNtrance-eXit) interlocking system at the stations and the automatic block lines (automatic operation of signals).

The replacement of classical signalling systems into relay technology started after the Second World War. The Marshall help started in 1947, installing relay technology. This continued until the mid nineties, though it can be said that it was divided in two phases. The first phase lasted until the mid sixties. In this period of twenty years most of the stations were equipped with relay technology and more than 1000 kilometres of the train tracks were prepared with automatic block. Most of these installations are still being used today. After these twenty years, the second phase kicked in, the speed of replacement could not be pursued. Several reasons accounted for this fact. First, there were financial problems. Second, the plans had to be revived several times, for example the increasing amount of trains required a lot of modifications. Around 1990 the last mechanical interlocking was replaced by relay interlocking (Scholten and Werff 2003).

1.2.2 Automatic train protection

In 1962 a serious train accident induced the decision to implement a train protection system additional to the existing signalling system, ATB (Automatische-Trein-Beinvloeding). This system, ATB-EG (eerste generatie, i.e. first generation), functions as a safety system when a train driver makes a mistake. The maximum allowed speed is transmitted to the train. It was decided to use a system with an American origin since the interface with existing interlockings and track circuits.

The technology was implemented of the same type as those from these ATB systems. Existing relay based signalling systems were equipped with ATB, though this was not an easy or cheap process since the system had to be modified. Implementing these ATB systems in existing relay signalling systems was not financially attractive since the current systems needed to be rebuilt. Furthermore, operational difficulties played a role. It is not easy to rebuild these systems since train traffic needs to be disrupted. In order to reduce the costs and reasons of reliability it was decided not to introduce an ATB code level for speeds lower than 40 km/h. With 40 km/h in case of a disturbance the train could still run, however slowly over a short distance.

In the nineties a new generation fail-safe ATB was introduced. It was launched since the existing system could not interfere below 40 km/h and therefore accidents might occur. It was called the ATB-NG (new generation). It works slightly different compared to ATB-EG (eerste generatie, i.e. first generation). ATB-NG does not always stop the train, compared to ATB-EG, but applies the brakes

gradually. When a certain speed is achieved, the driver can control the train again. The ATB-EG on the other hand reacts in a way that the train is stopped. ATB-NG was not introduced at a large scale in the Netherlands. New lines are not automatically equipped with this system. A consideration can be made between those two systems. ATB NG was introduced to offer protection to rolling stock that is not compatible with ATB EG and is mainly applied in the east and north of the country. An upgrade from EG to NG is not attractive considering a cost perspective view. In addition, other technologies were on the rise, therefore it was decided to stop the investments towards ATB. The disadvantage entails the fact that these NG installed ATB are not suitable for EG to drive. Vice versa NG is able to drive on lines installed with EG-ATB. It lasted around 40 years until almost the entire Dutch rail track was supported with ATB systems (Scholten and Werff 2003).

1.2.3 Electronic interlockings

The first relay technology was operated with switches and buttons. Though, when the computer was introduced this changed. In 1988 the EBP-system (in Dutch; electronische bedien post) was implemented. This system is still in use today, though some functions have been modified over the years. With the help of a monitor and keyboard EBP can control relay based interlocking. EBP itself does not contain safety functions. The advantage of EBP entails the fact that changes in infrastructure are relatively simple and is introduced in the entire Dutch railway infrastructure.

In 1984 the first pilot installations of a new developed electronic EBS system, an electronic interlocking type, took place in Hilversum. Originally the system is German and replaces existing relays-systems and it has its own control panel. It is particularly suitable for large stations. Currently eleven EBS installations are present in the Netherlands namely at Rotterdam, Amersfoort and in Arnhem, Breda, Kijfhoek, Woerden-Harmelen, Hemboog and Hoofddorp.

Upward of 1992 existing relay interlockings are also replaced with VPI (Vital Processor Interlocking) electronic interlockings. The functionality of VPI electronic interlockings is equal compared to relay interlockings. VPI does not have an own operating system, therefore EBP has been chosen. VPI is of American origin.

Both, VPI and EBS are first generation electronic interlockings. The output of the systems is comparable, though the architecture is different. The design and engineering process also are not the same. VPI is based on Boolean logic, which means that all signalling principles and functions are presented by Boolean expressions. On the other hand EBS signalling principles are included in basic software, especially developed for NS. The choice between VPI and EBS was roughly, on big emplacements EBS was implemented. VPI on the other hand was more suitable for smaller emplacements.

Relay technology and VPI were initially controlled with EBP. Though, an electronic traffic control was introduced, called VPT (in Dutch; vervoer per trein – transport by train). VPT interfaces on the operational level with EBP and EBS. EBP can be regarded as a fallback control system, in the event that VPT does not function, EBP can take over.

Figure 2 shows the relation between those systems mentioned above. In short it can be stated that the Dutch railway network has the following train safety systems at the moment;

1. Interlocking, NX interlocking systems and automatic block systems based on relay technology
2. In the last 20 years two types of electronic interlockings VPI and EBS were introduced
3. For Betuwelijn, quadrupling of tracks between Amsterdam and Utrecht and the High Speed Line unique systems were established (Railconsult 2003; Scholten and Werff 2003).

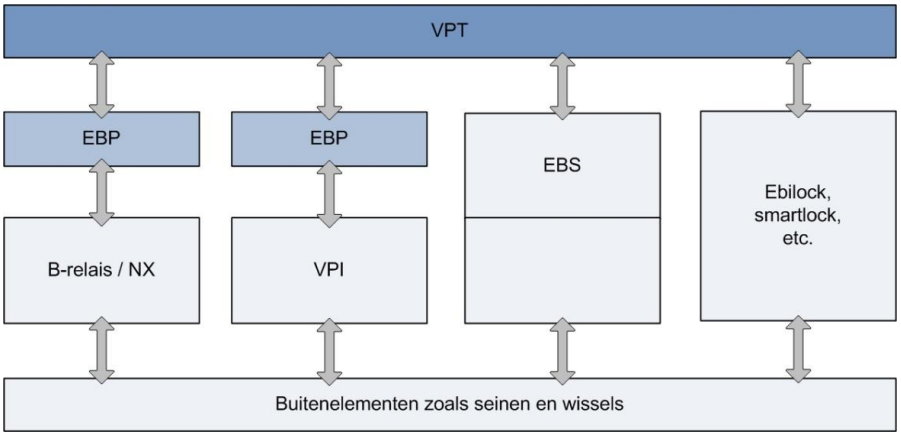

Figure 2 – Relation different train safety systems.

1.2.4 A need for change

Both the Netherlands and European railways need new or modernized train safety systems. This is necessary for a few reasons.

First of all, the ageing of the exiting installations plays an important role. The first relay based systems were installed more than 50 years ago. In addition, the life-cycle of this system is around 50 years, therefore they need to be replaced since they are subject to wear and tear. If the system is not replaced, more imputed errors might occur resulting in possible disruptions. These train safety systems follow a bathtub curve as shown in Figure 3. The probability of failures will increase as the system is aging. The status of current train safety systems relies in the second part of the figure, therefore random failures occur. Though, an increasing failure rate will be met when these train safety systems meet the end of their life-cycle in 2018. Furthermore, it should be mentioned that this bathtub curve can also be plotted considering financial costs; costs of train safety systems will increase during their lifetime. At some point costs will exponentially increase, therefore the economic lifetime will be met. Regarding this bathtub curve it is apparent why these train safety systems need to be replaced.

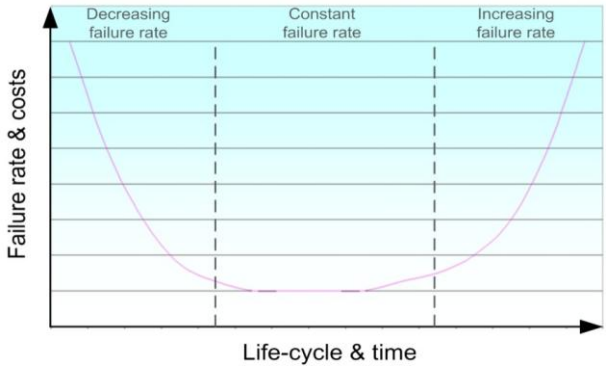

Figure 3 – Bathtub curve illustrating the financial and failure rate over time.

Research executed by ProRail showed that the intensity of the train traffic will increase. This research was conducted by the national transportation and traffic plan (NVVP) and they identified the need of railway transport for the coming years (Waterstaat 2000). It is thought that such an increase of railway traffic requires a more flexible network capacity compared to the present situation. New regulations are required when there is increasing traffic intensity, traffic mix and the speed of trains. Though, these regulations have to be synchronized with the technology applied. Furthermore, higher requirements concerning performance and maintenance of the systems are needed since the train traffic will increase.

What also needs to be taken in consideration is the fact that the full capacity of the existing systems is almost exhausted. If it is necessary to allow more trains to the railway network and the system that will be implemented must contain the ability to allow this. The electronic safety systems that were implemented in the nineties have to be reconsidered in an economic, operational and technical suitability before their life-cycle of 25 years ends. Therefore, regeneration of these systems needs to start already.

Another reason concerns the fact that European policy developments, the introduction of ERTMS, should allow standardisation and guarantee interoperability. It is expected that the INESS will contribute to the standardization of European signalling infrastructures. The Netherlands is positive about this project since it might bring economies of scale/availability of components from several suppliers/sharing know-how and experience. If the Netherlands does not participate a risk emerges that the European standards are not compatible with the Dutch requirements of safety. Dutch requirements are higher compared to other European countries. This is established since the density of traffic is relatively high compared to most other countries.

The European commission also enforces integral cooperation at several places. In 2001 a decision has been made about the basic function of ERTMS for the trans-European high speed network. For high speed tracks that are constituted in this network it resulted in the fact that they must be equipped with the interoperable ERTMS system, for example HSL-Zuid (Scholten and Werff 2003).

1.2.5 Mistral

This research focuses towards the decision making process about implementing new train safety systems. For this reason the centre of attention relies upon a project called Mistral. Mistral is a project which is concerned about the replacement of the oldest train safety systems in the Netherlands. This means that train safety systems that were installed between 1953 until 1968 need replacement. It entails 17% of the total network of rail-infrastructure. Railinfrabeheer started to develop a strategy with regard to train safety specified in a document called MISTRAL (Migratie Treinbeveiliging Intergraal, i.e. migration train signalling integral. This document (ProRail 2004) presented a framework to entirely implement new or modified signalling systems within 25-30 years. The framework is prepared that ERTMS can be introduced whenever desired (ProRail 2010a).

1.2.6 BB21

In short, BB21 might, from a certain point of view, be considered as a ‘precursor’ of Mistral, therefore it should also be mentioned. Back in the eighties it became apparent that current techniques that were used on the train track, especially in terms of signalling, needed to participate in the world of ICT. In order to make the system cheaper, more reliable, more flexible, better

maintainable, more available and more functional. BB21 resembles both control (besturing) and safety (beveiliging) for the 21 century. These developments are found in the rest of Europe as well. The European Union introduced interoperability, which leads to ERTMS (European Train Control System). ERTMS is the interoperable train safety system. Furthermore, ERTMS was compulsory for the HSL-Zuid. BB21 transformed into a program in order to implement ERTMS at several mega-project, for example Betuweroute, HSL-Zuid and Amsterdam-Utrecht. Program BB21 must ensure that ERTMS will be introduced properly. Subsequent to this program the know-how and know-why are secured. Mistral also could learn from this project since it involves the implementation of new electronic train safety systems (ProRail 2008c).

1.2.7 Department railway-signalling (TB) of ProRail

The department railway signalling of ProRail is responsible for the development and functionality of train safety in train tracks. In addition, they are responsible for internal ProRail rules for installing and maintaining these systems. They prevent trains from colliding and derailing with the help of train safety systems. This is an important subject since it concerns the safety of travellers and goods, which is an important incentive for ProRail. It should be mentioned that the interests of this research relies within the fact that TB is considered as the focal actor (ProRail 2009).

1.3 Organisational structure of the decision making process

This section will describe what the general decision making process looks like and shows the organisational structure of the company. The external parties that play a role in this decision making process will also be mentioned.

1.3.1 General decision making process

In this section the decision making process, which evolves through sequential steps will be explained. The decision making process starts at DACAB, this is the starting point if we look at the decision making process from the perspective of the department TB. DACAB stands for design authority and change advisory board. Several employees of the department TB and a regional specialist are instituted in this team. DACAB members could be involved with B-relays, electronical safety systems etcetera. They contain tacit knowledge and their job encompasses to give advice about technical principles concerning train safety. This advice is forwarded to the management team of TB (MT TB). Though, the MT TB is also informed by SMO (systems meets operation) and resource management (‘productieoverleg’). Furthermore, the subject of the decision making process explains where in the decision making chain it must be approved. The decision making process evaluated in this research involves high investments and strategy. For this reason it must be approved at higher management levels, more precisely at the board of directors. The president-director is primarily responsible for decision making, therefore it is illustrated as a separate step in de decision making process. All levels that are present in the decision making process at ProRail will be illustrated in Figure 4. In addition, this decision involves national strategy, since ERTMS (the European standard) could also be implemented as well, it also exceeds existing budgets and therefore this decision will be introduced at the government.

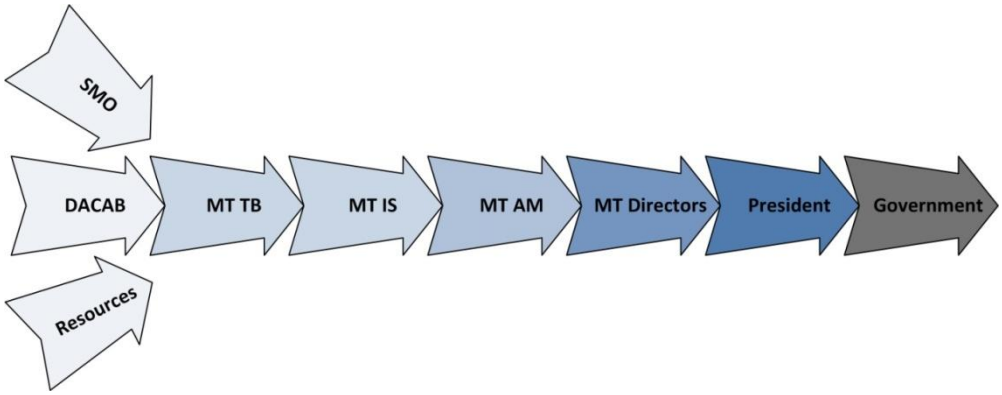

Figure 4 – General decision making process.

1.3.2 Organisational structure of ProRail

It this section the organisational structure of ProRail is presented. It is of significance importance since it is needed in order to visualize the total picture of the decision making process and how this process is intertwined over the organisation. Figure 5 presents an overview.

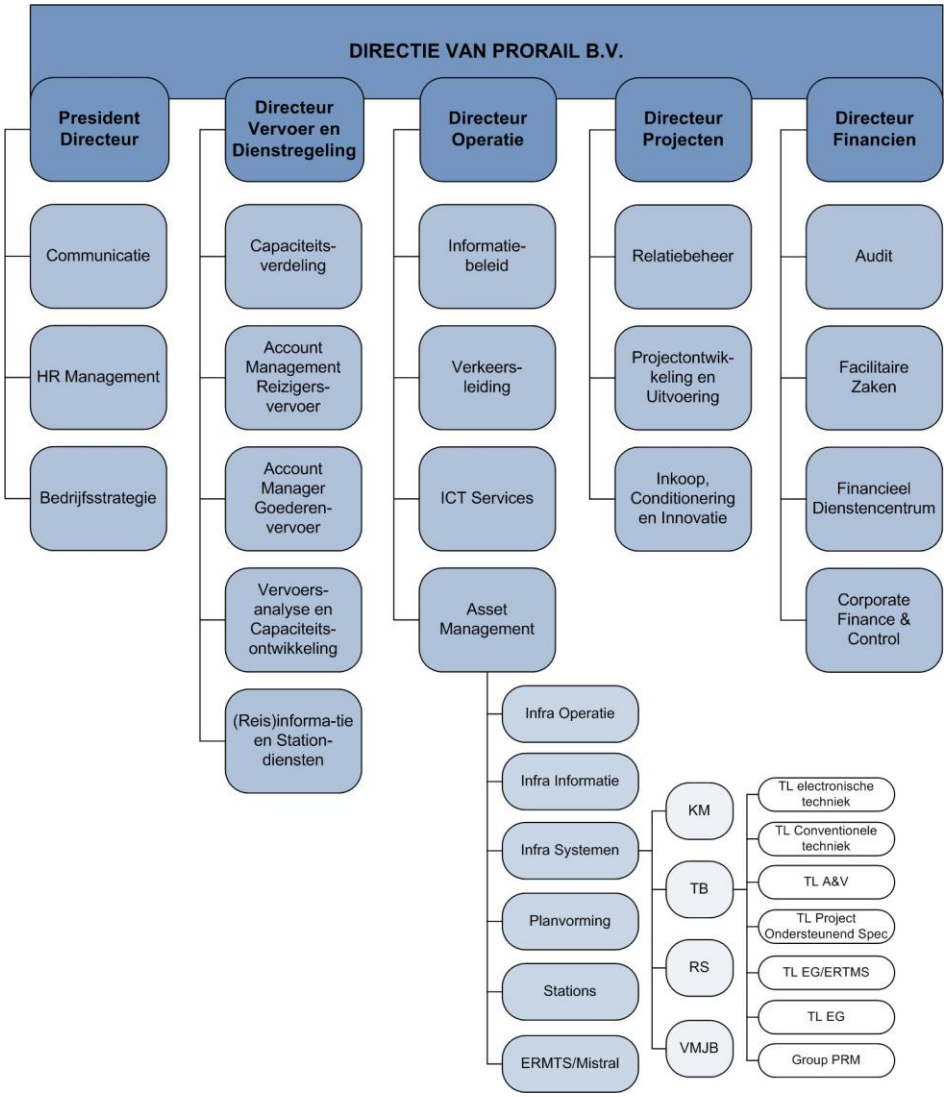

Figure 5 – Organisational structure of ProRail (with an extended view of Asset Management).

1.3.3 External actors

ProRail is surrounded by multiple actors that are also important players in the decision making process. The most important relation ProRail contains is with the government and the “transporters” (NS &GVN). The collaboration between these three parties is known as the institutional triangle. The agreements between those parties constitute the basis of a reliable train system in the Netherlands. As can be seen, ProRail cannot make a decision in “splendid isolation” about the implementation of new train safety systems, since other parties are involved. In addition, suppliers, engineering bureaus, and European guidelines also effect the decision making process. The scope of this research will not include these external parties and will mainly focus on the decision making process *within* ProRail.

2. Introduction

The previous chapter provided background information about ProRail and train safety systems. It became clear that aged train safety systems should be replaced because they are subject to wear and tear. In addition, the main idea was to replace conventional train safety systems upward of the year 2008, however a decision has not been reached. This Master thesis focuses on the evaluation of the decision making process about implementing new train safety systems within ProRail. In this chapter we will elaborate on the research problem and the subsequent objectives and questions. Last, we will elaborate on what will be the most appropriate methodology in order to find an answer to the research question.

2.1 Research problem

A decision needs to be taken at ProRail about the implementation of a new train safety system. This section will discuss *why* evaluation of this decision making process is the subject of research.

In 2000 the first signs to implement new train safety systems became visible. In the following period it was decided that aged equipment, between 1953 and 1968, should be replaced between 2008 and 2018 (ProRail 2004). However, the current decision making process is still ongoing and aged train safety systems are not replaced until now. Consequently the Netherlands is not prepared for a country wide replacement program. This results into an increase of not imputed errors, due to the fact that the technical life-cycle of these train safety systems will be met.

Originally, the implementation of new train safety systems should already be in progress in the Netherlands in order to prevent the occurrence of disruptions. ProRail imputed the question to evaluate this decision making process in order to find out why this process is still ongoing. ProRail requested to evaluate this decision making process by an external party in order to learn from the situation. It may contribute to awareness of the company and highlighting bottlenecks of this decision making process. When these bottlenecks are clear it may help ProRail to realise their targets, which will be explained in the next paragraph. Conducting this research may help towards the establishment of more effective and efficient decision making processes within ProRail, helping to run the business smoother. This research can also be of great managerial relevance. Poor decision making will waste time of the manager, costs are higher due to delays, and it limits innovation. Conducting information about this in-depth case study may give new insights about decision making effectiveness; furthermore, it can be used in such a way that it will improve current (and future) objectives.

As already mentioned ProRail has certain targets and this research may contribute towards the realisation of these. Maintaining reliability and safety is one of ProRail's main incentives in order to meet social and economical values. Therefore, it is important to guarantee these incentives towards travellers and goods. Furthermore, it is vital to maintain the second busiest train network in the world, which is crucial for the economic performance of the Netherlands. The issues mentioned here clarify that the implementation of a new train safety system is key. However, since the decision making process is still in progress, ProRail ask us to investigate what the challenges of this decision making process are. They will benefit from this interesting opportunity by learning and gaining knowledge about this decision making process.

2.2 Research objective

This section describes the objectives of this research. It will create the basis for the development of the research questions which will be explained in the next paragraph.

2.2.1 General background of decision making challenges

It is expected that several factors contribute towards the challenges in this decision making process, they will be explained below in order to describe the entire situation of this phenomenon.

The decision concerns two kinds of train safety systems; conventional (B-relays) and the new electronically safety system, both have advantages and disadvantages. The conventional system (B-relays) has a life-cycle of 50-60 years. It is a robust and well established system which is, simple, safe, cheap and reliable, because this system also has a low failure rate. Furthermore, the technique is relatively conservative (out dated) and the design regulations have been changed over time resulting in a more complicated implementation than genuinely thought. On the other hand, electronic safety systems have a life-cycle of 25 years, the system is more expensive and difficult (Scholten and Werff 2003). There is also less experience within ProRail's staff concerning the new safety system, however it is proven to be reliable and safe. Furthermore, knowledge and information about the new electronic safety systems is not present at ProRail, but rather at provider agencies. In addition, the conventional system is less suitable for switching to European safety standards compared to electronic safety system. In short, it is difficult to weigh the pros en cons between these systems, especially for managers that need to make the decision. This challenge may influence the duration of the decision making process.

Managers have to deal with many different opinions and perspectives that emerge during the process due to the fact that lots of stakeholders are involved (e.g. employees, departments, ministry and engineering companies). Every actor has its own preference concerning this subject. They will enthusiastically elaborate about their own preferences, without discussing the pitfalls. These factors make it complicated for the manager to gather and filter the right information in order to make a genuine decision. Tacit knowledge about these train safety systems is playing a role in the decision making process as well, making it even harder to get a grip on the subject. It is possible that this will influence the speed of the decision making process.

Another factor that might contribute to the challenges of decision making relies on the fact that it seems that decisions are unintentionally established due to circumstances. To clarify what is meant, we will give an example. At a certain point in time it was decided that new electronic train safety systems will be implemented. Though, due to financial shortage and other issues, the decision radically changed towards the implementation of conventional train safety systems. It seems that it is a challenge for ProRail to make a strategic plan for this decision making process. In addition, a future prospect is hardly taken into account (e.g. for how long will companies produce these B-relays or how should employees be recruited in the future since they will not contain the knowledge about conventional technologies when they are schooled nowadays).

To conclude, a well defined decision making process seems to be lacking. For this reason it is hard to determine where in the process a decision has been taken. It seems that rarely a decision does reach a "go" or "no go", but instead only small steps were taken. All these challenges mentioned above

might influence the decision making process. This study will explore what factors (and key-points) will influence the decision making process.

2.2.2 Objectives

The features mentioned above contribute towards the challenges that might be present in the decision making process, however they have not been analysed yet. Therefore, ProRail asked to perform this research to gain more insights about this topic. This research will have an explorative character in order to find all the factors that play a role. Thus, the goal of this research entails to discover *why* a decision of this particular subject has not been reached yet *and* what the causes are of this phenomenon. This informing role of this thesis provides additional value for ProRail's insights by evaluating and mapping the current decision making process. As already mentioned earlier, multiple decision making levels are involved since the subject of decision making is concerned with high investments. In addition, every involved person or department must be included in this research in order to evaluate the decision making process in a complete manner to unravel possible problems. Therefore, it is of prior importance to generate an overview of this complete decision making 'chain'. Only then, it becomes possible to fulfil this informing role and to realise this aim.

At the first glance *three* aspects are of importance concerning the issues highlighted in the previous paragraphs. Based on the possible decision making challenges, it seems that the decision making process is affected by the aspects *information asymmetry, power and information requirements at various levels of decision making.* Based on these three aspects *five* theories were chosen in order to clarify the results that will emerge. These theories are principal agent theory, resource dependency theory, transaction cost economics, social network theory and contingency theory. Chapter three will elaborate upon these topics in further detail.

2.3 Research questions

This paragraph will be divided into two parts; focussing on the main- and sub research questions.

2.3.1 Main research question

The main focus of this research will be on the question how the decision making process between two families of train safety systems has evolved. In order to provide insights about decision making effectiveness, underlying factors that influence the decision making process have to be investigated. Therefore, the following research question arised;

1. *"Which factors influence the decision making process about two families of train safety systems at ProRail, since a decision has not been reached?"*

2.3.2 Sub research questions

The main research question implies the rise of several sub questions. In order to evaluate the decision making process, it is important to pinpoint the following questions in order to perform this research;

2. *"What did the decision making process look like considering the past decade?"*

3. *"Which (or what kind of) information is available and communicated between the different line managers?"*

4. *"Which (or what kind of) information is available and communicated between the different business units?"*

In order to provide insights about decision making effectiveness it is important to find out what factors influence this decision making process. Defining these factors can also help to establish recommendations for the company. Therefore, another sub question evolved:

5. *"What are the main factors in the decision making processes that are responsible for the fact that a decision has not been reached yet?"*

As was mentioned in the research objective, a literature study about *five* theories will be performed. These theories may help to explain the factors that will be found in this decision making process, helping us to clarify the phenomena that may occur. This leads to the following sub question:

6. *"What theory gives meaning towards the results that are found by evaluating the decision making process and contributes towards explaining the phenomena that occurred?"*

By combining this information with the answers to the previous sub-questions, the research will try to answer the main question as mentioned above.

2.4 Research methodology

This section describes the research approach that will be followed in order to gather the information that is required to answer the research questions.

In order to answer the research questions explorative research will be performed. The objective of explorative research in general is to gather information that will help to define challenges, in this particular case it defines factors that occur at the decision making process of implementing new train safety systems at ProRail. The aim of this research is to conduct an intensive study of this specific decision making process, therefore a case study will be an appropriate method. The research problem will be approached with a grounded theory perspective by utilizing empirical data (Velde, Jansen et al. 2004).

First, a literature study will be performed, since multiple theories exist that may be helpful to explain the challenges in this decision making processes. On beforehand, five theories will be explored that could be related towards this topic. The answer of the last research question will be answered by comparing these theories with the empirical results that will be generated throughout this research. Every theory will have a different view towards this real life decision making process, each contributing towards this research in another manner.

This research can be divided into *two* main analyses. We will elaborate on both below. The first step of this research is collecting data by means of three pre-interviews in order to explore important features influencing the decision making process. This data will be analysed using discourse analysis, which can be used as a tool in order to generate key-points which are important in the decision making process. The first analysis *(pre-interviews*) will mainly answer the second question. This analysis forms the basis in order to answer the second and fifth question in the second round of interviews. The pre-interviews will generate certain assumptions about the decision making process, thereby generating a "framework" functioning as a building block on which the second analysis

(interviews) will be based. It is required to generate these assumptions in the first round of interviews in order to arrive at useful interpretations after the second round of interviews. These subsequent steps are important to be made, otherwise little structure and comprehensive data will produce an excessive amount of data, which will be difficult to interpret leading to poor results.

As already mentioned, the second analysis is based upon factors (and key-points) that were generated from the first analysis *(pre-interviews)*. These interviews will be conducted including various representatives within the organisation. The entire decision making line, from TB towards the ministry will be interviewed, as well as the different business units that are involved in the decision making process. Again, discourse analysis will be used in order to analyse the data. Since interviews will be conducted with various individuals, the context and dependence of the key-point that are addressed after the first analysis, will be illustrated in a graphical framework. Deeper insights into the way of decision making will be provided which is the main goal of this research. This second analysis enables us to answer all the research question, except the second question. This question can already be answered after the first round of interviews though, the second round of interviews may provide some additions. Figure 6 illustrates the methodology as explained in this paragraph.

Furthermore, additional data is collected from multiple sources within ProRail (e.g. reports, presentations, and archives) in order to complete the description of the case. Therefore, qualitative research is performed from multiple sources. First, several interviews are conducted. Second, existing data will be examined, because information about the decision making process can also be found in internal existing records. This offers the opportunity to verify the collected data and will help to answer the research question in a more detailed manner.

Based on these empirical results, a theory from the ‘ground-up’ can be developed about the phenomena that are present at ProRail’s decision making process. Though, this does not answer any research question, and therefore it is not included within this research. However, it is interesting to be included in future research.

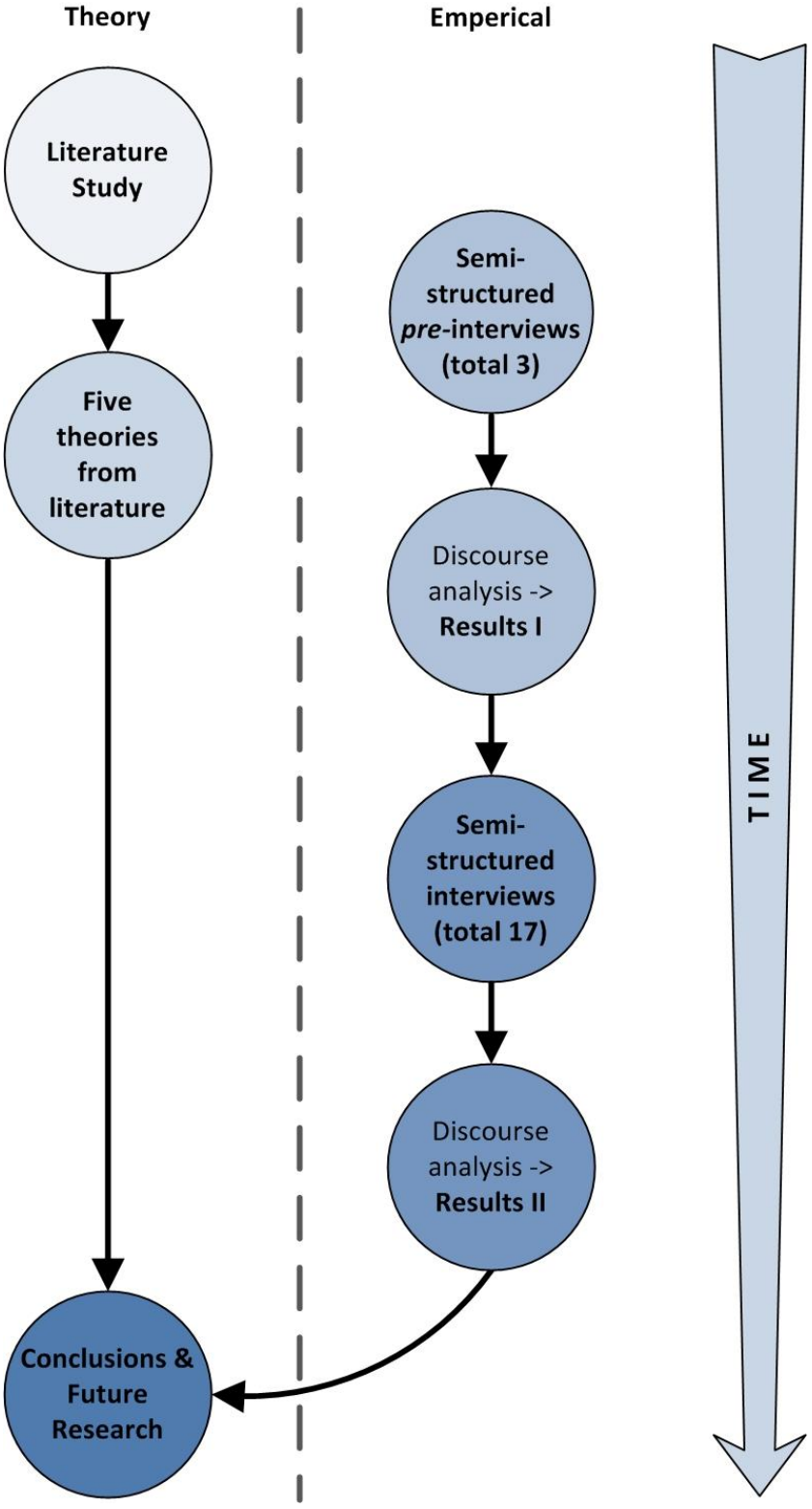

Figure 6 – The methodology cycle of this research.

2.5 Report outline

This thesis consists of ten chapters. Chapter three illustrates a literature study where five relevant theories will be explored, namely; principal-agent theory, contingency theory, transaction cost economics, social network theory and resource dependency theory. In addition, little background information will be given about relevant subjects in this research.

Chapter four presents the analytical approach and data collection about the first analysis that will be performed. Chapter five will discuss the results that were obtained in chapter four. A framework will be established that will be used for the second round of interviews. Chapter six provides the analytic approach concerning the second analysis. In addition, chapter seven will elaborate the results from the second data analysis.

Chapter eight presents the conclusions and discussion. Chapter nine will discuss the limitations of this research, furthermore, some directions for future research are highlighted. Lastly, chapter 10 will provide some recommendations for the company.

3. Literature study

This chapter consists of the literature study that is performed in order to scientifically support this research. First, it will further elaborate on general information. Subsequently, the three aspects will be explained which have been mentioned before. Last, the five theories from literature will be closely looked at.

3.1 General

The problem statement and research objective defined a few difficulties concerning the decision making process between conventional and new electronic train safety systems at the department train safety of ProRail. In order to perform our research, a distinction has been made between three different aspects. These aspects were already mentioned in the research objective section and may be of influence on the decision making process. In order to get a better grip on the subject 5 theories were chosen based on these aspects. These theories, *principal agent theory, social network theory, transaction cost economics, contingency theory* and *the resource dependency theory* may help towards the explanation of the results that will be found. Before we dive into the theories and their definitions, we will first give a short introduction about the scientific background of decision making processes.

3.1.1 Decision making

As already mentioned a decision needs to be taken between two families of train safety systems. The real decision making process involves a lot of people and the whole structure involves feedback. There will be a great many decisive moments within the total decision, namely at different levels (personnel → DACAB → MT → manager → … → director). For this reason it is important to know what a decision is and when precisely a decision will be reached, since also sub decisions will be taken. For this research we will use the following definition:

Decision: a decision has been reached when the president-director (the last person in the decision making process) has attained a choice about a problem or subject.

3.1.2 Multi level decision making

As stated above decisions proceed with a couple of steps and decisive moments before an actual decision has been reached. Therefore, since the decision making process evolves through different kinds of steps it presents a multi-level decision making process. In multi level decision making (or team decision making) decisions deal with two distinguishing characteristics. First of all, the team deals with status differences, one member is primarily responsible for the decision. Second, distributed expertise plays an important role. This means that each team member has its own expertise and therefore they bring different knowledge and information to the decision problem. In all kinds of organisations these hierarchical teams with distributed expertise are common, the same hold true for the department railway signalling of ProRail (Hollenbeck, Ilgen et al. 1995).

Decision making can be complex for organisations. Nowadays organisational decisions may be much more wicked since they can include social, environmental and economic concerns (Courtney 2001). Another difficulty is that decision makers are subject to a hierarchy of influences that effect the decision making process. Decision practice is also influenced by aspects related to the context in

which decision makers are situated. Furthermore, a director weighs different factors in order to make a decision, for example performance and finance, compared to a technical employee, it is hard to cross this chasm. Figure 7 shows a simple example of multi level decision making network and shows that multiple levels and actors are involved.

Figure 7 – Example of multi level decision making network.

3.2 Aspects

Three *aspects* mentioned before will be explored and explained in further detail. In addition, five theories will be assorted based on these aspects in order to give meaning towards the decision making process. These theories are also described in the following paragraphs. Furthermore, little background will be given about strategic, tactical and operational decision making.

3.2.1 Information asymmetry

Information asymmetry concerns the fact that not all relevant information is known at every party involved. It studies decisions of agents in transactions, where one party contains more or better information than another. This information asymmetry creates an imbalance in power. Examples of these problems are moral hazard and adverse selection. Both moral hazard and adverse selection are economic understandings. Moral hazard concerns the fact that a party's behaviour differs when they are not directly at risk for their actions. Adverse selection is about the fact that some information and behaviour of one party is hidden from the other party before signing a contract. This leads to adverse selection where bad results happen when these parties have asymmetric information. Information asymmetry might also cause inefficiency since not every participant encloses the information needed for their decision making process (Eisenhardt 1989).

It is well known that information is needed in order to make a genuine decision. Simon expressed the idea that human decision making is limited by the availability of information (Simon 1947). Therefore, this factor, information asymmetry, is of importance in this research. It is thought that information asymmetry is subject in this decision making process, thereby making the decision making process more complex. In our opinion information asymmetry occurs in this decision making process for a couple of reasons. First, it is hard for the manager to comprehend all tacit knowledge available. One might call it a knowledge gap between the employee with tacit knowledge and the manager resulting in information asymmetry. The manager cannot comprise the subject on which it needs to make a decision. Furthermore, everyone has different opinions concerning this subject. Therefore, information asymmetry might evolve since the flaws of an actor's preference are not presented. Additionally, information asymmetry might arise since not every actor in the decision making process communicates with each other or holds back certain information. For this reason some people might have more information than others.

Figure 8 illustrates the phenomenon of information asymmetry and how this is unequally balanced. Employees might contain more knowledge (heavier on the scale) compared than managers, therefore they have an information advantage and can choose which information they share and which information they do not share.

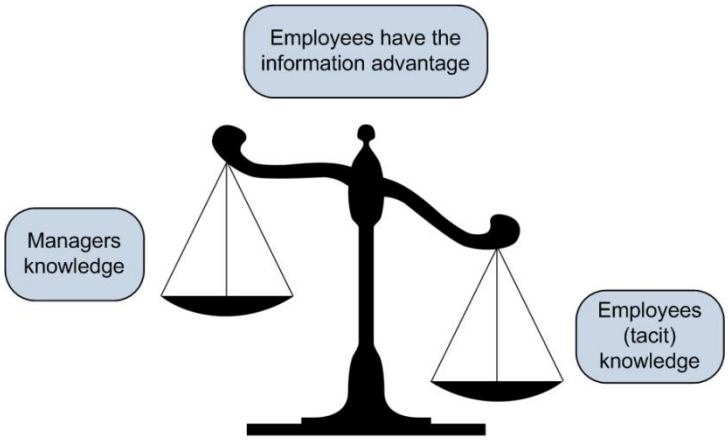

Figure 8 – The phenomenon of information asymmetry.

3.2.2 Power

Power can be described as the will that someone (a group or individual) can exert over others. It is crucial for the achievement of goals, communication competency within a group or the resolution of conflicts. Power is defined in multiple ways and in multiple fields. Only the field of economics differentiates five types of power (purchasing power, monopoly power, bargaining power, managerial power, and class power) (Vatiero 2009). In this research the most important one is bargaining power. Bargaining power concerns the ability of players to influence the outcome. Another interesting part in this research concerns the fact that information can be seen as a form of power. If two agents enter a contract, one agent can have more or better information that the other party, resulting in a form of informational economic power. This can also be called information asymmetry.

Power has a link to information asymmetry, as already mentioned, information asymmetry might arise as not every actor in the decision making process communicates with each other. For this reason some people might have more information than others, which can be used to exert power over others. Not all information is known resulting in the fact that people might force their favour. Power can play a role in the decision making process and it is of importance to know how the power-relations are situated in the decision making process. Employees might influence the outcome of the decision making process with the help of establishing a network around their prevalence and thereby exerting power. If we know the 'power relations' one might know what goes wrong in the decision making process. Therefore, this theme might contribute to our research.

3.2.3 Information requirements at various levels of decision making

The decision making process consists of different 'decision making steps' at different levels in the organisation. It is known that people at different levels in a company have different types of decision making responsibilities, therefore power plays a role. There are various levels at which decisions are needed to be taken and these levels need different information requirements in order to make a decision. When it is known what information is needed and where it is needed in the decision making

process, possible faults which might occur during the decision making process can be discovered. When this is known it might be explained why and where in the decision making process things go wrong, entailing important factors in our research.

There are three types/ levels of decision making, namely strategic, tactical and operational decisions. Every level/type needs different information in order to make a decision.

Strategic decisions

Strategic decisions are concerned with a long term goal of the entire company, these decision are usually made by top managers. These decisions are more general in nature. The aim of strategic management is to give direction to the company. An example what market what products will the business produce or should they put effort on new products? Most of the time, strategic decisions are complex and the outcome is doubtful, since the availability of information is often incomplete (MacNair and Vangermeersch 1998).

Tactical decisions

Tactical decisions have a focus on short term goals, the centre of attention lies more on intermediate term issues and the decisions are more detailed and specific. These decisions are typically made by middle managers and based on aims or objectives of the organisation. The purpose of this level is to help the company reach their strategic goals (MacNair and Vangermeersch 1998).

Operational decisions

These decisions have a focus on day-to-day, routine activities within the company. Normally these decisions are made by lower level managers. They usually respond to regular problems and at this level they help to make sure that daily activities will progress in a good manner and thereby helping the company realising strategic goals (MacNair and Vangermeersch 1998).

These three levels are interrelated. The strategic level controls the tactical level and the tactical level in return steers the operational level. Controlling this cycle can be managed with the help of a PDCA cycle (plan-do-check-act). It is important that long term goals are translated in short term goals, which are in turn translated into operational activities. It is important to get the right balance between the strategic, tactical and operation level since it can have a positive influence to the way a company performs.

For these reasons this is also an important theme in our research. The decision making process is not really clear, therefore it is not known which information needs to be provided in the different steps of the decision making process. In various levels of decision making, dissimilar information is needed in order to make a genuine decision. Managers have different considerations compared to technical employees, needing different information in order to make a genuine decision. Especially since people have their own responsibilities and at every layer other things and therefore information requirements need to be taken into account in order to make a genuine decision.

Each decision level needs various kinds of information in order to make a genuine decision, since they all have different responsibilities. This is depicted in Figure 9.

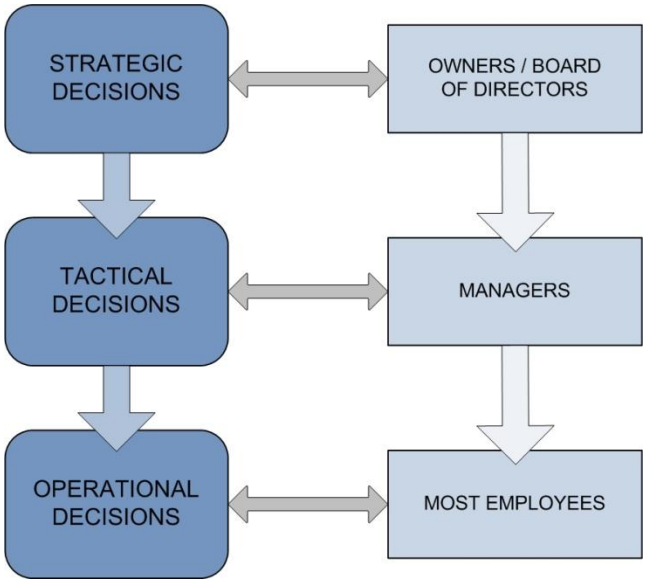

Figure 9 – Different decision making levels.

As can be seen in the statements above the focus of this research starts at these three aspects, since they may acquire more insight about the decision making process. Furthermore, the aspects are related to one another and have an overlap (green box) as can be seen in Figure 10. The overlap of these aspects function as a building block in order to choose suitable theories that may help to investigate the nature of the decision making process. This can be seen in Figure 10 as well.

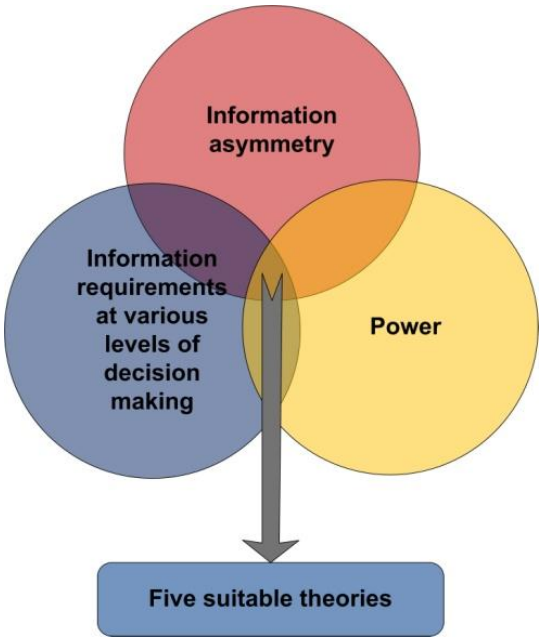

Figure 10 – Overview of three aspects combined.

3.3 Theories

As we have mentioned before, five theories that play a vital role in this research will be further included. We will elaborate on each of them below.

3.3.1 Principal agent theory

First, we want to know what the principal agent theory entails. Agency theory attempts to describe the relationship between the principal (a party that delegates work to another, the agent) and the agent using a metaphor of a contract (Jensen and Meckling 1976). The Agency theory is concerned with resolving two problems that can occur in agency relationships. The first is the agency problem that arises when (a) the desires or goals of the principal and agent conflict and (b) it is difficult or expensive for the principal to verify what the agent is actually doing. The problem here is that the principal cannot verify that the agent has behaved appropriately. The second is the problem of risk sharing that arises when the principal and agent have different attitudes toward risk. The problem here is that the principal and the agent may prefer different actions because of the different risk preferences (Eisenhardt 1989). The frame of analysis concerns the relationship between the principal and the agent, therefore the focus of this theory will be on determining the most efficient contract governing the principal-agent relationship given assumptions about information, people and organisations. The field of agency theory are the relationships of a principal and agent who are engaged in cooperative behaviour; however, they have different goals and different attitudes towards risk (Eisenhardt 1989). There are two streams of agent systems, namely principal agent stream and the positivist stream. In short the principal agent stream looks at the contract between the principal and the agent. While positivists look towards agency problems and the various contract alternatives that are available.

How is the principal agent theory linked to our research, in other words linked to our three aspects?
In the agency theory, information is playing a role. In some cases a principle knows what the agent has done, however this is not always the case. For example when a scientist works on his own project, it is hard for the manager to detect what the scientist is actually doing, since the research is very complex. Therefore, the principle does not contain complete information. This is one of the agency problems that might occur, namely moral hazard (an agent is shirking). Another problem that might arise is adverse selection which refers to the fact that someone is applying for a job, since he has the skills (according to himself), however the employer cannot judge whether this is true. Therefore, a link to *information asymmetry* can be made. An important information asymmetry problem that might occur at ProRail is that various levels are involved in the decision making process. These different levels have a different conceptual framework, they speak another language and therefore a misunderstanding is soon being reached. For example a specialist will not share what he knows because he feels misunderstood. It is the task of the middle management to close this chasm between technical experts and management. This theory can also be related to *power* since with the help of knowledge someone might influence the outcome. Information is a form of power and therefore power is linked to agency theory.

Agency theory is also similar to the information processing approaches. It assumes that individuals are bounded rationally and that information is distributed asymmetrically throughout the organisation that is why agency theory can be coupled to information asymmetry. In order to close the chasm between a scientist and manager you might need other *information requirements at these different levels*. Various mechanisms may be used trying to align interests of the agent with those of the principal, such as piece rates, commissions, profit sharing, efficiency wages, the agent posting a bond, or fear of firing. The principal-agent problem is found in most employer/employee relationships. Therefore, it also plays a role in the decision making process. In addition, scale

differences in salary might influence the decision making process. Employees that earn more are generally speaking taking more serious; if he says it is like this, it is respected and believed. Thought this might not always be true.

There is a source of gain in cooperative activity involving working as a team. In multi-level decision making ProRail can also gain (a source) in working as a team. Team production is production in which several types of resources are used (at ProRail different types of information), the product is not a sum of separable outputs of each cooperating resource and not all resources used in team production belong to one person (Alchian and Demsetz 1972). Cooperation in groups also relates to the agent theory. The agency theory cannot verify if the agent behaved appropriately. The same holds true within team production, since it is difficult observing the total output of a team, therefore people might shirk. This refers to a lack of effort on the part of the agent, which is a problem in principal agent theory. With the help of monitoring team behaviour it is thought that shirking is reduced however imperfect knowledge and therefore risk underlie the problem of team behaviour.

Organisational approaches to control, proposes two basic control strategies. First, control can be established with performance evaluation. This refers to the process of monitoring and rewarding performance (already mentioned above) (Ouchi 1979). This strategy emphasizes the information aspects of control. Second, control can be achieved by minimizing the divergence of preferences among organisation members. This also might play a role at the decision making process of ProRail. Since there are different departments involved and various layers there might be a divergent preferences among organisation members, this must be minimized in order to engage more control in the decision making process. Members will cooperate in the achievement of organisational goals, since employees understand these goals. This type of control, explained above, can be coupled to the principal agent theory, since the agency theory suggests two underlying strategies of control. First, behaviour based and outcome based. This can be established by performance evaluation (Eisenhardt 1985).

In order to visualize this theory the basic idea of the principal agent theory is shown in Figure 11. Here P stands for principal and A for agent.

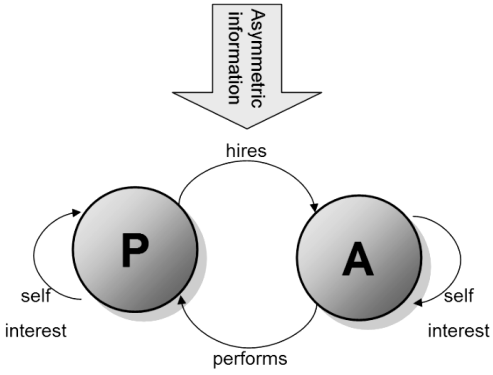

Figure 11 – Basic illustration of Principal Agent theory.

3.3.2 Social network theory

The social network theory views social relations with the help of nodes and ties. Individual actors within the network are shown with nodes and the relationships between these actors are indicated with ties. There are a lot of different possibilities, but the simplest form is a map of all the relevant

ties between the nodes. This social network theory produces a view in which the relation and ties of individuals with others actors within the network are more important than their attributes. The ability of individuals to influence their success relies within the structure of their network. These social networks can contribute to the examination of how companies interact with each other. It shows informal connections, as well as associations and connections. For companies it presents a way to gather information, prevent competition and even plan setting prices or policies. In this research the latter two are of less importance. With the help of this theory the network of the decision making process of ProRail can be made. Therefore, as stated earlier, the ability of individuals to influence their success, their *power* in the decision making process, relies within the structure of their network. Furthermore, it is interesting to know *how* information is gathered throughout the decision making process. With the help of this social network we might see which information is present at which actor in order to solve the possible *information asymmetry* problem. Furthermore, with the help of such a network we might see what information is required in which position of the network. Connecting to the third factor of our research, information requirements at various levels of decision making (Barnes 1954). Barnes was the first to study social networks with the aim at understanding the different ways in which members of a society interact with one another. The classic question of social theory is how behaviour and institutions, and thus the decision making process, are affected by social relations. Granovetter argues that most behaviour is closely embedded in networks of interpersonal relations and that such an argument avoids the extremes of under and over socialized views of human action. Therefore, he examined to what extent economic action is embedded in structures of social relationships. In trying to demonstrate that all market processes are amenable to sociological analysis and that such analysis reveals central, not peripheral, features of these processes, Granovetter narrowed the focus to problems of trust and malfeasance. Much of his criticism about over and under socialized conceptions of action relies on a strategy “physiological revisionism”, an attempt to reform economic theory by abandoning an absolute assumption of rational decision making. However, Granovetter suggests that rational action must always be problematic, it aims not only at economic goals but also at sociability, approval, status and power, which are all important in de decision making process and social network theory (Granovetter 1985).

Granovetter also examined the relation between micro and macro levels of sociological theory. (Macro concerns norms whereas the micro levels consider individual level beliefs). In this paper it is discussed that the level of overlap between two individuals varies with the strength of their tie to one another. The impact of this principle on diffusion of influence and information, mobility opportunity, and community organisations is investigated. Most of the time models focus on strong ties, however Granovetter focuses on weak ties explicitly. As was already known, strong ties are important in the exchange of information since strong ties imply the willingness to share information and it was thought that weak ties did not have the intended effect of information sharing. However, Granovetter discussed that weak ties also play an important role during the exchange of information given that weak ties may have access to more and different information because they contain connections in various networks (Granovetter 1973). Therefore, in this research both weak and strong ties are playing a role. Both can help to find out how information is proceeded during the decision making process adding to the aspects information asymmetry and information requirements at various levels of decision making.

With the help of network analysis numerous tools are provided to map the structure of inter-organisational relationships (or ties). Network analysis is focussing on horizontal relationship, however there is also a network analysis; supply chain analysis which focuses on vertically organised ties. The resemblance between the two is that they both contribute to inter-organisational collaboration. Netchain analysis considers the combination of those two. A netchain is a set of networks comprised of horizontal ties between firms within a particular industry or group, which are sequentially arranged based on vertical ties between firms in different layers. Combing supply chain and network analysis is crucial for a more advanced understanding of complex inter-organisational relations (Chaddad, Cook et al. 2001). This can also make a contribution to our research.

As mentioned before this social network theory is an approach to study the exchange of resources between actors (individuals, groups or organisations). One resource that is of importance during the decision making process, and thus our research, is information. Haythornthwaite studied information exchange with an approach of social network analysis (Haythornthwaite 1996). Combining those two gives us an insight of information relationships and to what kinds information is being exchanged, to whom and to what extent. These are all important in our research since it appends to explain our research aspects, *information asymmetry and information requirements at different levels*. They help to explain these aspects since the patterns of forwarding and receiving information describes how in the network information moves around and how actors are positioned in the network. The position of an actor in a network also affects what information flows from whom to them and vice versa. People might control or facilitate the information flow. When there is a better understanding of the flow of information, ProRail might modify the information routes and therefore helping the decision making process by knowing which and what kind of information is needed when and where in the process. Furthermore, this network can help to understand in what place of the decision making process certain constrains between actors are present. These constraints limit the actor's gate to information which is important in the decision making process. Additionally a network position can be used by an actor to promote or add information and therefore actors can influence the decision making process. Therefore, the aspect *power* also connects to this theory. Previously we discussed that is significant to now the social network in order to receive valuable information. However, it is also noteworthy that this information can be used. A well structured network is a good way to face information overload or knowing what information is important. Therefore, the aspect *information requirements at various levels* are related as well. In addition, this is especially important for managers to gather and filter the right information. In short, with the help of a social network analysis you can identify how information flows, between which actors the information flows and who controls the information, all important questions in our research (Haythornthwaite 1996). In addition, it might be interesting to know what the influence of different leadership styles is on the decision making process. For example, first ProRail had a director with engineering background, nowadays the director has an economic background. Will they both use the same information flow or demands in order to make a decision?

It is even more interesting to dig into this theory since we are concerned with the choice between a conventional or new electronic train safety system. Burckhardt (1994) concentrated on social influences and the role of interpersonal relationships with respect to technological change. Attitudes, spreading of beliefs and behaviour in an organisation were investigated in relation with technological change. The results illustrated that social context affected the development of behaviour and

attitude subsequent of a technology change. Therefore, it is even more intriguing to use this theory in order to grasp an idea about the behaviour of information flow during the decision making process (Burkhardt 1994).

Moreover (Uzzi 1997) developed an understanding of organisation networks and embeddedness. The basis of this paper is formed on the literature on organisation networks. It made a distinction between accounts of transaction by two forms of exchange. First, the embedded ties, that is referring to close or special relationships. Second, arm's length ties are explained as market relationships. It was shown that the expectations and behaviour of exchange partners are regulated by embedded relation. More specific there are three key points concerning embedded relation namely; trust, fine grained information transfer and joint problem solving arrangements. Those are all important points in the decision making process of ProRail. In short, this paper explains the link between social structure, micro behavioural decision making processes and economic outcomes in the perspective of organisational networks. Furthermore, according to Uzzi forms of collaborations are not just based on economic motivations in the network theory. Power and trust are of importance (Uzzi 1997). In order to visualize this theory, the basic idea of the social network theory is shown in Figure 12.

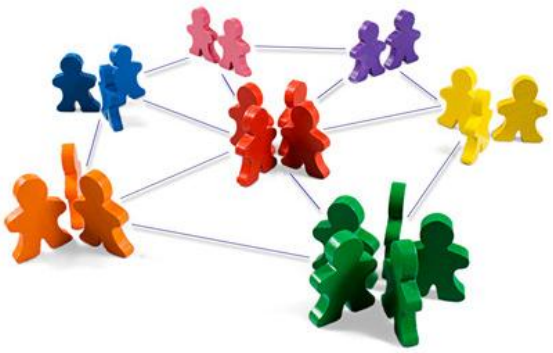

Figure 12 – Example of the basic idea of the Social Network theory.

3.3.3 Transactions cost economics

In economic and related disciplines transaction cost means a cost that is made in making an economic exchange. There are several kinds of transaction costs, for example search and information costs, bargaining costs and policing and enforcement costs. In general transaction costs are defined as the costs of "all the information processing necessary to coordinate the work of people and machines that perform the primary processes". Transaction cost economics suggests that the difficulties and costs related to market transactions might favour hierarchies and sometimes markets as an economic governance structure.

Coase explained transaction, coordination and contracting costs must be considered in explaining the extent of vertical integration. This started from the saying that activities are directed internally or purchased in the market for profit maximizing firms that will undertake such activities. Coase forced economics to look for ignored limitations on the trading process that does not focus on interfirm transactions, but on intrafirm transactions (Coase 1937). Insights of Coase of transaction costs are necessary to explain particular forms of economic organisation. The theory of Coase is used in order to investigate one particular cost of using the market system, the possibility of post contractual

opportunistic behaviour. Following Coase's framework, opportunistic behaviour can be solved with the help of vertical integration or contracts. According to Klein, Crawford and Alchian business relationships are often structured in complex ways, it is not that easy to represent businesses with a contract or vertical integration (Klein, Crawford et al. 1978).

Transaction cost economics is an interdisciplinary theory which links economics with organisation theory and overlaps with contract law (Williamson 1979; Williamson 1981). The purpose of contract law is facilitating exchange, in our case the exchange of information. Transaction cost economics is essential for studying organisations and mainly focuses on efficiency. Therefore, it might be helpful in our research. The approach of transaction theory has been applied in the study of organisations, more specific at three levels of analysis. First, it concerns the overall structure of the company. It regards how operating parts are linked to one another. This is also an interesting subject in the decision making process of ProRail, how are all the different departments linked to one another? The second level concentrates on the operating parts and if they should be executed within or outside the firm and why. This can also repel on the decision making process of ProRail, since there are two big and two smaller engineer bureaus involved and should this all be executed in or outside the firm and why? The third strikes the fact whether the way in which human assets are organised.

There are some behavioural assumptions on which transactions cost relies. The first one refers to the fact that human agents are subject to bounded rationality. Second, it is thought that some agents behave opportunistic. Furthermore, there are three dimensions in which behavioural assumptions are described, namely uncertainty, the frequency with which transactions recur, and the degree to which durable, transactions specific investments are required to realize least cost supply (asset specificity). Some of the behavioural assumptions in this transaction cost economics originated in the organisation theory (Williamson 1981). In addition, transaction cost economics considers the company as a governance structure. By governance it is meant that order is reached in a relation when potential conflict might menace to upset opportunities in order to realize mutual gains (Williamson 1998). This is also why it can be linked to our research. A choice must be taken concerning the conventional and new train safety system. There is a mutual gain, namely safety of the train track. However, in the decision making process, a potential conflict might arise, for example what technology must be implemented. For this reason it is important to govern a relationship between the different actors in order to reach this mutual gain.

Transaction cost theory also refers to our aspects introduced earlier. For example contracts in an uncertain world can be incomplete this will increase the costs due to *information asymmetry* and asset specificity. Furthermore, this theory can be linked to *power*. A company can have contracts, such as defining the power of a manager over his employees. It is also known that decisions which are taken in the firm are going well beyond the neo classical economics. In the decision making process, this theory might also play a role. The transaction costs theory can also be used as a connection between the relationship among individuals (Jensen and Meckling 1976).

An interesting addition of this transaction cost economics is that it might be costly for companies to look for better alternatives. This also plays a role at the department train safety systems of ProRail. There are several alternatives concerning train safety systems, however it might be costly to employees to look for better alternatives. Therefore, costs can be minimized in order to engage a long term contract with their employees.

3.3.4 Contingency theory

There are a variety of contingency theories. Though, in general it considers that different situations needs call for different characteristics. Theorists also classified the style of leadership as contingent to the situation, therefore referring to the contingency theory.

Fiedler came up with the idea how to govern successful leadership. Fiedler carried out several studies of effective and ineffective leadership in which he concluded that contingency theories are a class of behavioural theory that contend that there is no one best way of organizing/ leading and that an organisational/ leadership style that is effective in some situation may not be successful in others (Fiedler 1970). More concise the best organisation or leadership style is dependent on various internal and external constraints. These organisational settings and leaderships styles are the parameters that form the basis of this theory. There are four important ideas concerning this theory namely:

- There not one best way to manage;
- The design of an organisation must fit with the environment;
- Effective organisations do have a good fit with both the environment and also between its subsystems;
- The needs of an organisation are better satisfied when it is properly designed and the management style is appropriate both to the tasks undertaken and the nature of the work group.

Fiedler defines leadership style as the way leaders and employees interact with each other. Every leader has its own personality and therefore Fiedler categorized different leadership styles. The main centre of attention concerns two leadership styles namely, task oriented or people oriented leadership. According to Fiedler task oriented leaders are more effective in extremely favourable or unfavourable situations. Relationship oriented leaders on the other hand perform best in situations with intermediate favourability. With the help of this classification we might find out what the best leadership style would be for ProRail in order to get a grip on the decision making process between conventional and electronic train safety systems. Furthermore, when people (managers) are more people oriented leaders they favour interpersonal relationships, these are important in the decision making process since a lot of information is gained throughout these interpersonal relations. The second parameter, organisational settings or in other words the situational variable can be defined as that facet in the organisation in which leaders can exert influence within their team. Fiedler divided these situational variables in leader to member relationship, task structure and position power. The first, leader to member relationship, classifies the level of acceptance team players have towards their leader. The second, task structure, considers the amount of job specificity among subordinates. And the latter, position power, will describe the level of power that a leader contains consequently resulted from its position in the organisation. These situational variables can be linked to our three aspects. It is quite obvious that there is a link to *power*. Position power describes the level of power that a leader contains. With the help of this power it can exert their will over others. Therefore, it might be of importance in this research. Furthermore, information asymmetry might be clarified with the help of this theory. As stated before information for this decision making process is

also obtained throughout interpersonal relations. This also can be seen as a form of *information asymmetry*, when there is a good interpersonal relation the effect of information asymmetry in the decision making process might be less (Fiedler 1970).

With the help of this theory it might be judged how this decision making process might be guided in the best way possible. Furthermore, with position power, task structure and leader member relationships it is possible to make a leader more effective and therefore make the decision making process more effective (Fiedler 1964). In addition, this contingency theory is a form of leadership. Leadership can be described as the following: the process of social influence in which one person can enlist the aid and support of others in the accomplishment of a common task. Naturally power has a big influence on this social process, therefore this factor, power, is related to this theory. Leadership is essentially a problem of wielding influence and power. When we say that different types of groups require different types of leadership we imply that they require a different relationship by which the leader wields power and influence.

However, Fiedler is not the only contingency leadership theory that is around. Furthermore, the Vroom-Yetton decision model, the path-goal theory, and the Hersey-Blanchard situational theory exist.

As the name already refers, the Vroom-Yetton decision model relates the contingency theory to decision making. In our research this is of much importance. This model suggests that the effectiveness of a decision procedure is dependent of some aspects.

- The importance of the decision quality and acceptance;
- The amount of relevant information possessed by the leader and subordinates;
- The likelihood that subordinates will accept an autocratic decision or cooperate in trying to make a good decision if allowed to participate;
- The amount of disagreement among subordinates with respect to their preferred alternatives.

All these points can be linked to our research. The first one, the importance of the decision quality and acceptance, might differ between the various levels of decision making. For example, for the department train safety systems it might be of big importance that the decision's quality and acceptance is high, however this might not be of big importance for the director. Second, the amount of relevant information possessed by the leader and subordinates might indicate information asymmetry. It is also important since at every decision making level, various relevant information is needed. Leaders and subordinates have different responsibilities, other forms of power and therefore the leader and subordinates differ in various levels of decision making. Referring to our factor *information requirements at various levels of decision making*. Third, the likelihood that subordinates will accept an autocratic decision or cooperate in trying to make a good decision if allowed to participate, plays a role. This also makes an important link to our factor *power*. Fourth, the amount of disagreement among subordinates with respect to their preferred alternatives is interesting since a decision needs to be taken between two different safety systems, in other words different alternatives. There might be a disagreement between the subordinates between those two

systems (Vroom and Yetton 1973). The model of Vroom & Yetton & Jago on normative decision making can be of big help in this research since it is an excellent example of extracting and modelling knowledge (or information) (Vroom and Jago 1988). This is important since we want to know which knowledge is available in what stadium of the decision making process. With this model the decision making tree will show a situation which might help to determine which style or level of involvement to use during the decision making process. Also the *information requirements at various levels of decision making* might be enlighten with the help of this theory.

In short the path-goal theory and Hersey-Blanchard situational theory will be highlighted. The path-goal theory presents a leadership theory in organisational studies which is discussed by House 1996 (House 1996). The theory is concerned with the fact that the behaviour of a leader is contingent to the satisfaction, performance and motivation of his employees (subordinates). It is also argued that the leader deals with behaviours which complement employees' abilities and compensate for deficiencies. This theory can be classified as both contingency and as transactional leadership theory.

The difference with Fiedler's contingency model is that the path goal theory explains that the leadership behaviours are fluid and can be changed depending on what the situation requires.

Situational theory is introduced by Hersey and Blachard and suggests that the leadership style must match with the appropriate level of followership development. In this theory the behaviour of a leader is explained as a function of both the characteristics of the leader itself but also the characteristics of the followers (employees) (Hersey, Blanchard et al. 2007).

3.3.5 Resource dependency theory

Resource dependency theory examines how external resources of an organisation affect the behaviour of the organisation. The theory characterizes links between organisations as a set of power relations based on the exchange of resources. Although this theory was originally formulated in order to discuss the relationship between organisations, it can also be used in order to discuss the relationships among different units within an organisation, for this reason it can be used in our research since we want to get a grip on the different relations between different units in the decision making process at ProRail.

The resource dependency theory contains three core ideas.

1. Social context matters;
2. Organisations enclose strategies to improve their autonomy and emulate interests;
3. Power which is essential in understanding the in and external actions of an organisation.

Resource dependency theory conducted its background from social exchange theorists and political scientists. As stated before this resource dependency theory focussed on exchange and power relations in and around organisations. Power based research was already introduced by theorists, such as (Weber 1947). Also (Selznick 1949) introduced power based arguments from intra organisational relations. The basic story of exchange-based power in the theory was derived from Emerson. Emerson looked at the power aspects of social relations, before we explain this in more detail, a short explanation of the social exchange theory will be given.

Social exchange theorists

In short the social exchange theory is a junction of economics, psychology and sociology. Homans (1958) was the originator of this theory. This theory was developed in order to understand social behaviour of humans in economic undertakings (Homans 1958). Nowadays there are many forms of social exchange theorists, however with the eye on resource dependency theory (Emerson 1962) played an important role. First of all Homan's heart of the social exchange theory will be stated:

"Social behaviour is an exchange of goods, material goods but also non-material ones, such as the symbols of approval or prestige. Persons that give much to others try to get much from them, and persons that get much from others are under pressure to give much to them. This process of influence tends to work out at equilibrium to a balance in the exchanges. For a person in an exchange, what he gives may be a cost to him, just as what he gets may be a reward, and his behaviour changes less as the difference of the two, profit, tends to a maximum".

This statement can also be linked to one of our aspects, namely *power*. As stated above, a person (A) that gets much information of others (B) are under pressure to give much to them, therefore B might exert their will over A, since A owns them. This also might play in our research wince power might influence the information flow. This can influence the DM process and therefore relates to our research.

The relationship between two actors results in various contingencies whereby actors change their resources to each other's expectations. According to (Emerson 1962; Blau 2009), the relationship between these actors can be explained by the power mechanism. Furthermore, Emerson discussed that power is not the property of an actor but of a social relation, since it completely exists in the other's dependency. Emerson spoke of a social relation and these relations are subject to ties of mutual dependences between the different parties. In his account power and dependence is obverse of each other. To explain this, actor A is dependent on actor B since B controls some resources (information) that A wants to know. However, A is dependent on B to the degree that B has power over A. Consequently it can be said that both A en B have power over each other, making them interdependent. As can be concluded social exchange theory adds a big part in the resource dependency theory since it can be said that power results from resource dependency. As stated above it is also genuinely clear that our factor *power* is linked to this theory.

The resource dependency theory suggests that when actors are missing a resource, (in the decision making process, information) they will look for and start a relationship with another actor which contains the resource they need. In addition, they especially might look for relations or resources that will enhance and strengthen their own point of view. This might also link our aspects to this theory. First of all it has a connection with: *information requirements at various levels of decision making*. When it is known when people are missing information, they are going to look somewhere else. However, when we know when they start to gather information at a different place it can be said that they did not have enough information is that particular decision making process. Therefore, it can also be evaluated what information is needed and therefore what the requirements are at various levels of decision making. Furthermore, it might also contribute to our aspect *information asymmetry*. When people are gathering information from other places and do not communicate it with other actors that play a role in the decision making process, information asymmetry might occur.

Since it is possible to change the dependence of relationships companies might minimize their own dependency by increasing the dependence of other organisations or to minimize their own dependency. For this reason we can also link this theory to our aspect *power*. Different parties in the decision making process might be more or less dependent of each other. In addition, because of this interdependency in the decision making process people can exert their power to one another. Organisations are viewed as coalitions alerting their structure and patterns of behaviour to get hold of and maintain needed external resources.

Resource dependency rests on some postulations that explain how organisations work to obtain power. First of all it though that organisations consist of internal and external coalitions which appear from social exchanges (Pfeffer and Salancik 1978). These social exchanges are created to influence behaviour. Second, it is assumed that the environment comprises essential resources in order for a company to survive (Pfeffer and Salancik 1978). The last postulation supposed that organisations work towards two objectives. First, they want to get hold of resources which makes them less dependent on other organisations. And secondly they want that other organisations become dependent on them since they control important resources (Markus and Pfeffer 1981).

According to (Aldrich and Ruef 2006) the resource dependency theory allows an active role for managers. Since managers can manipulate dependency relationships, therefore they can play a role in controlling and changing the network of the organisation. This is interesting in our research, managers have difficulties in gathering and selecting the right information. When managers manipulate dependency relations they might get a better grip on the decision making process since it can control the network of an organisation and therefore also the decision making process.

Furthermore, there three forms of organisational dependency which all calls for different forms of coordination (Thompson 1967).

1. Pooled dependencies; whereas organisational units may operate independently, but are dependent on the collective efforts of all.

2. Sequentially dependent; here the output of a unit immediately supports another organisational unit by providing them the resources.

3. Reciprocal dependency; in which the actors are both mutually dependent on one another for the needed resources.

The first one can best be coordinated with the help of standardization, while the second fits best with coordination by plan fits and reciprocal dependencies are best managed through a process of mutual adjustment (Thompson 1967).

There are also information systems that can be designed to control and coordinate organisational activities by capturing features of dependency relations. With the help of IT designs the resource exchange interface might be efficiently managed. This is realised by improving the information exchange (necessary in the DM process), strategic coordination and process coupling (Tillquist, King et al. 2002).

4. Analytical approach first analysis

The analytical approach of the pre-interviews and how they will be conducted will be explained in this chapter. The method for analysis, discourse analysis, will be clarified in detail.

4.1 Analytical methodology of pre-interviews

This paragraph will discuss what discourse analysis entails, how this data will be analysed using transcription and what the analytical process will look like.

4.1.1 Discourse analysis

Discourse analysis is an analytic technique rather than a theory. Growing interest began towards the end of the last century in qualitative research and ways of analysing the data it produces. This analysis method contains a multidisciplinary perspective since it has its origins in multiple disciplines, for example sociology and communication studies (Grant, Michelson et al. 2005).

Discourse analysis is one of the ways of analysing qualitative data, such as interviews. Qualitative methods are increasingly being understood as theory-dependent ways of describing, analysing and interpreting data (Frohmann 1994; Potter and Wetherell 2004). What underlies this basic analytic method of qualitative analysis is the interpretative repertoire (Gilbert and Mulkay 1984; Wetherell and Potter 1988; Potter and Wetherell 2004).

There are different discourse analysis techniques though, in general discourse analysis describes the study of conversation and texts (e.g. interviews, case studies); it is a broad term used to analyse approaches to written or spoken events. Discourse analysis can describe very different research activities with different kinds of data and therefore it is used in a wide range of fields. Therefore, it can be said that it is a versatile technique, since it can almost be applied to every situation and language (Yates, Taylor et al. 2001).

There are a number of ways to understand 'discourse' and there are different theoretical approaches to discourse analysis all of which, in turn, impact upon how it is conducted. Since there are a number of methods we shall explain the differences in discourse analysis briefly. One can assert that a dichotomy in discourse analysis exists. Some discourse analysts are concerned with the process of interaction; while others are more content driven. Furthermore, roughly speaking, there are four different approaches to discourse analysis.

1. The analyst's primary interest lies in the language itself;
2. The analyst focuses on the activity of language use rather than on the language itself, interaction becomes the major focus;
3. This approach to discourse analysis looks for patterns in the language associated with a particular topic *(in our case decision making)*;
4. The last approach is to look for patterns within much larger contexts (in those of society and culture) (Yates, Taylor et al. 2001).

As stated above, discourse analysis is a theoretical framework and a method for analysing spoken and written language (Potter and Wetherell 2004). As there is a variety of discourse analytic approaches available the third options explained above seem most appropriate in the context of this study. Discourse analysis is looking for patterns in relation to a particular topic, namely the decision

making process of implementing a new train safety system. More precisely we will use thematic analysis, which will be explained later. Furthermore, this analysis will be content driven when compared to analysing the process of interaction. Thus the analytic approach will examine what challenges are at hand in the decision making process at ProRail. In other words, this study has taken a look at *how* decisions are constituted and *what* the challenges of the decision making process are.

4.1.2 Data analysis

In discourse analysis a conversation or piece of text is transcribed, after having been transcribed, it is deconstructed. This involves features in the text, such as discourses. A discourse is a particular theme in the text, for example a statement that reiterates a view. Discourse analysis focuses on the variability of interpretations and brings out background assumptions (Parker 1992). The aim of discourse analysis is not only to identify interpretative repertoires, but also point out the power and influence of particular narratives (key-points). Discourse analysis makes it possible to weigh the consequences of different discourses (Potter and Wetherell 2004).

In order to perform discourse analysis a text or recorded conversation is required; in our case the pre-interviews are recorded and therefore also our subject of analysis. These pre-interviews need to be transcribed in order to use them as a resource in analysing the evaluation of the decision making process. The goal is to look for patterns in the language associated with a particular topic or activity, in our case the decision making process.

4.1.3 Method of analysis

There are many different forms of discourse analysis, however as stated above we will use thematic analysis. Thematic analysis sets on to recognize significant categories or themes in a certain amount of data. By looking at the text we try to find whether a number of recurring themes are present. The goal is to identify categories or themes that are important in the decision making process. With the help of thematic analysis it is certain that important themes in the decision making process will be highlighted.

4.1.4 Transcription

Turning talk into text is possibly the most labour intensive and time consuming activity of discourse analytic research. How long it takes to transcribe one hour of recorded material all depends on the required estimates. The range lies between four hours, for the simplest transcription, to more than twenty hours for detailed description (Yates, Taylor et al. 2001). The degree of transcription depends on the kind of research since it influences the analysis detail. In this research we are concerned with content therefore a relatively simple transcription is made. It is not necessary to transcribe the fact that interviewees suddenly talk louder, softer or have a long pause in between the lines they are saying. It is more important to know *what* was said and not *how* it was said. In our opinion this greater detail in transcription does not generate greater analysis or analytic conclusions.

An example of how we transcribed these pre-interviews is presented here:

> *Interviewer: Oke, en krijgen jullie goed door, van de laag boven je wat je moet doen?*
> *Interviewee: Nee, dat zeker in de technische gedeelte van het advies, dan is er rechtstreeks contact met het project die het ons komt vragen. Soms wordt het wel aangekondigd vanuit het management dat er een vraag aankomt, zonder en verder inhoudelijk op in te gaan. Dus*

als je puur kijkt naar het antwoord wat wij mogen geven om het maar even zo te zeggen, daar zijn wij helemaal vrij in.
Interviewer: Jullie geven dus advies, krijg je dan ook teruggekoppeld wat ze met het advies doen?
Interviewee: Ja, de communicatie is niet helemaal optimaal op dat gebied. Dat hangt een beetje van de persoon af of het advies duidelijk is. Als je in 1 keer goed advies geeft en duidelijk is, ja dan is het 1 richtingsverkeer. Dan is het vaak klaar.
Interviewer: Kan je wel wat vertellen over het verloop van het besluitvormingsproces, of stond je daar eigenlijk te ver buiten?
Interviewee: Nee ik stond te veel buiten. Waren echt meer individuele vragen die bij ons terecht kwamen.

This kind of detail in transcription is usually seen as an adequate approach to the identification of themes or categories that are regarded as representative. Since we are interested in the factors that influence the decision making process it will be sufficient.

4.1.5 Analytical process

The first stage involves familiarizing oneself with the data, the transcripts were read and, factors (and key-points) were identified using discourse analysis. After these factors had been abstracted the following four points were indicated;

1. Is there inconsistency within a single pre-interview or between different pre-interviews;
2. Identify a regularly occurring attribution to some specific cause or event, the reference might take different forms but will refer to the same points (which factors occur in each interview);
3. Identify key-points of the decision making process;
4. Point out the importance and relevance of these key-points in order to establish a framework.

4.2 Data collection pre-interviews

This section will elaborate upon the interview selection and interview procedure of this research.

4.2.1 Interview selection

Both the reason and assumption why people in certain positions are chosen to be interviewed for the first round of interviews will be explained.

General

It is known that a decision about the implementation of a new train safety system, the conventional versus new technology train safety systems, has not been reached yet. This research focuses on the subject *why* this decision has not been reached. Therefore, the decision making process needs to be evaluated. The main purpose of these pre-interviews is to evaluate the decision making process, for example what are important events that have happened in the past years. Furthermore, we would like to know what factors challenge the decision making process, because a final decision has not been reached yet. In addition, we would like to engender a general overview of the decision making process. The goal of conducting these interviews is to generate factors that have an influence on the decision making process. In the second round of interviews these factors will be investigated in more detail. In short, the first round of interviews serves as a backbone to gain more insight towards this decision making process, especially towards the challenges that this decision making process faces.

Choice

In order to construct a general overview of this particular decision making process it was chosen to conduct three interviews. These interviewees all have a different background and function in this decision making process. Interviewing various people at different 'layers' is important since it widens perspective towards this decision making process. It is important to interview people at different layers since they probably have different perceptions towards this subject. This will enrich our results, which is very important in exploratory research.

We are interested in the evaluation of the decision making process, therefore three different employees, each of which with another link towards this decision making process, will be interviewed. The position of interviewees in the organisation is presented below in Figure 13.

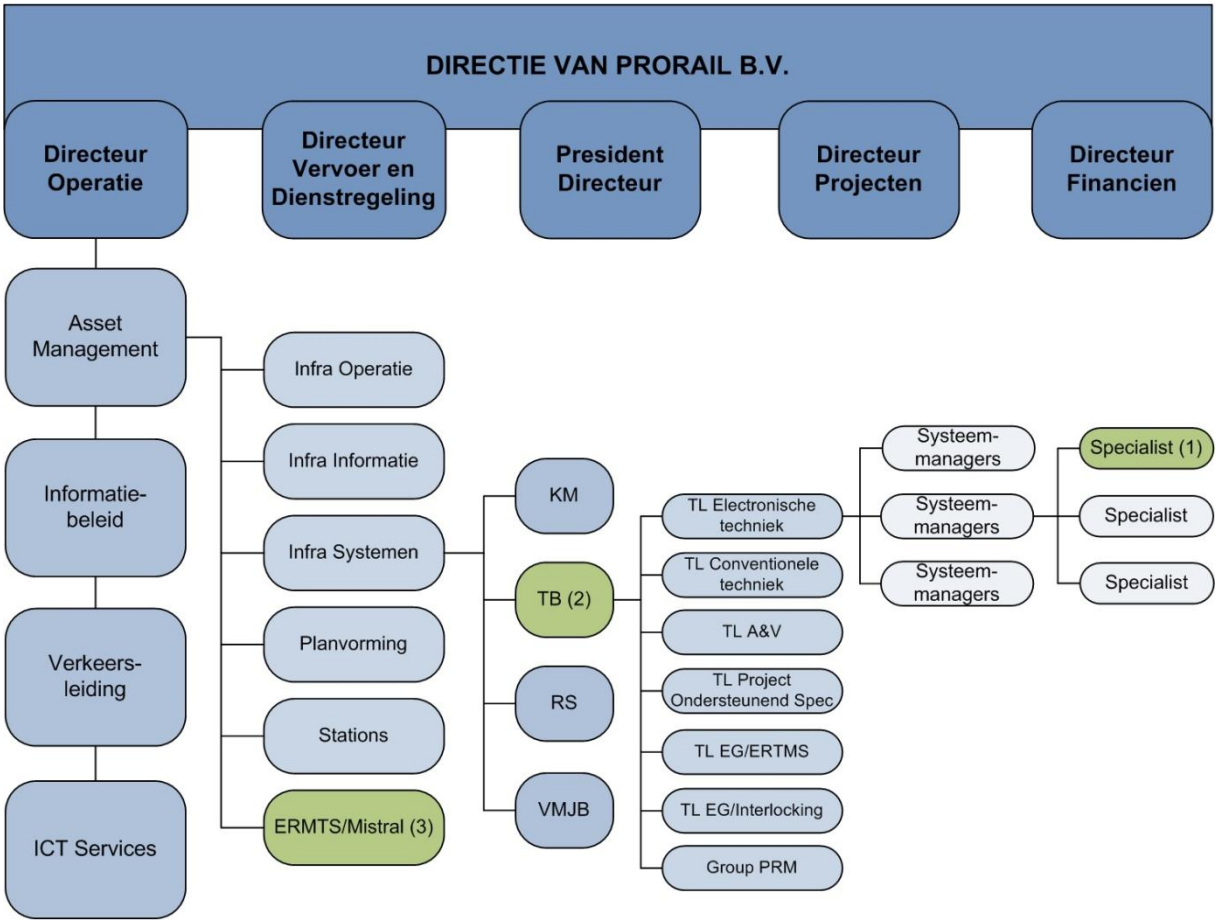

Figure 13 – Position of the pre-interviewees in the organisation.

4.2.2 Interview procedure

First, our potential interviewees were contacted and when they agreed to participate in this research a date was set. Approximately a week before the actual interview would take place, the questionnaire was sent towards these interviewees. Therefore, the interviewees could prepare the interview. We find this important because it is not a day-to-day subject to talk about and in this way reliability will be increased since poor recall of participants will be reduced. With the help of this procedure more data will be generated, this will increase to establish our aim, namely understanding and evaluating the decision making process.

These interviews will last around 90 minutes. Before an interview started a short introduction about the interview was given. Each participant was reminded about the study and the purpose of this interview. Each interviewee was given the same (amount of) information. This information can be found at the interview-questions in Appendix A. Furthermore, consent was asked from participants because the interviews were recorded on a memo recorder.

Since we conducted semi-structured interviews, several predefined topics were discussed. However, the main idea was to run the conversation through as naturally as possible. Furthermore, if other subjects were brought up by the candidate or if clarification about a certain subject was needed we would also discuss them in a natural way. Before ending the interview, participants were asked if there were subjects that they missed out on during this interview. This gives them the idea and opportunity to be involved in the research.

5. First data analysis (pre-interviews)

This chapter elaborates on the results that were collected from the pre-interviews. The consistencies, inconsistencies, basic assumptions, and the timeline of the decision making process will be explored.

5.1 Interview data

This section will elaborate upon the results that were generated from the conducted pre-interviews. With the help of these results a framework that forms the basis towards the second round of interviews will be generated. This step is vital in order to arrive at useful interpretations after the second round of interviews. All the participants that were approached agreed to be interviewed an overview of their position in the organisation can be found in Figure 13. Furthermore, they allowed that the interview was recorded and that the interview may be included in this study.

5.2 Results first analysis

This section will explore what inconsistencies and consistencies between and within the interview are present. Furthermore, the basic assumptions and starting points will be verified.

5.2.1 General

At first transcripts were read multiple times in order to get familiar with the data, thereby generating important knowledge that could assist in generating themes. Systematic content analysis was performed after the fact that these factors were addressed in a checklist. And with the help of discourse analysis these factors were identified. The results can be seen in figure 14. Analysing data will be as follows, first inconsistencies between and within interviews will be highlighted. Afterwards consistencies will be mentioned, thereafter the basic assumptions and starting points will be mentioned in order to generate a general framework.

5.2.2 Inconsistencies between and within pre-interviews

In this research, inconsistencies between or within interviews were almost none-existent. Several subjects were cited by various individuals, though not by others. However, it did not indicate an inconsistent character.

5.2.3 Consistencies between and within pre-interviews

All participants mentioned several points concerning the decision making process in relation to the implementation of a new train safety system.

- Firstly, every participant was saying that the decision making process is time consuming and iterative when a question was posed about the decision making process.
- Secondly, several participants mentioned that responsibilities are ambiguous in this decision making process.
- Thirdly, interviewees pointed out that there were a few difficulties concerning group decision making. This has an effect on the speed of the decision making process.
- Also culture of the company was highlighted as a factor influencing the decision making process.
- Another factor that decreases the speed of the decision making process, concerns the fact that there are different interests present at this decision making process.

- The pre-interviews showed that the amount of people that were involved during this decision making process influences the efficiency of the process.
- It is difficult to establish very consistent decisions.
- Every participant involved also agreed upon the fact that goals changed during the decision making process.
- There was consensus between these different pre-interviews about the fact that people perceive information to be contested.
- Power is another factor which all participants mentioned, since it influenced the decision making process.
- Tension between various people, which may influence the decision making process was also notified by the participants.
- Entrance of new people also was highlighted as an influencing factor towards this decision making process.
- The company was reorganised several times, this was also cited in the pre-interviews as a factor that influences the decision making process.

5.2.4 Basic assumptions and starting points

In the previous paragraph several factors are mentioned, however it is significant to know what the basic assumptions and key-points will be, that challenge the decision making process. These two things will be explained in further detail.

In this analysis it became clear that the decision making process is considered to be time-consuming and iterative. Therefore, a decision has not been reached yet since the speed is decreased. Though, these different interviewees agreed about this fact, we are intrigued to know why these interviewees have this opinion.

It is thought that company culture, is the starting point of the iterative and speed of the decision making process. In this research culture is defined as stated by Hofstede:

> *"Culture is the collective programming of the human mind that distinguishes the members of one human group from those of another. Culture in this sense is a system of collectively held values."*

During the analysis several issues were mentioned, they will be explained here. ProRail's culture offers space, for employees, to interfere. It will induce several positive aspects. Though, in this decision making process it may partly explain why the endurance of the decision making process is relatively long and iterative. Space is offered to interfere, therefore multiple insights and interests enter the decision making process. This may gain new insights, though it is also more difficult to establish a decision due to the discussions that may emerge during the process.

In our opinion company culture can be subdivided in three major key-points, namely inconsistent decisions, group decision making and organisational structure. We will explain them briefly. *First,* inconsistent decisions occur due to changing goals. Several reasons underlie the fact that the goals of decision making are changing. Power, uncertainty, administration and entrance of new people may trigger this inconsistent character. The most important point we want to establish here is that inconsistent decisions are connected to company culture. For example, when a new manager enters

the decision making process space is offered to interfere. Therefore a decision that already has been established may be revised due to their opinion. It can both have a positive or negative influence, but it can be said it influences the inconsistent character of the decision making process. *Second,* the nature of group decision making is not regarded as easy. It is a factor that will result towards a time-consuming and iterative decision making process. The complicated nature of group decision making relies in the fact that there are multiple people involved and collaboration between different parties is not always easy. Group decision making is also difficult because tension between different departments is present. This tension is mainly caused by the fact that a common goal is hard to reach because of the inconsistent character of the decision making process. The fact that a goal is difficult to reach, due inconsistencies, will affect the process of group decision making. ProRail's culture also affects the difficulty of group decision making. The fact that "space is offered to interfere" contributes towards the difficulty in group decision making. If everyone may interfere, more interests will emerge. This will result in a more difficult group decision making process. Furthermore, due to both, the inconsistent character of decisions, and the ambiguity around responsibilities in this decision making process. A tension between various people may emerge, which will not have positive effect towards group decision making. All factors mentioned above, contribute towards the fact that group decision making is difficult, which partly explains the iterative and time-consuming character of the decision making process. *Third,* organisational structure has an influence towards the speed and iterative character of the decision making process. As already mentioned, both organisational structure and responsibilities are ambiguous in this decision making process. Therefore, it is hard to determine what the responsibility of a department encompasses. In addition, ProRail is reorganised during this decision making process. This results in a decrease of speed due to the fact that decision making processes are organised in another manner.

The previous paragraph illustrated that the theme culture is the starting point towards the explanation that the decision making process is considered to be time-consuming and iterative. Inconsistent decisions, group decision making and organisational structure are key-points that explain these characteristics points of the decision making process. Culture may be considered as an independent variable having an effect towards these key-points. It must be noted that these key-points enclose an overlap at several subjects. The difficulty of group decision making is caused both, by changing goals and organisational structure. Group decision making is struggling due to the fact that a common goal cannot be established due to the inconsistent character of the decisions. This may induce a tension between involved persons. Explaining the fact that the decision making process is relatively slow. Furthermore, group decision making is harder due to the fact that organisational structure is ambiguous. As can be seen these three key-points are intertwined. It seems that they are intertwined due to three main subjects, namely suboptimal collaboration, responsibilities are ambiguous and decision making goals are ambiguous. Figure 14 illustrates how the conceptual framework of the factors that influence the decision making process is illustrated.

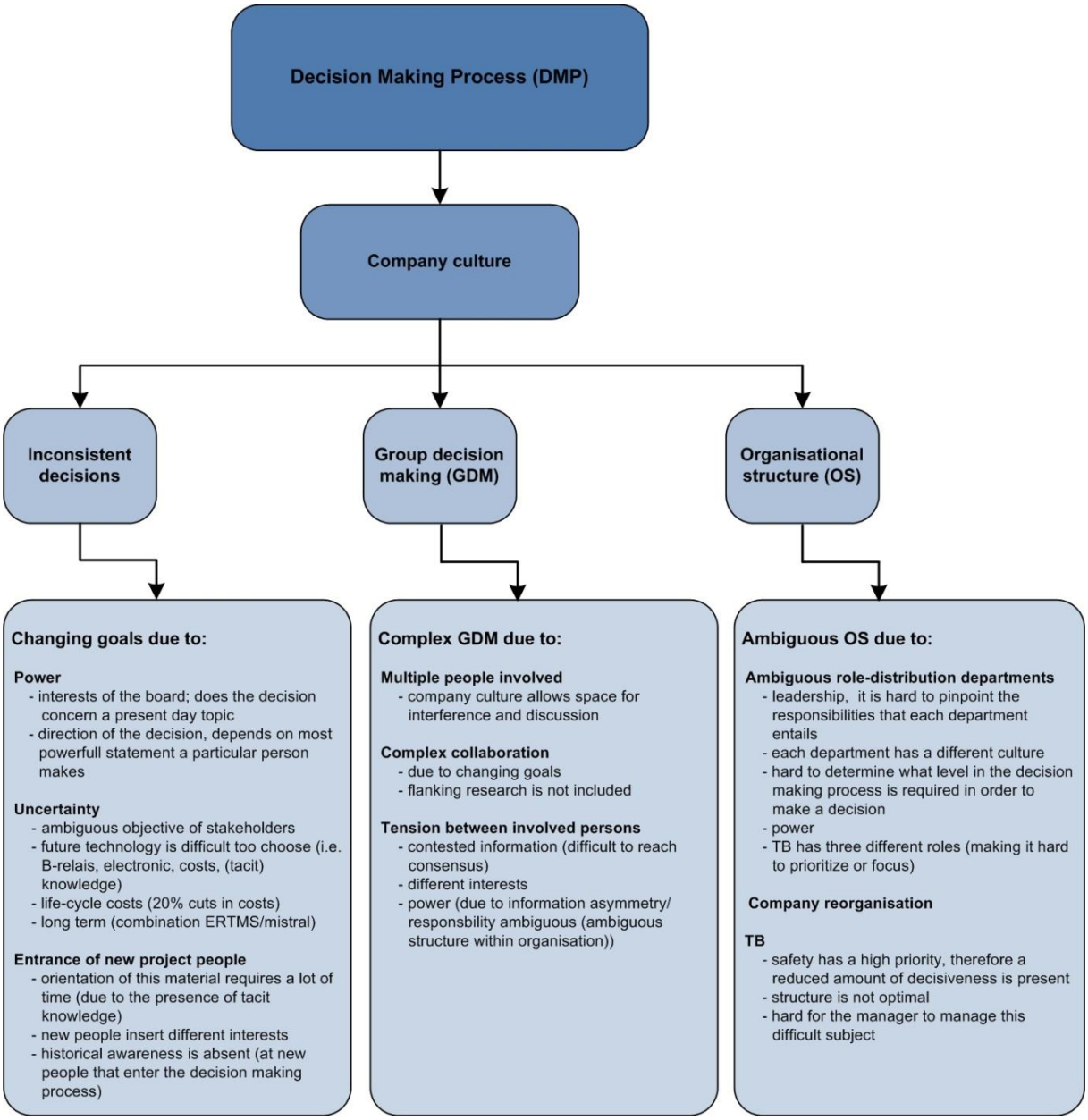

Figure 14 – Conceptual framework of the factors influencing the decision making process.

5.3 Results

Based on both the discourse analysis and the existing data (documents) the following results emerged. The development of the decision making process concerning the implementation of new train safety system is established here.

The first idea that train safety systems needed to be replaced emerged around 2000. The department 'projects' noticed that current systems were deteriorating. This resulted in presumptions about the current train safety systems, namely that these train safety systems needed to be replaced. However, it was until 2003 that research about this subject was conducted. This research analysed the state of the current safety installations. This research was performed by AEA Technology. The conclusion stated that the residual lifetime of the current train safety systems is limited. After this investigation the choice was made to replace the entire train safety system that was equipped in the 1953-1968 period, before 2018. Subsequent of this research it was believed that replacement was necessary and the preparation of a replacement plan was started (Arcadis 2003; ProRail 2003; Technology 2003)

In 2003 other research was also performed, this concerned the cost effective research of both B-relays and electronic systems (Rijnconsult 2003). This research asserted that electronic train safety systems are cheaper compared to B-relays. Around 2003-2004 the policy of the train safety department was to replace conventional interlocking systems that were equipped between 1953 and 1968 before 2018 with electronic train safety systems .

The research of AEA mentioned above did not contain sufficient information about cable quality therefore another study had to be conducted. In 2005 KEMA started this exploratory research. In 2006 more thorough research was also conducted by KEMA, this research yielded many recommendations (KEMA 2005) Furthermore, two distinct projects were formulated in 2005, namely 'Mistral lange termijn' (i.e. long term) and 'Mistral korte termijn' (i.e. short term).

As a result of the AEA research, the question was raised if all components have to be replaced. Multiple components are regularly checked in preventive maintenance and when necessary they are replaced. Perchance these systems will last for ancient times when this maintenance schedule is persisted. The fact that the relay wiring of conventional train safety systems has a technical life time of 50 years and needs to be replaced has been confirmed by multiple sources, for instance (Arcadis 2003). In another part of the research the current state of not only wiring but the whole system was tested. This stated that not only the wiring components were subject to their economic and technical life-cycle, however also other not (easy) exchangeable parts of the equipment should be replaced (i.e the relay cabin itself, ground cables, etc). The research made also clear that other measures should be taken. Some equipment needed to be repaired directly in the routine process of short term maintenance, other equipment needed an upgrade within three or eight years. This could mainly be resolved by implementing new components. Second, long term maintenance, systems that needed an upgrade between 15 and 25 years were apparent.

In 2002 it was decided to start the development of successors of the first electronic interlocking in use (VPI, EBS). These successors were called VPI+ and EBS+; these were considered to be the systems that were able to replace the aged relay based interlockings. These developments were prepared together with the corresponding suppliers. The strategy was to merge the result of these

developments with the results of the BB21 program, which main goal was to introduce a European interoperable train protection system (ERTMS); described later in this paragraph. The procurement process with one supplier didn't result in a contract for development and realisation, the other system came into service in 2007 (EBS+, location Deventer).

In 2004 a plan was formulated in order to make a strategy for Mistral. A budget in order to study the project was also requested which was approved by the management board. A project plan compiled for Mistral was introduced to the management board in 2005. It contained, for example, determination of the scope and cost estimation.

In 2006 the Mistral proposal was discussed with the board of directors. It was stated that 25% of the installations that were equipped between 1953 and 1968, needed to be substituted before 2018 in conjunction with safety. In 2007 an approach of Mistral was presented to the supervisory board in order to start the program. The percentage that needed to be substituted was adjusted to 17%. This proposition reached an agreement though, with additional assignments. It was decided that the first three out of 23 Mistral corridors in total, could be performed with electronic interlocking, called plateau 1. Plateau 1 is similar to "Mistral korte termijn". In addition, Plateau 2 is in coherence with "Mistral lange termijn" (ProRail 2010a).

Another program called BB21 is, from a certain point of view, considered as the precursor of project Mistral. This program started in the late nineties. BB21 concerned developments of new electronic systems. This project developed new electronic systems, as it was called, "for the 21th century". BB21 was started because of the implementation of ERTMS to be applied on mega-projects like the Betuweroute and quadrupling of tracks between Amsterdam and Utrecht. This project invested and gained a lot of knowledge. Therefore, a requirement of Mistral established by the director and ministry considered the fact that this knowledge should be used in project Mistral (ProRail 2008c).

In a later stage Mistral became a separate program in the organisation. To establish this, it was decoupled from the department train safety. In addition, the implementation strategy of ERTMS also played an important role towards Mistral in 2007. 'DO samen spoor' (ProRail, NS, gemeenschappelijke vertegenwoordiger van goederen vervoer) applied an implementation strategy of ERTMS. The goal is to establish a universal 'ERTMS level two' throughout the Netherlands. ERTMS is a European computer based development that promotes interoperability of control and signalling systems on the track. It was important that both projects (Mistral and ERTMS) did not slow each other down, or interferes with each other. It should also be borne in mind that conventional train safety systems must be replaced with a system which is applicable to ERTMS. 'DO samen spoor' was convinced that 'ERTMS level two' could only be implemented with electronic train safety systems. Therefore, it was a blessing in disguise that the replacement necessity also played a role. 'Smart' replacement could be performed, aged relays could be replaced with new electronics. In the same time, these systems are prepared towards the implementation of 'ERTMS level two'. It can be asserted that both projects, ERTMS and Mistral, must be in harmony in order to prevent desinvestments.

A turning point in the decision making process was classified in 2007. A department introduced a concept paper about the fact that B-relays were significantly cheaper compared to electronic train safety systems (ProRail 2008a). On top that, the delay of the 'Betuweroute' encouraged a discussion

about what train safety system should be implemented. Due to scope creep, advantages of ERTMS were questioned by several parties. Furthermore, several questions about the advantages of these train safety systems arised. Could ERTMS facilitate more passengers on the train track? The case turned from a technical point of view towards a social cost-benefit requirement. After this turning point new decisions were taken. In 2008 a dual track policy was introduced. First, plateau one will be implemented with electronic train safety systems. Research into alternative technologies was started in parallel. Alternative technologies could also imply a need for electronic systems, electronic systems that are 'open source' and COTS (commercial off the shelf). The goal of this research was the question whether the alternative technology could realize a decrease in costs when implemented, compared to proprietary electronic safety systems innovated by European system suppliers (ProRail 2008b).

Around 2008 the TB department became more involved in the Mistral program. This was caused due to the fact that the requirements of the 'Hanzelijn' were not in harmony compared to the requirements of Mistral. Requirements for the 'Hanzelijn' were designed according to the fact that ERTMS will be implemented. Mistral constituted requirements without ERTMS. In short, the requirements between 'Hanzelijn' and Mistral were different in one way but also needed a common national specification baseline. Therefore, TB was engaged in the process again, because it is their field of expertise.

Due to scope creep, it became apparent that the price of B-relays decreased, though the price of electronics increased thus reinforcing the effect that conventional systems became even cheaper. Based on this information a decision was made in 2009. Mistral would equip electronic train safety systems at plateau one. Plateau two would only be provided with electronic systems, only if the costs decreased with 30% (ProRail 2010a; ProRail 2010b).

Furthermore, in 2010 a decision was reached. Program Mistral was interrupted and changed. This meant that the program organisation was dismantled. It was no longer a separate program in the organisation. In ProRail, TB was responsible for the developments and specification while the department 'Projecten' was responsible for the realization of the infrastructure projects. In this new situation the specifications of the department TB were delivered to the department 'Projecten'. The former Mistral organisation was no longer involved. Figure 15 will give an overview about the progress of the decision making process (ProRail 2010b).

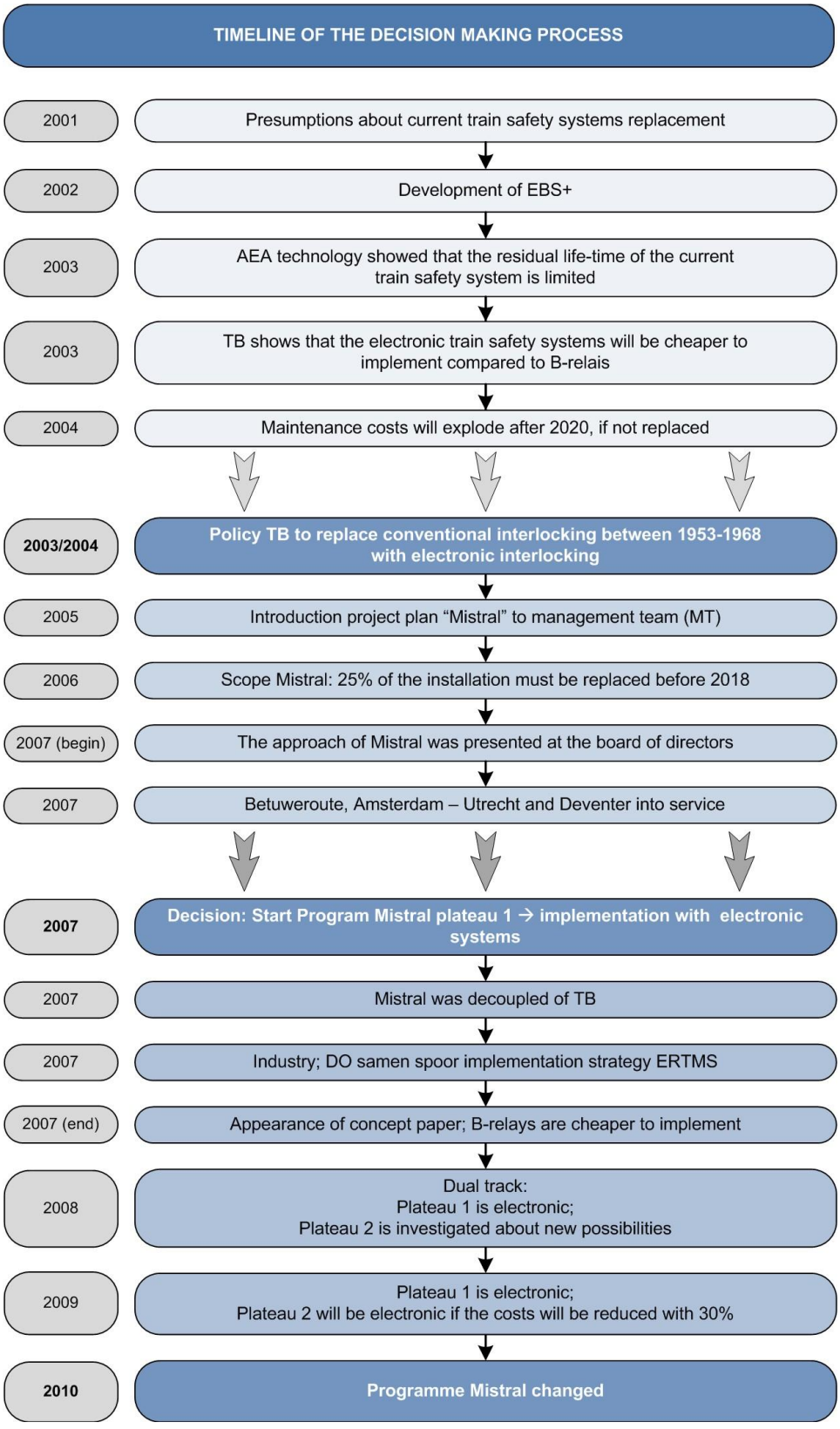

Figure 15 – Timeline of the decision making process

6. Analytical approach second analysis

This chapter will focus on the methodology that was used in the second analysis of this thesis. It will explain the analytical methodology and subsequently the data collection methods will be verified.

6.1 Analytical methodology of interviews

The same approach will be used that was executed at the first analysis. Thematic discourse analysis will be performed in order to find factors that influence the decision making process. Subsequently, chapter four shows the method of analysis, the level of transcription and the analytical process that will be used.

Added value second round of interviews

After the first round of semi-structured interviews factors, that may challenge the decision making process, emerged using discourse analysis. A framework was established which can be found at Figure 14. This framework was constructed to assist towards the evaluation of the decision making process. After the first round of interviews, more insight was gained about the decision making process and factors that influence the decision making process emerged. The second round of interviews will verify if these factors are present and what the "level of importance" of these factors will be concerning this decision making process. With the help of this second analysis main factors that are challenging in this decision making process will emerge. A broader spectrum of individuals will be consulted, in order to cover the various layers and departments throughout the organisation that are involved in the decision making process. This is important since higher management levels might experience the decision making process in a different manner compared to middle or low management. A difference between business units might also be present. Adding these aspects will provide richer and more reliable data about the decision making process, since every party is taken into consideration. These interviews will enable us to pinpoint what factors in the decision making process are of key-importance that contribute to the main challenges. Furthermore, since multiple layers will be interviewed the communicational aspect in the decision making process can be analysed. In addition, since the second analysis is based upon the framework that was established after the first round of interviews, structure will be given in order to prevent poor results due to an excessive amount of data.

6.2 Data collection interviews

This section will elaborate upon the interview selection and interview procedure of the interviews.

6.2.1 Interview selection

In this section the reason and assumption why people are being interviewed will be discussed.

General

In the second round of interviews we are mainly interested in the decision making process in the hierarchical organisation, this line is depicted in the Figure 16.

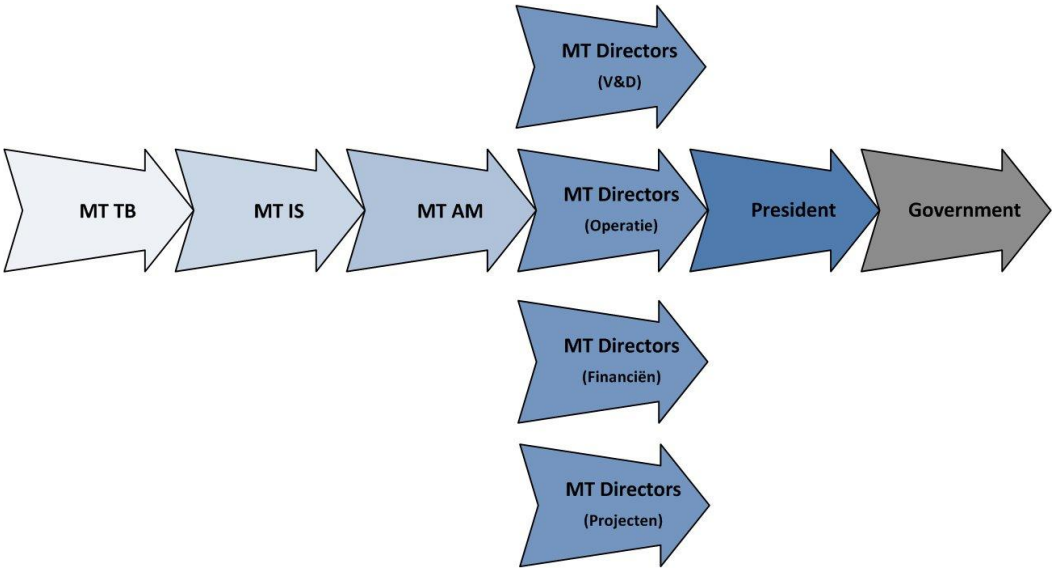

Figure 16 – The current decision making process with the vertical and horizontal axis.

We are interested in the fact how this particular decision making process evolves throughout these sequential decision making steps. What is the interaction between these different levels of decision making? How do these different levels communicate with each other? Does each layer perceive the same problem perception? When all these different layers are interviewed, an entire representation of the decision making process will emerge. Helping us to visualize a complete overview of the decision making process. Enabling to find what factors and where in the process, influence the decision making process about the implementation of a new train safety system. In addition, various business units are involved in the decision making process, this is also depicted in Figure 16. Based on the comments stated above several people were approached in order to participate in this research.

Choice

In order to construct a general overview of this particular decision making process it was chosen to conduct seventeen interviews. As already mentioned previously, the interviewees all have a different background and function in this decision making process. Interviewing various people at different 'layers' and various 'business units' is important since it widens perspective towards this decision making process. It is important to interview people at different layers since they probably have different perceptions towards this subject. This will enrich our results, which is very important in exploratory research.

A list of interviewees was based on the comments stated above. The position of the interviewees in the organisation is presented below in Figure 17.

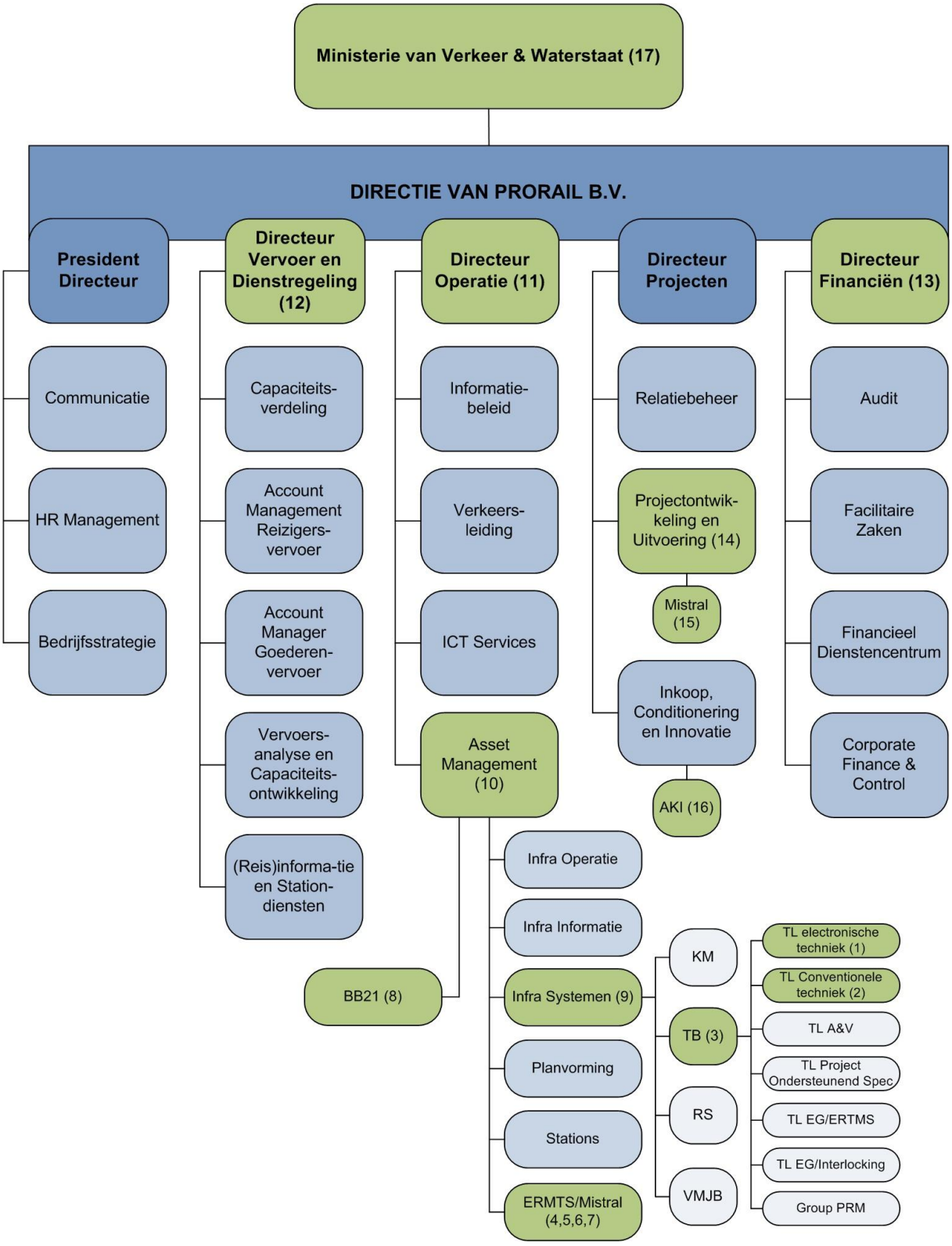

Figure 17 – Position of the interviewees in the organisation.

6.2.2 Interview procedure

This interview procedure is equal to the first round of interviews. Therefore, the interview procedure can be found in section 4.2.2 explained earlier. The content of these interviews are different compared to the first round of interviews. These interviews are more structured in nature. After the

first round of interviews a framework was constructed to assist in the exploration of the evolution of the decision making process. This framework functions as a guideline in our second round of interviews. Moreover the questions for these interviews are based upon this framework. Appendix E shows the interview questions that were conducted.

These interviews are more structured in nature compared to the first round of interviews, they can be regarded as semi-structured. The main idea was to run the conversation through as naturally as possible. If other subjects were brought up by the candidate, that might be important for evaluating the decision making process, or if clarification about a certain subject was needed we would also discuss them in a natural way. Therefore, it has a semi-structured character. It is important that these interviews have a semi-structured character, because a broader spectrum of people will be interviewed. Conducting semi-structured interviews enables us to reveal factors that were not notified in the first round of interviews. Furthermore, semi-structured interviews will present an excessive amount of data, which will be hard to analyse. Before ending the interview, participants were asked if there were subjects that they missed out on during this interview. This gives them the idea and opportunity to be involved in the research.

7. Second data analysis *(interviews)*

During this research, seventeen interviews were conducted which gathered a lot of data and information. These interviews were analysed using thematic discourse analysis. Multiple factors that influence the decision making process emerged when this analysis was performed. Based on the observations of our empirical dataset, a framework was established. This chapter will explain *how* this framework was generated. Furthermore, our observations will be compared with five theories. These theories were explained in the literature study in chapter three. Every theory has its own aspect in explaining difficulties in the decision making process. This chapter explores *which* observations are indicated at *which* theory.

7.1 Interview data

This chapter elaborates on the results that were collected data from the interviews. The consistencies and inconsistencies will be explored.

7.1.1 General

As mentioned above thematic discourse analysis was used in order to analyse the empirical data set. The content of the second round of interviews was based on the framework of figure 14. This framework was established after the first round of interviews. Compared to the first round of interviews, the second round of interviews consulted various individuals at every 'layer' and 'business unit' in the organisation. This widens the perspective to find difficulties in the decision making process. It is important to interview various people at different position because they have their own perception about this subject. It will help to generate a proper view about the decision making process. In addition, interviewing multiple people at various positions will enrich the results which is very important in this exploratory research.

The first step to analyse our data is to explore what 'patterns of repertoires' are present within and between the interviews. Discourses are highlighted and therefore factors emerge that contribute towards the challenge in the decision making process. The discourses (in this case, factors that influence the decision making process) and interview participants were plotted in one scheme. This generated a table that gives an overview about what factors, that influence the decision making process, are observed and which interviewees mentioned this factor. This table is the starting point for several topics that will be discussed in this chapter. *First*, *in*consistencies between and within interviews could be verified. *Second*, consistencies between and within interviews could be verified. *Third*, this scheme helps to verify basic assumptions and starting points. A framework will be generated based on our observations in order to clarify the challenges of the decision making process. Table 1 will illustrate the matrix of the discourse analysis where interview participants and factors are plotted.

Before we will discuss these points mentioned above it should be notified that every participant allowed that the interview was recorded and that the interview could be included in this study. Figure 17 shows the positions of the people that were interviewed in the second round of interviews.

Discource Analysis Matrix																			
Discourses themes	***Context of these themes***	**1**	**2**	**3**	**4**	**15**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**16**	**17**	**Total**
Political influence		1	1	1	-	1	1	1	-	1	1	1	1	1	-	-	1	1	13
Duration (time consuming)		1	1	1	1	1	1	1	1	1	1	1	1	1	1	-	1	1	16
Iterative process		1	1	1	1	1	-	-	-	1	1	1	-	-	-	-	-	-	8
Complex		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	17
	Long	-	-	1	-	1	-	-	-	1	1	-	1	-	1	-	-	1	7
	Strategic	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1
	ERTMS/Mistral	1	-	1	1	-	1	-	1	1	1	1	-	1	-	1	1	1	12
	Suppliers	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	2
	Technique	-	1	-	1	1	1	1	-	-	-	1	-	-	-	-	-	-	6
	Concerns a lot of money	-	-	-	-	1	-	-	-	-	1	1	-	-	-	-	-	1	4
Goal	*Ambigouos*	1	1	1	0	0	0	1	0	1	0	0	1	0	1	0	1	0	8
	Level of leadership		1	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	3
	SOT levels are not clear	1	1	-	-	1	1	-	-	1	-	1	0	-	1	-	-	-	7
	Complex to establish strategy	1	1	1	1	1	1	1	-	1	1	1	1	0	1	-	-	-	12
	Complex to establish strategy at TB		0	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Business case not clear		-	-	-	-	-	1	-	1	-	-	1	1	-	1	-	-	1	6
	Not easy to establish	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	2
	Facts unclear	-	-	-	-	-	1	1	-	-	-	1	-	1	1	-	-	-	5
Sense of urgency	*At others*	0	-	0	-	0	-	1	0	0	0	1	0	-	-	-	1	-	3
	Self	1	-	-	-	-	-	1	-	-	1	-	1	0	0	-	0	-	4
Culture	*Scope*	1	1	1	-	-	1	1	1	1	1	-	1	-	1	1	-	-	11
	Decision acceptance	0	-	-	0	-	-	0	-	-	-	-	-	-	-	-	-	-	0
	Freedom to interfere	-	1	1	1	-	1	1	1	-	1	-	-	-	-	-	1	-	8
	Level of decisiveness	1	1	1	1	1	1	1	1	1	1	1	-	-	-	-	-	-	11
	Safety important	-	-	-	1	1	1	-	1	-	-	-	1	-	-	-	-	-	5
	Difference departments	-	-	-	1	1	1	1	1	1	-	1	1	1	1	-	1	-	11
	Not money driven	-	-	-	1	-	1	-	-	-	-	-	-	-	1	-	1	-	4
	Technical oriented	-	-	-	1	-	1	-	1	-	-	1	-	-	-	1	-	-	5
Group decision making	*Level of collaboration*	1	1	1	1	1	1	1	1	1	1	1	-	1	-	1	1	-	14
	Level of collaboration at higher levels	1	-	1	-	-	1	-	-	-	1	-	1	-	-	-	-	-	5
	Scope	1	1	1	-	1	1	1	-	-	1	-	-	-	-	-	-	-	7
	Level of consensus	1	1	1	1	1	1	1	-	1	1	1	1	-	1	1	1	-	14
	Level of consensus at board of directors	1	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	3
	Decision acceptance	0	0	0	0	0	0	0	-	-	0	-	0	0	0	0	-	-	0
	Amount of people	1	-	1	1	1	-	1	-	1	-	-	0	1	1	1	1	-	10
	Tension between individuals	1	-	1	1	1	1	1	-	-	1	-	1	-	1	-	1	-	10
	Contested info	1	1	1	1	1	1	-	1	1	-	1	-	-	1	1	1	-	12
	Various interests	1	1	1	1	1	1	1	-	1	1	1	1	1	1	-	1	-	14
	Various interests exter	-	-	1	1	1	-	-	1	1	1	1	1	1	1	0	1	-	11
	Level of leadership leadership	-	1	1	-	-	1	1	-	1	-	-	-	-	1	-	-	-	6
	Level of understanding		-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1
Communication	*Complex Multi-Level-Decision-Making*	1	-	1	1	1	1	1	-	1	1	1	1	1	-	-	-	-	11
	Level of understanding	1	1	-	1	0	1	1	-	1	1	-	1	1	-	-	-	-	9
	Level of leadership	1	-	1	1	-	1	1	1	-	1	-	-	-	1	-	1	-	9
	Level of transprancy	1	-	1	1	-	-	1	-	1	-	1	1	-	-	-	-	-	7
	Complex management of technology	1	1	-	1	-	-	1	-	1	1	1	1	1	1	-	1	-	11
	Level of communication	1	1	1	1	0	1	1	-	1	1	1	1	-	-	-	1	-	11

Discource Analysis Matrix																			
Discourses themes	***Context of these themes***	**1**	**2**	**3**	**4**	**15**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**16**	**17**	**Total**
Organisational structure	*Ambigouos*	-	-	-	-	1	1	1	-	1	1	-	1	1	-	-	-	-	7
	Responsibilites ambigouos	1	0	1	1	1	0	1	0	1	1	-	0	1	0	1	0	-	9
	Task-distribution ambigouos	1	0	1	1	1	0	1	0	1	1	-	0	1	0	1	1	-	10
	Dependent of other business units	1	1	-	1	-	-	1	1	-	1	1	1	1	1	-	1	-	11
	Reorganisation Mistral has influence	-	-	-	1	-	1	-	-	-	1	1	1	-	-	-	0	-	5
	Reorganisation ProRail influence	-	-	1	1	-	1	-	-	1	0	0	1	-	-	-	0	-	5
Inconsistent decision	*Inconsistent*	1	1	1	1	0	1	-	1	1	1	1	1	1	1	1	1	1	15
	Costs	1	1	-	-	-	1	-	1	1	1	-	1	-	-	1	-	1	9
	Decisions are postponed	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
	Dependency stakeholders	1	1	-	-	-	1	-	1	1	1	-	1	-	1	-	-	1	9
	Present day topic	-	-	1	-	-	1	-	1	1	1	-	-	-	1	-	-	-	6
	Uncertainty	1	1	1	1	1	1	1	1	1	1	-	1	1	1	1	1	1	16
	Scope creep	-	1	-	-	-	1	-	-	-	1	-	-	1	1	-	1	1	7
	Decapitalisation	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	2
Uncertainty	*Uncertainty*	1	1	1	1	1	1	1	1	1	1	-	1	1	1	1	1	1	16
	Jump forward		-	-	-	-	-	-	-	-	-	1	-	-	-	-	-		1
	Complex	1	-	-	-	-	-	-	-	-	1	-	-	-	1	1	-	-	4
	Technological choice	1	1	1	-	-	1	-	-	-	1	-	-	-	1	-	1	-	7
	Different interests	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	2
	Business case	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	2
Power plays a role		1	1	1	1	1	1	-	1	1	1	1	1	1	1	-	1	-	14
	Level of leadership	1	1	1	1	-	-	-	-	-	-	-	-	-	1	-	-	-	5
Leadership		1	1	1	-	-	-	1	1	1	1	-	1	1	1	-	1	-	11
	Level of leadership	1	1	1	1	-	-	-	-	-	-	-	-	-	1	-	-	-	5
Level of decisiveness		1	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	3
Extern interests		-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	2
Information Asymmetry		-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	2
Administration plays a rol		-	-	0	-	-	1	0	-	0	0	-	0	0	0	-	-	-	1
Influence new people	*Positive*	1	-	-	-	1	-	-	-	-	-	-	-	1	1	1	1	-	6
	Slows down	1	1	1	1	1	1	1	1	1	1	-	-	-	1	-	1	-	12
	Adaption of new job takes time	1	1	1	-	-	1	1	1	1	1	-	-	-	-	-	-	-	8

Table 1 – Matrix of discourse analysis.

7.1.2 Inconsistencies between and within interviews

Inconsistencies are not found *between* and *within* the interviews. It should be noted that inconsistencies between interviews may seem apparent in some cases. Though, when the context of a discourse is taken into consideration, it is clear that inconsistencies are not at hand. The fact that inconsistencies are not apparent can be seen in Table 1.

7.1.3 Consistencies between and within interviews

As can be seen in Table 1 a lot of consistencies can be found in our discourses. The most important ones are presented in this section.

- Firstly, every participant agreed upon the fact that the decision making process is time-consuming. Almost half of our participants were saying that it is an iterative process.
- Secondly, each interviewee was saying that the decision making process is complex. Eleven out of seventeen participants mentioned that the complexity was caused by the fact that Mistral was linked towards another project (ERTMS).
- Thirdly, it is noteworthy that eleven out of twelve participants talked about the subject that it is hard to define a strategy. The other (five) participants did not talk about strategy.
- Also culture of the company was highlighted as a factor influencing the decision making process. Most individuals mentioned one cultural aspect, namely that people 'are focussed on their own task'.
- Furthermore, eleven out of seventeen participants noticed a cultural difference between the four business units is present at ProRail.
- Almost every participant confirms that politics have an influence on the decision making process.
- Practically all contributors agreed upon the fact that group decision making is a difficult subject.
- Basically the entire group of interviewees were saying that it is hard to reach consensus.
- Mainly it was considered that there are different interests at hand in this decision making process.
- Eleven participants mentioned that decision acceptance was not always in attendance.
- Furthermore, most people were saying that contested information plays a role in the decision making process.
- The majority of individuals notified that a tension was present between various parties in the decision making process.
- All participants mentioned that power influences the decision making process.
- It is mentioned that the level of leadership influences the decision making process.
- Communication is another theme that was mentioned by our interviewees, being a difficult aspect in this decision making process. The interviewees were saying that multi-level decision making, and managing this difficult subject of technology are factors that contribute towards the difficulty in communication.
- Additionally, interviewees agreed that several departments are dependent on one another is this decision making process.
- With one exception, everyone agreed upon the fact that the decision making process could be more consistent.

- Uncertainty in the decision making process is another aspect influencing the decision making process mentioned by most participants.
- Administration of the decision making process does not have a negative influence on the decision making process according the majority of individuals.
- The influence of new people entering the decision making process is also mentioned as a factor that influences the decision making process by most participants.

7.1.4 Inconsistencies between upper, middle and low management

This paragraph will describe the inconsistencies that are observed between upper and lower management. The differences between these management layers can be verified in Table 1. It is interesting to look at these differences, because it can address difficulties in the decision making process between upper and lower management.

- First of all, individuals at lower management do not mention anything about a business case. On the other hand, upper management mentioned that the business case should provide more clarity.
- Second, in terms of complexity lower management refers towards technical difficulties, though upper management mentioned other difficulties.
- The cultural aspect, freedom to interfere, is not mentioned at upper management. Lower and middle management did mention this cultural aspect.
- Individuals of lower management mentioned that a difficulty of the decision making process relies in the 'level of decisiveness' of several individuals. This subject is not discussed at upper management.
- Lower management considers the fact that the influential aspect of middle management is a difficult factor in this decision making process. On the other hand, upper management considers that the influential aspect is a difficult factor at lower management.
- Upper management talks about the fact that some individuals mainly reason from the technical and content driven aspects. This is not considered as a problem at lower management levels.

7.2 Basic assumptions and starting points

The previous paragraphs addressed what factors influence the decision making process. This paragraph will explain how these factors are related. A framework will be constructed where the factors (aspects that influence the decision making process) and starting points (key-points), will be highlighted. This paragraph clarifies *which* key-points will be addressed and *why* they will be addressed as key-point. Table 1 can be consulted to see what factors are of importance.

Five key-points namely, group decision making, communication, culture, inconsistencies and organisational structure are addressed as key-points in our framework. This can be seen in Figure 18. The reason *why* they are addressed them as key-points can be seen in the bullet points (factors that influence the decision making process). These key-points are chosen because they contribute towards the fact *why* this decision making process is time consuming and iterative. In addition, this framework, consisting of factors and key-points, is mainly based on the observations that were made from our empirical data-set.

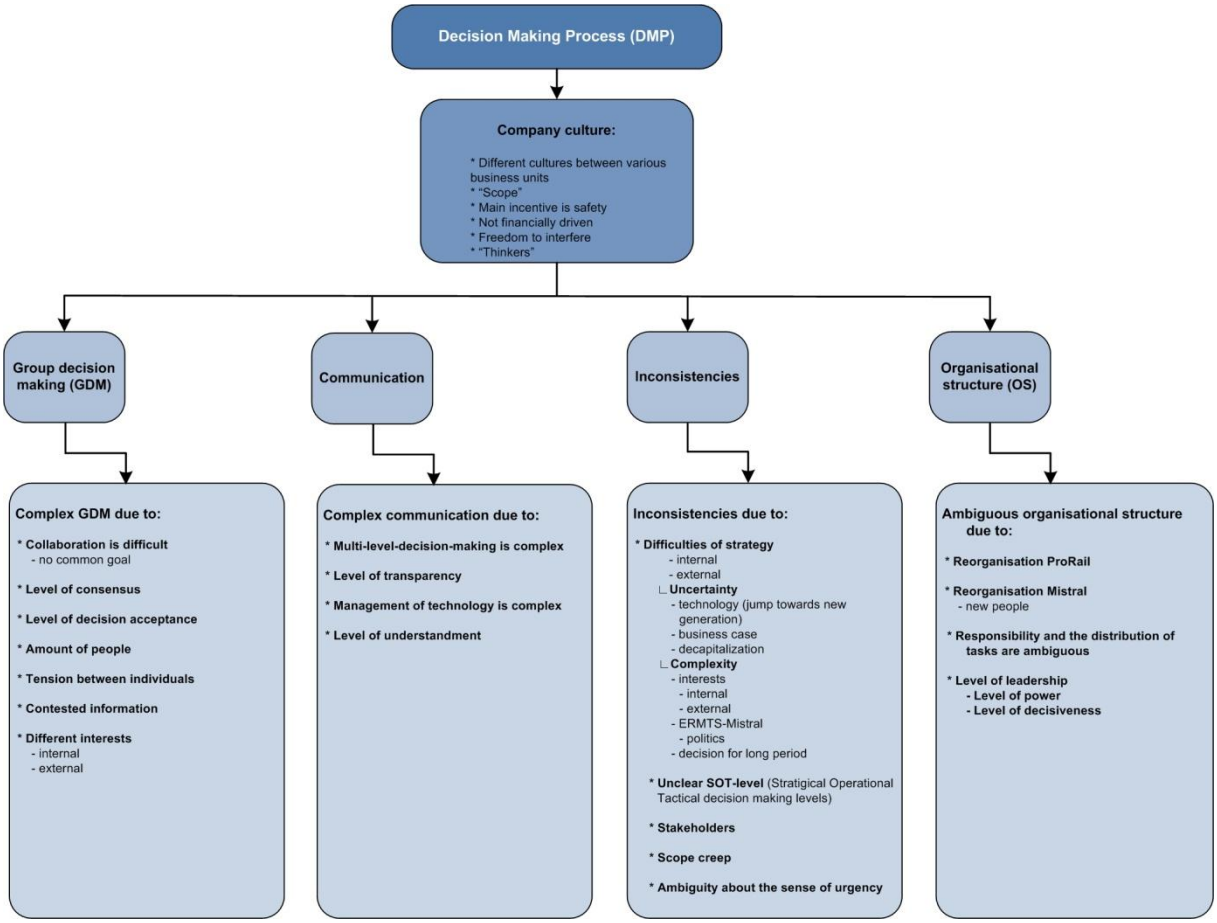

Figure 18 – Framework of the factors influencing the decision making process.

7.2.1 Culture

Observations

Several cultural aspects were mentioned by the participants. *First,* most interviewees were saying that a cultural difference is at hand between the different business units. It was mentioned that decision making was more difficult, because it was challenging to understand and communicate with each other due to this cultural difference. *Second*, most interviewees refer to the cultural aspect that individuals will operate and think in their own scope. Therefore, it is difficult for most individuals to overview all the aspects in the decision making process. *Third,* several individuals stated that safety is an important incentive for ProRail. Some interviewees were saying that, due to this cultural aspect, people are more careful in this decision making process, since it involves safety issues. *Fourth,* few interviewees mentioned that ProRail's culture was not financially driven. *Fifth,* the participants were saying that everyone may interfere. Several participants stated that this cultural aspect has its disadvantages. According to these participants it makes the decision making process more difficult due to the fact that the amount of people is increased and that more interests are present. *Lastly,* interviewees mentioned that ProRail's culture is a "think" compared to a "do" organisation due to its technical. And therefore it may influence the speed of the decision making process.

Conclusion

The paragraph above shows the observations about culture using our empirical data-set. A link from culture to the iterative and time-consuming character of the decision making process could be made

based on the previous paragraph. However, here we will explain in more detail *why* culture contributes to the time-consuming and iterative character of the decision making process. *First,* the diversity in culture will make decision making more complex, because the culture of business unit A will have a different decision making style or process compared to business unit B. This may induce tension or friction between the different business units because it is more difficult to understand each other. It takes time to align the different decision making processes/styles and therefore it will increase the duration of the decision making process. *Second,* individuals operate in their own scope. Therefore, individuals do not always know what another person is working on. This creates the opportunity that people will work on the same subject, without knowing it from each other. Or even worse, jobs that are performed may have a contradicting effect upon one another. Therefore, the decision making process can be iterative and time-consuming. When working in a group it is possible to be much more effective and efficient than individuals. *Third,* safety is a big incentive for ProRail and because it concerns a social perspective individuals are more cautious to make a decision. This may increase the length of the decision making process. *Fourth*, ProRail is more a "think" compared to an "act" culture. Therefore, this decision will be elongated and iterative for several reasons. Uncertainty and doubt cannot be completely eliminated in decision making processes. ProRail has a "think" culture and therefore they are interesting in the degree of uncertainty and risks. These factors change because this decision making process operates in a very changeable and complex environment. Therefore, more information can be gathered throughout time, because new information can be conducted, that may give new and improved insights which are important for decision making. This results in an iterative and more endured decision making process. It should be noticed that uncertainty and doubt cannot be completely eliminated in decision making processes. For that reason and because ProRail is a "think" compared to an "act" culture, this process may go on for a long time. *At last,* the cultural aspect "freedom to interfere" also contributes to a longer and iterative decision making process. When individuals have the freedom to interfere it might increase the various decision alternatives. In addition, each individual has its own interests towards the subject. When everyone may interfere multiple interests are at hand and therefore it is harder to reach consensus. This will result in a time-consuming process. In addition, when new individuals enter the decision making process, they have the freedom to explore and change the process due to ProRail's culture. This can also induce an iterative character, since new people may change the process.

7.2.2 Group decision making

Observations

First, group decision making was highlighted by all interviewees since most were not completely satisfied about this subject. Several individuals mentioned that suboptimal group decision making is caused by the difficulty in collaboration. In addition, several participants mentioned that group decision making became a low priority, since other individuals did entirely perform as a group. *Second,* multiple participants mentioned that the difficulty of collaboration is caused by the fact that various individuals have different interests in this decision making process. According to several interviewees this leads to discussions and tension between different. *Third,* participants stated that it is difficult to reach consensus. *Fourth,* it was stated by most interviewees that the level of decision acceptance influences the level of group decision making. *Fifth,* most participants mentioned that there are many people involved in the decision making process. Therefore, group decision making is

more complex, since it is harder to reach consensus. *Sixth,* it was highlighted by several people that group decision making was affected by the tension that was at hand between different parties. *Seventh,* several interviewees stated that contested information was present in this decision making process.

Conclusion

Group decision making is highlighted as a key point, because it is a subject that has an effect the time-consuming and iterative character of the decision making process. In general, group decision making can be very time consuming. The problem relies in the fact that each individual approaches the decision differently, making collaboration difficult. For example, everyone has different experiences, values and styles about decision making. This will induce tension between several people, which might lead to discussions and therefore an increased length of the decision making process. In addition, various people with different interests are involved. Every opinion is taken into account and therefore it is hard to reach consensus, resulting in an increased length of the decision making process. It is likely that the duration of the decision making process increases when the group is larger, because there are more interests in attendance. This will make the decision making process even more complex. It could be logically deducted that the level of decision acceptance influences the endurance and iterative character of the decision making process. Decision acceptance is relatively low due to the limited level of transparency this will lead to an increase of the level of contested information. This lack in transparency is caused by the fact that people cannot always verify what the motives of certain individuals entail. Especially when these motives are variable the level of decision acceptance will decrease and level of contested information will increase. Both when decision acceptance is low or contested information is high, discussions will arise since multiple individuals oppose or contest the decision that is made leading to iterative and longer decision making process.

7.2.3 Communication

Observations

The majority of the interviewees mentioned that communication was difficult in this decision making process. Several reasons were addressed by the participants. *First,* the interviewees stated that communication throughout the decision making line was not optimal. In addition, participants mentioned that people at different levels have a different scope. Therefore, communication is difficult because it is hard to understand each other. *Second,* a number of people mention that communication is difficult due to the level of transparency that was at current during this decision making process. *Third,* participants mentioned that misunderstanding between the managerial and technical aspects of this decision making process are in attendance. Therefore, miscommunication will occur, because it is difficult to merge both 'worlds'. *Fourth*, according to the participants misunderstandings between individuals are likely to happen.

Conclusion

Communication is addressed as a key-point because it influences the duration and iterative character of the decision making process for several reasons. The goal of communication is to share information. Communication is important in the decision making process because decisions are based on examining information. It is mentioned that communication is a difficult factor in this decision making process. Therefore, it is harder to examine information to establish a decision,

increasing the duration of the decision making process. Several difficulties contribute to this challenging communication process. Multiple levels are involved in this decision making process. These levels have a different tasks and approach to the decision making process. Therefore, different types of communication are needed at different layers. It can also be stated that different types of communication are needed between 'managers' and 'experts'. Therefore, it is hard to understand each other or speak the same language because everyone approaches the decision making process differently. Miscommunications are likely to occur which may even lead to discussions or tension between individuals. Making decision making a more time-consuming and iterative process. Lastly, the level of transparency is relatively low, since individuals may have personal interests concerning this subject. Therefore, information can be suppressed influencing the communication flow in this decision making process.

7.2.4 Inconsistencies

Observations

Multiple participants mentioned that the decision making process was not extremely consistent. Several reasons were highlighted by the interviewees. *First,* the goal of the decision making process was ambiguous, therefore the course of action was not stable which caused the inconsistent behaviour. *Second,* the participants were saying that it was difficult to introduce a clear strategy. It was mentioned that Mistral was coupled to ERTMS and therefore it became a political and European issue. The decision making process became more complex and it was harder to establish a clear strategy. Interviewees also stated that technological uncertainty or the complexity to choose between two train safety systems makes it hard to establish a long term decision. And therefore it is difficult to depict a clear strategy. *Third,* several individuals mentioned that a clear distinction between strategic, operational and tactical level of the decision making process is not present. *Fourth,* several interviewees mentioned that stakeholders influence the direction of the decision making process. *Fifth,* an obvious inconsistency in this decision making process was mentioned by multiple participants. The inconsistency that was stated is that in 2007 a decision was reached about the implementation of train safety systems. Though, in 2010 this decision was reversed. Various interviewees mentioned that this inconsistency emerged due to scope creep (e.g. new financial insights).

Conclusion

Inconsistencies are addressed as a key point, because it contributes to the time-consuming and iterative nature of the decision making process. It is logically deductable that inconsistent decisions have an iterative character. When the direction of a decision is changed, it can be labelled as inconsistent. In terms of this change in direction decision making steps will be repeated, referring to the iterative character. It is difficult to establish a clear strategy or goal because this decision making process operates in a very changeable and complex environment. It is uncertain and complex due to the fact that this decision has to meet financial issues, safety issues, political issues, many stakeholders are involved and it is a large project. Due to these uncertainties a clear goal is hard to establish because scope creep may occur which may adjust the course of decision making. This also makes it difficult to verify the strategic, operational and tactical decision making levels. Both will lead to the inconsistent character of the decision making process, resulting in a longer and iterative decision making process.

7.2.5 Organisational structure

Observations

First, several interviewees mentioned that the iterative character of the decision making process was caused by the reorganisation of Mistral. It was mentioned that project Mistral was reorganised over the past ten years, which is illustrated in Figure 19**Error! Reference source not found.**. This project started at the department TB, thereafter it moved up one level towards IS. Subsequently a separate programme was initiated for Mistral that was situated at AM. Several interviewees were saying that these reorganisations induced the fact that questions about Mistral were reiterated. Therefore, these reorganisations led towards iterative and time-consuming processes. *Second,* some participants mentioned that the reorganisation of ProRail slowed down the decision making process. *Third,* some individuals stated that responsibilities or task distribution in the decision making process are ambiguous. In addition, the opinion of several interviewees considered that a certain level of leadership was missing in this decision making process. *Fourth, t*he level of decisiveness is also mentioned as a factor that will decrease the speed of the decision making process.

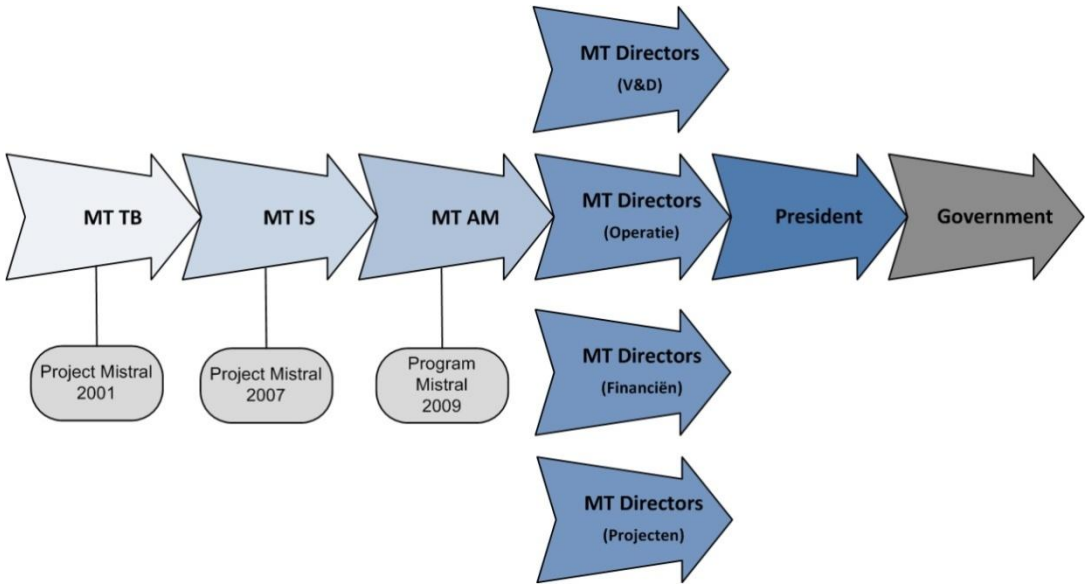

Figure 19 – Reorganisation of the project Mistral.

Conclusion

Organisational structure also explains the time-consuming and iterative character of the decision making process and therefore it is addressed as key-point. During the reorganisation of ProRail or Mistral, decision making steps were repeated several times. An important point should be mentioned. The reorganisation of Mistral was induced in order to decrease the “amount of steps” of communication in the decision making process. Therefore, it was expected that the decision making process became more efficient. It also should be mentioned that the structure of ProRail changed during reorganisation. First, the departments “Vervoer en Dienstregeling” and “Financien” were not present. After reorganisation it became a different organisation, respectively this will influence the decision making process.

During reorganisation decision making processes can change. This will interrupt the decision making process, because it takes time to adjust to the new system. Furthermore, the priority of a decision

can be decreased during reorganisation, since other subject contains a higher priority. These factors will influence the speed and iterative character of the decision making process. Furthermore, it is important that task and responsibility distribution will be coordinated. When task distributions and responsibilities are not clear, several things may occur. *First,* without knowing people may work on the same subject. This may generated different views about the same subject resulting in discussions, tension and a longer decision making process. *Second,* the danger looms that not all the information about the decision making process is mentioned, because not one individual will work on that subject. *Third,* it is also possible that employees will explore non-relevant information about the decision making process. In short, these points do not contribute towards an efficient and affective decision making process. *Fourth,* in our opinion unclear role distributions and responsibilities are caused by the fact that the goal is unclear. When the goal is ambiguous it is also hard to make a distinct separation between the operational, tactical and operational decision making. This might explain why the responsibilities and role distribution are unclear. The level of leadership is partly determined by the level of deciveness. This is relatively low, since role distributions are not clear. Due to ProRail's culture people will not "act" and claim the leadership position when the environment is unclear. Since, ProRail contains a "think" compared to an act culture. In short, responsibilities are not clear and no one will take responsibility to make a decision, decreasing the speed of the decision making process.

7.3 Interrelation of the key-points

The paragraphs above explained *why* several key-points are appointed. A framework was developed which can be seen in Figure 18. This figure shows the observations that were made during this research and what characteristics this decision making process contains. This section will explain how our key-points are interrelated to one another. This is interesting because the factors of one key-point, strengthen the less admirable factors of another key-point. Resulting in an even more time-consuming and iterative decision making process.

7.3.1 Interrelation group decision making and communication

First of all, the relation between *group decision making* and *communication* will be described. The intensity of group decision making will affect the intensity of communication, which is important for the efficiency of decision making. This decision making process about implementing a new train safety system, encloses a few difficulties concerning group decision making and therefore the intensity of communication will also be decreased. *First*, communication will be more difficult, because there are multiple people involved. *Second, t*he level of consensus, the level of decision acceptance, and the level of collaboration is relatively low. *Third,* a tension between various individuals is present due to contested information or different interests. These factors increase the tension within the group and therefore affect the intensity of communication because individuals are opposed to communication due to poor group decision making.

It can be said that each individual communicates in a dissimilar way, because the use of language is diverse. This makes communication difficult, because it is challenging to understand each other. This decision making process about implementing new train safety systems, concerns multi-level-decision-making and communication between a 'manager' and 'expert'. Both have a negative effect towards group decision making due to the dissimilar way of communication in multi-level-decision-making and between the 'manager' and 'expert'. Misunderstandings are likely to occur and therefore

tension between different group members may emerge. This does not have a positive influence on group decision making. In addition, people may not understand why a decision is taken due to misunderstanding, which has a negative effect on decision acceptance. At last, the level of transparency also negatively effects group decision making. When individuals cannot verify the motivation of individuals about a certain issue, due to limited transparency, it will decrease group decision making since the level of trust between individuals will decrease. Figure 20 shows the relation between those two key-points.

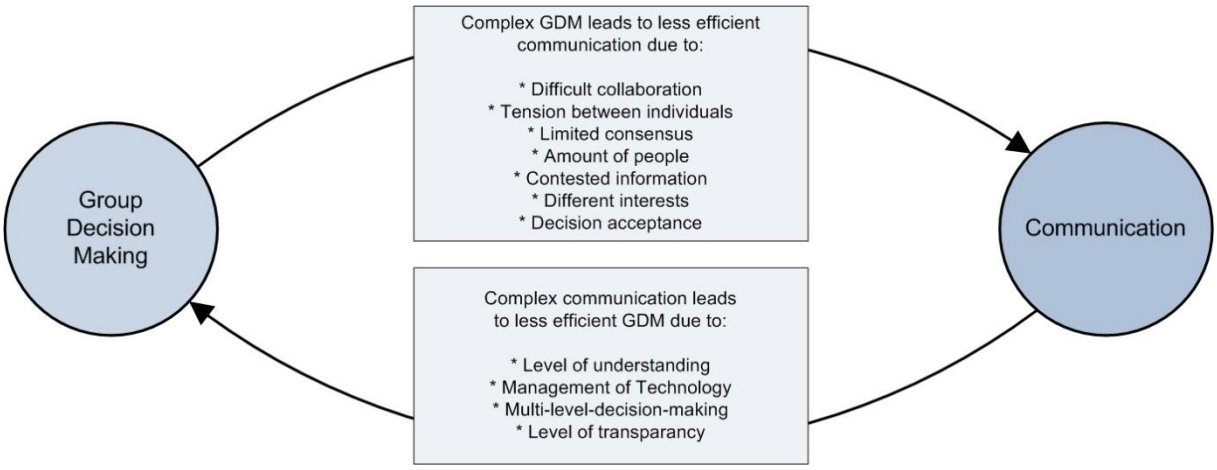

Figure 20 – Interrelation group decision making – communication.

7.3.2 Interrelation group decision making and inconsistencies

It is difficult to enclose a strategy in this decision making process due to the uncertain and complex character. Therefore, inconsistencies may occur and it is hard to accomplish a common goal. This will affect group decision making in a negative manner. Group decision making becomes more complex when a common goal is missing. Without having a common goal it is hard to match an individual task or even a common task. Individuals might get uninspired or agitated when an individual or common task is lacking. This does not increase collaboration but instead increases tension between individuals. Therefore, this inconsistent character of the decision making process, has a negative influence on group decision making.

On the other hand, the difficulty of group decision making may contribute towards an inconsistent character of the decision making process. Group decision making is difficult because multiple people with different interests are present. This will increase the complexity of the decision making process and therefore it is harder to obtain a clear strategy and be consistent. In addition, when the level of decision acceptance is low, people may be in opposition to the decision that was made. This might result in the fact that a decision that was established will be changed due to their protest that is allowed in the open culture of the company. Again the difficulty of inconsistencies reinforces the difficulty of group decision making and vice versa, decreasing decision making efficiency. Figure 21 below shows the relation between those two key-points.

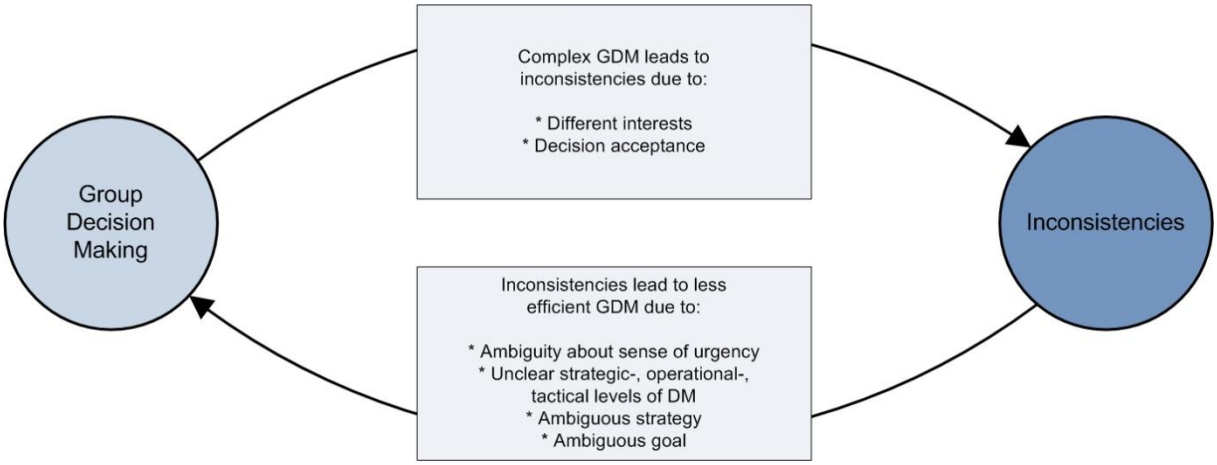

Figure 21 – Interrelation group decision making – inconsistencies.

7.3.3 Interrelation group decision making and organisational structure

The interplay between group decision making and organisational structure will be highlighted in this paragraph. The level of collaboration, the amount of people and decision acceptance, are characteristics of the difficulty in group decision making. These factors may increase the complexity to establish a clear responsibility and clear task distribution. For example, the low level of decision acceptance results in the fact that individuals will not embrace the level of leadership that a person contains. This will indirectly decrease the level of leadership since the 'leader' does not have followers due to the low level of decision acceptance. Therefore, it has a negative effect on the organisational structure.

A difficulty of the key-point organisational structure is that Mistral was reorganised several times. Tension between several individuals was triggered due to this action. Therefore, group decision making becomes more difficult because the level of collaboration will be decreased. Another difficulty of organisational structure concerns that tasks and responsibilities are ambiguous. Therefore, group decision making becomes more complex, because it is not clear by whom the variety of tasks should be performed. It is important to have a clear structure and group coordination, in other words organisational structure, for good group effectiveness. However, organisational structure is difficult and therefore group decision making becomes less effective. In addition, individuals may have different interests about the interpretation of the role-distribution. This may trigger tension between individuals. Therefore, the organisational characteristics have a negative effect towards group decision making. Figure 22 below shows the relation between those two key-points.

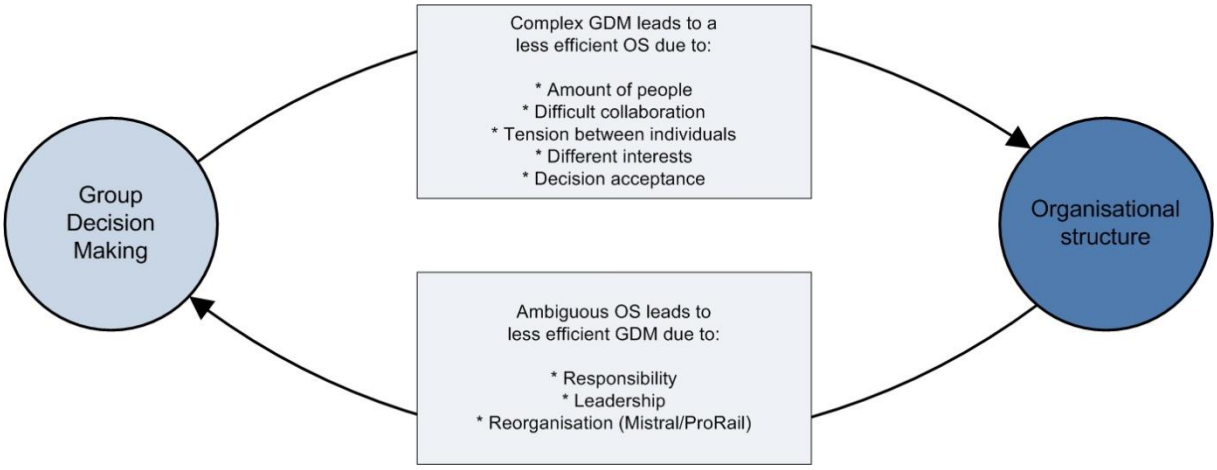

Figure 22 – Interrelation group decision making – organisational structure.

7.3.4 Interrelation communication and inconsistencies

Decisions are based on examining information and therefore good communication is required. When all information is known, decision making would be easy and consistent. In real life, not one decision contains all the knowledge in order to make a genuine and consistent decision. The difficulties in communication of this decision making process (the level of transparency, the difficulty of multi-level-decision-making, and management of technology and misunderstanding) contribute that not all the knowledge that is present is available at every individual. Examining information will be more difficult and therefore it is more complicated to establish consistent decisions. The level of decision acceptance may also contribute to the inconsistent character of a decision. As already explained before, due to the low level of decision acceptance individuals might be against a decision that is made. If multiple individuals are against this decision, the decision might be reconsidered, because they will contradict the decision that is made. Changing the course of the decision making process.

The amount of communication and information is influenced by the inconsistent character of the decision making process. The inconsistent character of this decision making process is not understood by all individuals, this might be cause by the limited level of transparency. When individuals do not have access to the motivation of these inconsistencies it can decrease the motivation and decision acceptance of employees. In turn this may lead to lower levels of communication. In addition, the ambiguity about the sense of urgency may also induce the same result. Furthermore, it is not clear what the difference is between strategical, operational and tactical decision making. This will increase misunderstanding between the different levels of decision making (multi-level-decision-making), because it is harder to understand in what segment you should operate; strategical, operational or tactical. Figure 23 below shows the relation between those two key-points.

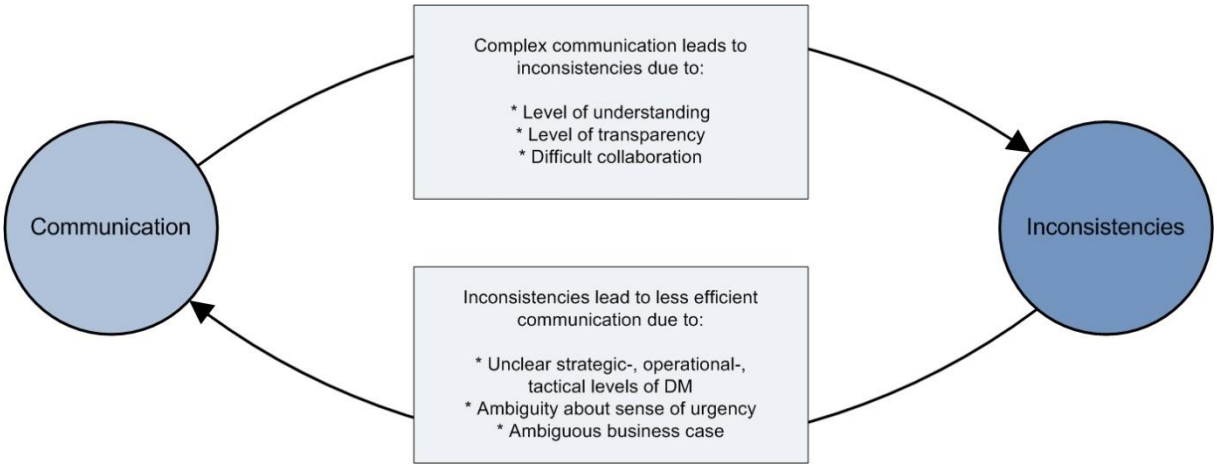

Figure 23 – Interrelation communication – inconsistencies.

7.3.5 Interrelation communication and organisational structure

The complexity in communication can have a negative effect towards organisational structure. When collaboration is difficult it is hard to pinpoint a clear task or role distributions between different parties. It is possible that motives that were the basis to realise a decision are based on misunderstandings. When this is apparent the decision making process may change again, being inconsistent. The same holds true for the level of transparency. If a decision is established and some individuals do not agree, they might raise some motives that were not stated before, due to limited transparency, but can change the course in decision making.

When Mistral was reorganised, it created tension between several individuals, because it was not completely understood why this decision was established. It is possible that it was not understood, because the motivation to reorganise Mistral, was not transparent for all individuals. This induced tension between various individuals, furthermore it affected the amount of trust between individuals, resulting in a decrease in communication. This will affect the level of communication, because motivation and decision acceptance of employees will decrease. The ambiguous character of task-distribution and responsibility make it complex to coordinate group or multi-level-decision-making processes, because clear goals or tasks are not visible. Therefore, misunderstandings will occur effecting the key-point communication in a negative way. It can be stated that difficulties in the organisational structure make it more difficult to perform good communication processes, which are necessary to establish efficient decision making. Figure 24 below shows the relation between those two key-points.

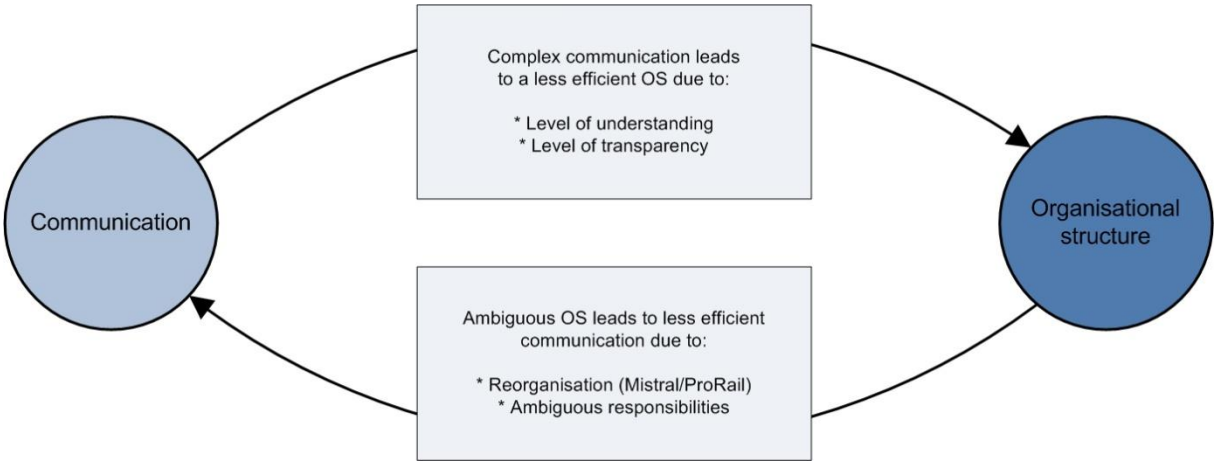

Figure 24 – Interrelation communication – organisational structure.

7.3.6 Interrelation inconsistencies and organisational structure

The last interrelation that will be defined is between the inconsistencies and the organisational structure in this decision making process. Several factors, for example, an unclear strategy, an unclear goal, or ambiguous SOT-levels in the decision making process, will affect the organisational structure in a negative manner. It becomes more difficult to establish a responsibility or role-distribution, because it is hard to coordinate decision making tasks and responsibilities when a common goal is lacking.

The organisational structure also influences the key-point inconsistency. The level of leadership, in this case the power and decisiveness that a person can have, might influence the consistency of decision making. This person might exert their powers over other in order to establish a decision of its own interests. Furthermore, the ambiguity around responsibility and task-distribution will increase the level of uncertainty. And therefore it may participate towards the difficulty to make a clear strategy. Figure 25 below shows the relation between those two key-points.

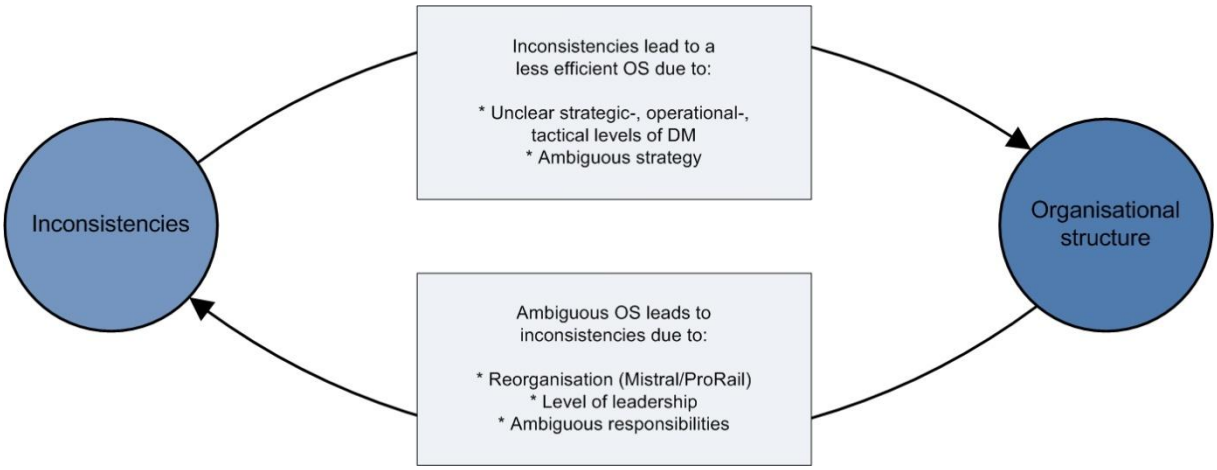

Figure 25 – Interrelation inconsistencies – organisational structure.

7.4 Independent variable culture

Compared to the other key-points (group decision making, communication, inconsistencies and organisational structure) culture can be seen as an independent variable. Culture has an effect towards these key-points though, not the other way around. The influence of culture towards these key-points is shown in Figure 26 and will be explained in this paragraph.

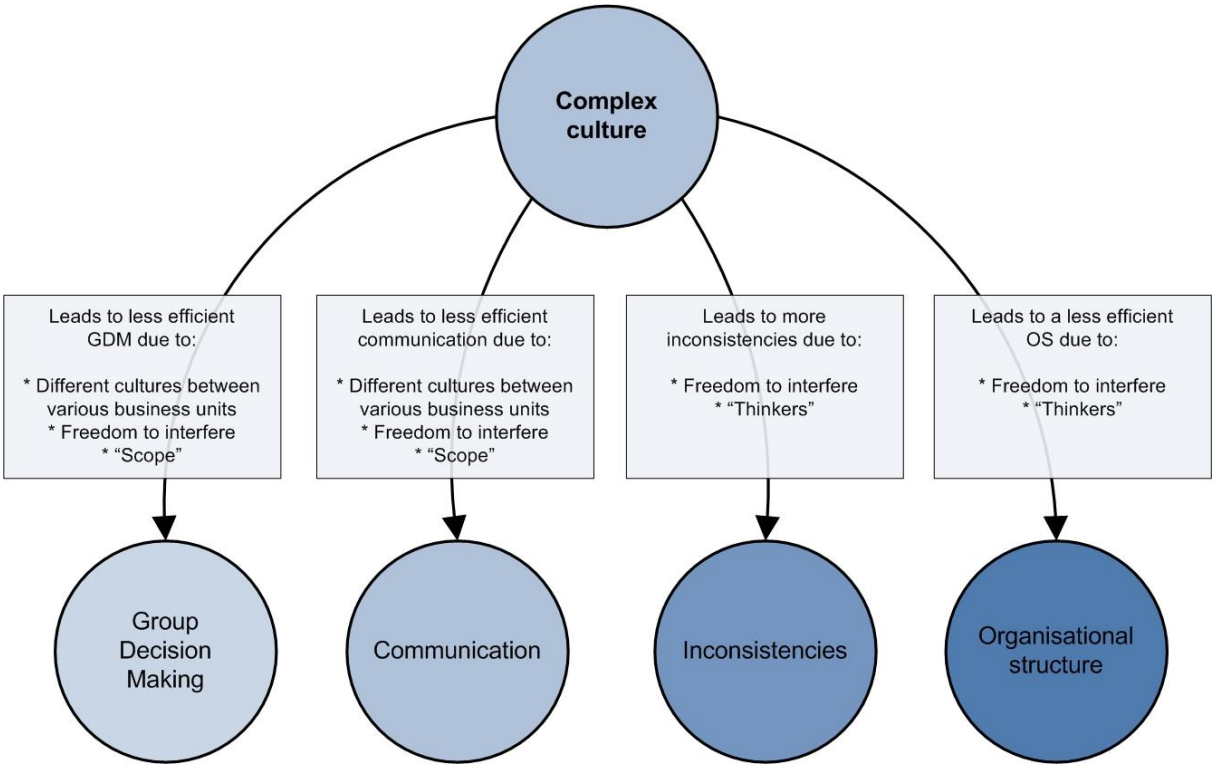

Figure 26 – Culture as an independent variable.

Features of ProRail's company culture contain that safety is important, more thinkers are present compared to doers, most individuals mainly focus their own scope, space is offered to interfere and all business units have a different culture. These features reinforce the difficulties of other key-points, making the decision making process even more complex.

First of all, the influence of culture on group decision making will be explained. Three main aspects of culture contribute to a less efficient group decision making process. *First,* due to cultural differences between the different business units is challenging to understand each other. This makes the collaboration in group decision making more difficult, because it takes time to align the different decision making processes/styles that are present in each culture. *Second,* collaboration and therefore group decision making are more difficult when everyone considers their own world. ProRail's culture is focused towards the individual, not as a group. Therefore, group decision making will be more difficult. *Third,* when space is offered to interfere, more interests are at hand concerning the decision making process. It is harder to reach consensus because more people are involved. Moreover the efficiency of the group decision making process will be altered due to this cultural characteristic.

Second, the influence of culture on communication will be explained. *First,* as explained above it is difficult to understand each other due to the cultural differences. Communication will become more

challenging because the different decision making and communication styles have to be aligned in order to understand each other. *Second,* it relies in ProRail's culture that individuals think and operate more in their own scope. It can logically be deducted that it instantly has an effect towards multi-level-decision making and management of technology. In order to communicate in an orderly fashion you need to think beyond your own scope in order to avoid misunderstandings. When individuals consider their own scope, misunderstandings will occur, because perspectives of other individuals are not entirely taken into account. *Third,* communication and decision making is more difficult when multiple people are involved. ProRail's culture offers "space to interfere", therefore multiple individuals will enter, and are involved in the decision making process. It can be said that this cultural aspect has a negative effect towards decision making effectiveness.

Third, the effect of culture on inconsistencies will be mentioned. *First,* the cultural characteristic "freedom to interfere" will increase the amount of individuals that are involved in the decision making process. This increases the amount of interests, opinions, information and new insights. This makes the decision making process more complex and uncertain. As a result, it is harder to make a decision that contains a clear goal. And therefore, it is harder to establish consistent decisions. *Second,* ProRail has a "think" compared to an "act" culture. Therefore, individuals want to gain more insights, about the decision making process. And consider every option before a decision will be taken. This decision making process operates in a complex and changeable environment. Therefore, new information can be gathered throughout time because the situation is constantly changing. Because this information is taken into consideration the goal of the decision making process will also change overtime.

Fourth, cultural will have an effect on the key-point organisational structure. It will be explained in this section. The cultural characteristic "freedom to interfere" will have the following effect upon the organisational structure. When everyone is allowed to interfere, role-distributions and responsibilities have a loose character. Therefore, responsibility and role-distributions becomes more difficult due to this cultural characteristic. *Second,* ProRail has a "think" compared to an "act" culture. The level of leadership (e.g. power and decisiveness) will decrease because individuals think and do not act.

7.5 Theoretical integration

In chapter two several theories were outlined, they can be of assistance to indicate what can be said about the empirical data that was gained. These theories are the principal agent theory, social network theory, transaction cost economics, contingency theory and resource dependency theory. All these theories could contribute to evaluate this decision making process from a different perspective. In this section it is investigated how the factors, that influence the decision making process are linked towards these theories.

7.5.1 Principal agent theory

The principal agent theory has two underlying assumptions. The first assumption considers the fact that the desires or goals of the principal and agent are in conflict. The second assumption concentrates on the aspect of information asymmetry. Due to information asymmetry it is difficult or expensive for the principal to verify what the agent is actually doing. In this section we will explain if these assumptions can be indicated in our empirical data.

The first assumption about conflicting goals between principal and agent, can be indicated in our research. During the reconsideration phase of Mistral the principal had a different goal in mind compared to its agent. This was about the implementation of new train safety systems. In addition, the business case was not approved during this decision making process. Therefore, it can also be stated that the goals between agent and principal are in conflict. The goal of the agent is that they would like to implement new train safety systems. This is in conflict with the goal of the agent that does not want to implement new train safety systems, because they are not satisfied about the business case.

The second assumption can also be found in this research for several reasons. The technological aspect in this decision making process is relatively complex. Information asymmetry may occur because the chasm between manager (principal) and expert (agent) might cause misunderstandings. Therefore, it is difficult for the principal to verify what the agent is actually doing, or what is meant. This chasm between principal and agent may result in the fact that they may prefer different actions because of their different risk preferences. This can partly explain why the key-points group decision making and communication are difficult, because these aspect affect the decision in a negative manner. Information asymmetry may influence the outcome of the decision making process. This aspect could also be indicated in this decision making process. The principal agent theory assumes that information is distributed asymmetrically throughout the organisation. This makes decision making less efficient and more difficult. This may partially explain why multi-level-decision making is not considered as a strong point in this decision making process.

An interesting observation considers the fact that principal-agent relations are generally considered as good. Though, communication is not regarded as a positive point. This is an example that this theory indicates several observations that were made during this research. However, more aspects in this decision making process are playing a role, that could not be explained in this theory.

7.5.2 Social network theory

Social network theory is based on the assumption that the relation between interacting actors is important. This theory considers that the ability of individuals to influence their success or power relies within the structure of their network. A distinction between strong, weak and absent ties is made. In this chapter the influence of social relations on the decision making process will be explained.

Social contact affects the productivity of individuals and groups and it affects the efficiency of decision making processes. A significant example that was present at this decision making process will be given. Project BB21 had a different organisational structure of the decision making process compared to Mistral. The manager of BB21 directly communicated with higher management levels. Thereby a powerful network was constituted, due to this network the project manager of BB21 was able to influence its success of this decision making process. On the other hand, Mistral started at lower management levels and multiple steps were necessary to reach higher management levels. Therefore, the productivity of this group decision making process was less compared to project BB21, because of the fact that a powerful network was not constituted. This example indicates an absent tie, which could partly explain why communication and group decision making are difficult to establish in this decision making process. The duration and iterative character of the decision making

process might be improved when significant networks are obtained in order to develop an efficient decision making process.

Weak ties can also be indicated in this decision making process. A characteristic of weak ties is that they tend to have novel information flows, compared to strong ties where information considerably overlaps their own knowledge. With the analysis of our results it became clear that several individuals gained information with the help of the connection with weak ties. Therefore, an information advantages was created.

This theory can give an insight about what kind of information is being exchanged, to whom and to what extent. It could explain patterns of forwarding and receiving information and how information moves around and how actors are positioned in the network. This may help to understand the problems in the decision making process. Though, this information about the decision making process could not be indicated in our results. Furthermore, the position of an actor in a network affects what information flows from whom to them and vice versa. This characteristic can also be indicated in our research. At a certain point in the decision making process information flows were mainly throughout one single business unit. If you were positioned in this business unit information flows to you. If you were positioned in another business unit information did not reach you. In a later stadium of the decision making process, the business units that were not involved missed information and therefore certain things were not clear. This had an effect on the group decision making process. Our results indicate that the position of an actor in the network affects what information flows from whom to them. This kind of information flows may have an effect upon group decision making and communication.

Social networks changed overtime due to reorganisation of ProRail or Mistral. In addition, social networks might change due to the fact that people enter or leave the decision making process. For example, in higher management an individual left and it took half a year before this position was occupied again. An important actor with a strong network position changed the social network of lower management layers. An important strong tie was missing in the network of lower management. Therefore, the gate to information was limited decreasing the power of lower management levels. This may affect the decision making process in a negative manner by decreasing the speed and efficiency.

It is proven that social context has an effect upon the behavioural development following from technological change. This aspect could also be indicated in this research. At higher management levels the spreading of believes about implementing new train safety systems affected the attitude of individuals in this decision making process due to their influential position power.

Expectations and behaviour of exchange partners are regulated by embedded information. Three key points are concerned with embedded relation namely; trust, fine grained information transfer and joint problem solving arrangements. The characteristic trust and joint problem solving arrangements cannot be indicated in this research, fine grained information transfer on the other hand can be indicated. Fine grained information transfer is present when actors have close relationship. This has a positive influence on communication because it is constantly flowing. One event in this decision making process mentioned that the decision making process was improved when a new project manager was attracted. This project manager had a close relation with an individual at higher

management levels. This relation increased the fine-grained information transfer increasing decision making effectiveness.

7.5.3 Transaction cost economics

Three important issues can be indicated with transaction cost economics: search and information costs, bargaining costs and policing and enforcement costs. Neither could be indicated in this decision making process, therefore it is an ill-suited theory to give meaning to the observations that were made.

7.5.4 Contingency theory

Contingency theory concerns the fact that an organisational or leadership style that is effective in one situation may not be successful in others. The main centre of attention concerns two leadership styles, task oriented or people oriented leadership. Furthermore, organisational settings can be defined as the facet in the organisation in which leaders can exert influence within their team. There are three variables towards this subject, namely, leader to member relationship, task structure and position power. In addition, the Vroom & Yetton decision making model and the Pathgoal theory will be highlighted. This section will explain if these subjects play a role in this decision making process.

People oriented leadership considers that actions will be explained or that they are approachable. First, decisions are not explained throughout the organisation and top-manager could not be reached, were not approachable for lower management, therefore it can be said that people oriented leadership is not applicable at this decision making process.

Task oriented leaders are more effective in extremely favourable or unfavourable situations. A favourable situation is at hand when a good leader-member relation, a highly structured task and high leader position power are in attendance. It can be concluded that these factors are not present in this decision making process (this will be explained later), therefore an unfavourable situation is created. According to this theory, this decision making process will be more effective with task oriented people. Individuals that use task oriented leadership lets group members know what is expected from them and assigns group members to particular tasks etcetera. This research showed, however, that the task and role-distributions was not clear. The cultural characteristic “freedom to interfere” partly explains why these role-distributions are unclear. This theory might give meaning towards the fact that task oriented leadership is best applicable in this situation, though ProRail’s culture makes it difficult to perform task oriented leadership. It can be concluded that task-oriented leadership is not at hand at ProRail. Although this type of leadership can be contingent to the situation, it is not contingent towards the cultural needs of the organisation, resulting in a management style that is not appropriate in this decision making process. This will cause iterative and longer decision making processes. Considering the statements above types of leadership are not indicated in this decision making process.

Organisational settings concern three aspects, the leader to member relation, task structure and position power. All of which can be related to our results. *First*, the level of acceptance that team players have towards their leader influences the decision making process. In our research it became clear that decision acceptance also influences the decision making process, therefore the leader to member relation will be low. *Second*, task structure is not considered to be a strong point in this decision making process, because the job specificity among subordinates is ambiguous. *Third,*

position power describes the level of power that a leader contains from its position in the organisation. It has already been described at the social network theory that position power is an important aspect in this decision making process. And that our results could also indicate this factor.

The Vroom Yetton decision model relates the contingency theory to decision making. This model suggests that the effectiveness of a decision procedure is dependent on four aspects:

- The importance of the decision quality and acceptance;
- The amount of relevant information possessed by the leader and subordinates;
- The likelihood that subordinates will accept an autocratic decision or cooperate in trying to make a good decision if allowed to participate;
- The amount of disagreement among subordinates with respect to their preferred alternatives.

We will explain if these aspects could be indicated in this decision making process. *First,* the decision acceptance, as explained above is relatively low in this decision making process. *Second*, the amount of relevant information possessed by the leader and subordinates is of key importance to establish good and efficient decision making. Our results showed that communication and group decision making do not have a positive effect on the amount of relevant information that individuals contain. *Third*, we can indicate that due to the cultural characteristic "freedom to interfere" that individuals are allowed in the decision making process. However, decision acceptance or cooperation does not seem to have a positive effect on this aspect. *Fourth,* our results show that disagreement among subordinates to their preferred alternatives is present in this decision making process. All aspects indicate that the decision making process is time-consuming and iterative, because these aspects decrease the effectiveness of this decision making process.

The fact that the behaviour of a leader is contingent to the satisfaction, performance and motivation of its employees can also be found in our research. Results showed that the decision making process often reiterates. Multiple times lower management has to answer or append questions that already have been posed before at higher management, or vice versa. This research showed that it decreases the level of satisfaction or performance of individuals. And therefore influences the decision making efficiency.

7.5.5 Resource dependency theory

Resource dependency theory focuses on exchange and power relations in and around organisations. A few assumptions of the resource dependency theory could be indicated in our research, they will be mentioned in this section. These assumptions are, organisations are dependent on resources, the resources of one organisational needs are often present at other organisations, resources are a basis of power therefore individuals can be dependent on each other, and power and resource dependence are linked.

In order to make a genuine decision you are dependent on information (resources). In this decision making process every business units contains different and relevant information for the decision making process, making them dependent of one another. This dependency power may influence the decision making process, because power is not the property of an actor but of a social relation. It

completely exists in the other's dependency. This kind of power is not indicated in this research. It should be mentioned that several parties in the decision making process contain autonomous power about a certain subject. This means that they exert dependency power.

Actors that are missing a resource will look for and start a relationship with another actor which contains the resource they need. An example that occurred at ProRail can be mentioned. It was already stated at the social network theory, and then it was called a 'weak tie'. In order to gain more information about a certain subject an individual contacted another actor that contained this missing resource.

Table 2 shows an overview of the theoretical integration. It is shown if the underlying assumptions of the various theories are indicated in this research.

Theory	Underlying assumptions	Indicated at ProRail
Principal agent theory	The desires or goals of the principal and agent are in conflict	Yes
	Due to information asymmetry it is difficult or expensive for the principal to verify what the agent is actually doing	Yes
Social network theory	The ability of individuals to influence their success or power relies within the structure of their network	Yes
	Strong ties	Yes
	Weak ties	Yes
	Absent ties	Yes
Transaction cost economics	Search and information costs	No
	Bargaining costs and policing	No
	Enforcement costs	No
Contingency theory	Task oriented leadership	No
	People oriented leadership	No
	Leader to member relationship	Yes
	Task structure	Yes
	Position power	Yes

	Vroom Yetton decision model	Yes
Resource dependency theory	Organisations are dependent on resources	Yes
	The resources of one organisational need are often present at other organisations (or within the company between departments)	Yes
	Resources are a basis of power therefore individuals can be dependent on each other	Yes
	Power and resource dependence are linked	Yes

Table 2 – Overview theoretical integration.

8. Conclusions and discussion

This chapter presents a brief summary of the background of this research before moving on to provide a summary of the analytic findings and an evaluation of these.

8.1 Conclusions

This paragraph will consists of two sub paragraphs. The prior will focus on the sub research questions. The latter will focus on the main research question.

8.1.1 Conclusions based on the sub research questions

This research evaluated the decision making process about the implementation of a new train safety system at ProRail. Train safety systems must be replaced before 2018, since the economic and technical life-cycle will be met. These systems are subject to wear and tear and if they are not replaced on time reliability and thereafter safety of the train track will decrease. Reliability is an important incentive for ProRail and must be maintained. Therefore, a decision needs to be taken about what train safety system will be implemented. As can be seen it is an important subject, however the process is still ongoing. Conducting this research gained insights about factors that influence the decision making process and created the opportunity to learn from this situation since factors were found that may help to increase decision making effectiveness. Therefore, the results of this research can be helpful for ProRail.

This research began with the clear question: *"Which factors influence the decision making process about two families of train safety systems at ProRail, since a decision has not been reached?"* A clear answer about this subject can be given. However, before we elaborate upon the main question the sub questions will be answered first.

In order to evaluate the decision making process it is of paramount importance to address the following question; *"What did the decision making process look like considering the past decade?"*. The sense of urgency to replace conventional train safety systems started around the year 2000 at the department TB. The estimated costs to perform this project were calculated around 1.3 billion euro. Therefore, the President-Director contains the final responsibility within this decision making process. In addition, ProRail needed approval of the government, because it is a state owned company. During the last decade, project Mistral was reorganised several times. Reorganisation decreased the amount of decision making steps towards the responsible person, in order to increase the speed of the decision making process. As already mentioned before, the sense of urgency to replace conventional train safety systems started in 2001 at the department TB. Studies were conducted in order to find out what systems needed to be replaced. As a result, a policy emerged in 2004 that conventional train safety systems, which were implemented between 1953 and 1968, should be replaced with electronic train safety systems. Project Mistral established an approach to execute this replacement issue. In 2007 the board of directors made the decision that electronic systems would be implemented. However, due to scope creep program Mistral was dismantled in 2010. The current state of the process entails that the department TB makes a strategy about implementing new train safety systems and the department "Project ontwikkeling en uitvoering" will execute this plan.

Multiple actors were involved during this decision making process, both internal and external. The scope of this research only focused on the internal environment. We are intrigued to know how communication flows throughout this decision making process. This could indicate factors that influence the decision making process. The following questions emerged: "*Which (or what kind of) information is available and communicated between the different line managers?"* and *"Which (or what kind of) information is available and communicated between the different business units?"*. Results that were conducted using discourse analysis were not sufficient to answer these questions. In general, individuals state that communication between the higher and lower manager or between different business units functions properly. However, these interviews did not provide enough support to answer these questions rationally. Discourse analysis does not appear to be a well suited method to conduct relevant information to answer these research questions. Other methods will be more appropriate. For instance, an extensive document and minute analysis will be a good method to answer these questions. In this research there was no time to perform extensive method triangulation, therefore these questions are poorly answered.

This section will further elaborate on the following sub question: *"What are the main factors in the decision making processes that are responsible for the fact that a decision has not been reached yet?"*. Several factors emerged using discourse analysis that have an influence on the decision making process mentioned in paragraph 7.2. It became clear that five key-points are responsible for the time-consuming and iterative character of this decision making process. These key-points are:

- Culture;
- Level of group decision making;
- Level of communication;
- Inconsistencies;
- Organisational structure.

It can be concluded that these key-points have a reinforcing effect on one another. This effect influences the decision making process since it increases the length and iterative character of the process. In addition, the key-point 'culture' is an independent variable. Cultural factors (e.g. individuals have space to interfere in the decision making process) reinforce the difficulties in group decision making, communication, inconsistencies, and organisational structure. Factors that are responsible for the time-consuming and iterative character are strengthened due to these cultural factors, influencing the decision making process in a negative way.

Furthermore, our findings were compared towards five theories in order to give our results meaning. The following sub question will be answered in this paragraph; *"What theory gives meaning towards the results that are found by evaluating the decision making process and contributes towards explaining the phenomena that occurred?"*. Neither of these theories encompass the difficulty and complexity of this decision making process. Though, these theories are significant indicators that will give meaning to our observations. The transaction cost theory was ill-suited in this situation since the underlying assumptions are not indicated. The principal agent theory and resource dependency are mediate indicators, since several assumptions were indicated in this research. For instance, that the desires or goals of the principal and agent are in conflict and the fact that organisations are dependent on resources. However, these issues are not the main problem that influence the duration of the decision making process. It became clear that the social network theory and

contingency theory gave the best meaning towards the results that were found in this research since underlying assumptions of these theories are indicated in this research. They also contribute towards the explanation why this decision making process has a time-consuming characteristic.

8.1.2 Conclusions based on the main research question

After answering all the sub questions presented above, the **main research question** can be answered. The main research question was:

"Which factors influence the decision making process about two families of train safety systems at ProRail, since a decision has not been reached?"

This section will highlight the main difficulties that cause the iterative and time-consuming character in the decision making process. Primarily, the difficulties of the five key-points that were found, will be mentioned. *First,* group decision making can be considered as a time-consuming process due to several factors: complex collaboration, difficulty to reach consensus, no complete decision acceptance, involvement of multiple individuals, presence of tension between individuals, contested information, and different interests between individuals. *Second,* communication is often complex and difficult and therefore slows down the decision making process due to the complexity in multi-level decision making, the amount of transparency, the amount of understanding between individuals and the difficulty to combine the technological aspects with managerial aspects. *Third,* inconsistencies contribute to the time-consuming and iterative character of the decision making process. This decision making process operates in a complex, variable and uncertain environment, therefore it is hard to establish a clear goal or strategy. Among others, external stakeholders are an example that contributes towards this difficult environment. The sense of urgency is not present at every individual this may also contribute towards an inconsistent character of the decision making process. In addition, a change in course can be triggered by scope creep (e.g. new insights). *Fourth,* the ambiguous character of the organisational structure also contributes to a more time-consuming and iterative process. The factors that induce this ambiguous character are the reorganisation of ProRail and Mistral. Furthermore, the level of leadership and the fact that role-distributions and responsibilities are not completely clear contributes to the ambiguous character of the decision making process. *At last,* cultural characteristics contribute to the time-consuming and iterative character of the decision making process. Besides, these characteristics increase the difficulties of the other key-points and therefore boosts characteristics that influence the decision making process in a negative way. These cultural factors are; different cultures are present at the different business units, most individuals is considering their own scope, the main incentive is safety, ProRail is not financially driven, there is freedom to interfere, and it is rather a "think" compared to an "act" culture.

The previous section answered the main research question. This section will complement the conclusion by explaining and concluding why this decision making process is already ongoing since 2001. The main difficulty relies in the uncertainty and complexity of this subject. *First,* Mistral was coupled to ERTMS during this decision making process. Therefore, it became a political issue. This increased the amount of stakeholders that were involved, and for this reason it is harder to reach consensus and make a decision. Resulting in a longer decision making process. *Second,* electronical train safety systems compared to conventional train safety systems, have a life span of 25 years and 50 years respectively. These systems have different features and it is hard to weigh the pros and cons

to make a decision. It is especially hard because the electronic train safety systems have not been fully developed yet. It is possible that a better and improved version will be launched at the market in the nearby future that is financially and technically admirable. *Third,* a long term decision has to be established, therefore individuals are more careful to make a decision. Destruction of capital may happen due to the fact that a new implemented train safety systems needs to be replaced because of legislative obligation, or because new and better technologies are available that have huge advantages. As can be seen it is difficult to make a long term decision, because it is uncertain when the jump forward has to be taken. *Fourth,* it can be concluded that due to the fact that the business case was unclear, various people did not have the sense of urgency to replace conventional train safety systems. This slowed down the decision making process. *At last*, scope creep is an important factor that explains the difficulties in this decision making process. During the past decade arguments about the implementation of new train safety systems changed. In the beginning of this decision making process it was shown that new electronic train safety systems would be cheaper to implement compared to conventional train safety systems. Among other arguments it was therefore decided to implement electronic train safety systems. Though, this decision was reversed, due to new insights (scope creep). Over time, the business case tilted from a more technological perspective towards a more managerial, costs-benefit perspective. Over time, the costs of technological and conventional train safety systems changed. In turn, conventional train safety systems will be cheaper to implement compared to electronical train safety systems. Furthermore, foreign countries that implemented new electronical train safety systems gained new insights. These new perspectives in combination with governmental budget costs changed the course of action. It can be concluded that scope creep is a difficult aspect in decision making which causes a longer and iterative decision making process.

8.2 Discussion

This section is based on the perspective of the researcher, since several issues in the decision making process emerged during this research. I would like to elaborate upon these issues.

It can be concluded that this decision making process is situated in a very complex environment. Multiple aspects, such as technology, finance, safety, politics, external stakeholders, and the difficulty to comprehend to these dynamics contribute to this complex situation. These aspects affect the decision making process, since this complex situation is accompanied with a number of problems. The difficulties that were explained in the previous section, are therefore likely to occur. These difficulties are inherent to the challenges that may take place in complex situations. The challenges that were identified in this research, (group decision making, communication, inconsistencies and organisation structure) are therefore understandable. However, several situations emerged that are remarkable and this research did not contain sufficient information to explain these difficulties in the decision making process. These issues will be discussed in this section and from my own point of view possible explanations will be mentioned.

First, when I was analysing the decision making process it did not become clear to me why the decision that was established in 2007 was revised. The main incentive to revise this decision was caused by governmental budget cuts. However, when this decision was established, the project-budget was labelled. A question emerged to me: “How is it possible to change the decision based on this incentive, when the budget to perform this project was already reserved?” It could partially be

explained by the fact that this decision making process turned from a more technical oriented perspective towards a more cost-benefit perspective, because the financial aspects became more important. This could be seen as a cause why the decision was changed. In addition, this research mainly focussed on the internal environment of ProRail, however external parties may also influence the decision making process. It is possible that external parties caused the decision to change. For instance, ProRail has to create a strategy about implementing new train safety systems in consultation with NS and "Goederen Vervoer Nederland". It is logically deductable that these parties have a major influence on the decision making process. In addition, suppliers, engineering company's etcetera also influence the outcome of decision making. Although this might be an explanation, it is still apparent that this information is not well communicated throughout the company. This might explain why this issue was disappointingly visualised in this research.

Second, I found it remarkable that not every business unit was involved in this decision making process *before* the decision was reached in 2007, especially since ProRail supports an open culture. Most interviewees mentioned that there is "freedom to interfere", however this research showed that higher management levels of three business units were not involved in this decision making process before 2007. It should be noticed that the cultural aspect "freedom to interfere" was not mentioned at higher management levels. Nonetheless, it is noteworthy that involvement of the different business units started after that the decision was established (in the year 2007, 2008 and 2010 respectively). I would expect that they are involved earlier than 2007 because these business units are dependent on one another. ProRail is a one system company, meaning that these business units perform collectively in order to establish and deliver a common goal. However, group decision making between the different business units was not present in the beginning of this decision making process. A reason that could explain this phenomenon is the fact that a common goal or strategy was not entirely clear. Therefore, it is hard to coordinate what the contribution of every business unit will be. This may explain why these business units were not involved, since their role, task or contribution in this decision making process was not clear. Therefore, information that could be important in this decision making process was not coordinated or available. Later, all business units were involved. It could be explained that a common goal was more visible. Therefore, communication could be better coordinated and the different tasks and responsibilities are clear towards all the business units.

Third, several individuals at higher management mentioned that the business case was not clear. To start with the indistinctness about the business case started around 2008, *after* the decision that was established in 2007. This makes me wonder if the decision was well considered or just substantiated when it was first established. The question emerged to me: "How is it possible that a business case is approved in 2007 and criticized a year later?". I believe that an explanation can be linked to the decoupling of Mistral and ERTMS and that the character of the business case changed from the technical towards a cost-benefit character. The situation changed and therefore the business case had to be adjusted. Upward of 2007 other business units got involved in the decision making process as well. This might have generated new information that is important for the business, causing it to change. However, throughout these years, the business case was still not comprehensible. I think it is remarkable that during the past three years a business case has not yet been established and approved. In order to successfully start and finish a project it is vital that a clear business case should have been written in order to set one clear strategy within ProRail where all business units would feel acquainted with. Communication was poor in this decision making process. It was apparent that

higher management mentioned that the business case was unclear, though lower management was saying that it was not understood why and how the business case had to be adjusted. I think the common goal was not well communicated to lower levels in the organisation. Therefore, lower levels do not contain all relevant information that was necessary about the decision making process to establish a valid business case. Furthermore, the responsible person for project Mistral was replaced four times during the process. It is logically deductable that these rapid changes do not have a positive effect on the establishment of the business case and the speed of the decision making process. Every individual has to get familiar with the information in order to execute and manage this project, business case and the decision making process. This takes time because it is a complex subject. In addition, several interviewees suggested that the knowledge about the decision was not transferred at all. Therefore, they had to conduct the information by themselves, making it a complex, iterative, and time consuming process to make a business case. Both factors, poor communication and the quick turnover time of employees, make it very difficult to establish a clear business case.

Also other important positions in the organisation were replaced during this decision making process in the last few years. In my opinion this has a negative effect upon the decision making process. It seems like individuals (that contain high position power) left the decision making process in difficult times. Therefore, a lot of knowledge, expertise and power is lost, which is especially important during these times. In my opinion it will negatively influence the decision making process since it will increase the time-consuming and iterative character. 'Management turnover' seemed to occur multiple times throughout the organisation and in this decision making process. This might be an explanation why this decision making process is still ongoing. New employees have to be acquainted with the subject, which takes time. In my opinion, the cultural aspect of ProRail, "allowing space to interfere" underlies the assumption that new individuals can coordinate and approach the decision making process in their own way. This can be a positive aspect, however it also means that the approach of the decision making process can be altered. "Management turnover" was relatively high during the past years, which could be an underlying assumption that the course of action in the decision making changed. This may lead to a decrease of employee satisfaction and motivation, since the course in the decision making process regularly changes. Employees will focus on their own scope which in their opinion will be best for the company. I think it will be hard for a new manager to implement a new decision making strategy because employees expect that the ship will turn when these managers are replaced again and therefore they will operate what is best for the company in their opinion.

Fourth, as was stated above, several interviewees mentioned that the knowledge about this decision making process was not actively transferred when a new individual entered the decision making process. I think it is remarkable that someone was not incorporated in the process, because it can prevent individuals from making the same mistake that were made earlier. In my opinion it is even more remarkable since ProRail has an open culture, and even then new individuals were not incorporated. I believe this can be explained by the fact that communication is a weak aspect in this decision making process. Furthermore, everyone is mainly considering their own scope. Both factors contribute towards the fact that information about the decision making process is not well transferred to new employees. I think that although ProRail has an open culture, it does not reach beyond the scope of an individual.

9. Limitations and future research

This chapter will elaborate on the limitations of this research and it will give recommendations for future research. Also, a discussion about several subject will be included.

9.1 Limitations

This paragraph can be divided into two parts. The first part will focus on reliability and validity of this research. The second part will focus on the limitations of this research.

9.1.1 Reliability and validity

Two distinct forms of limitations exist, namely reliability and validity. Both will be explained shortly before elaborating upon specific limitations that will be present in this study. Reliability is a measurement instrument which concerns its overall precision and accuracy. It is often measured due to its repeatability. Validity on the other hand offers an insights towards the degree in which a measurement instrument achieves its aim, did it measure what you wanted to measure? Reliability and validity are commonly used to establish quality of any empirical social research like ours. In this chapter the reliability and validity of both our interviews and discourse analysis will be verified.

In general reliability of qualitative approaches, and thus interviews, do not assume that the same results will be achieved with repetition, therefore it becomes unreliable. Possible causes of unreliability will be shortly mentioned. First, socially desirable answers are more likely given, because respondents lose their anonymity due to direct contact with the interviewer. Second, participants may have a limited or selective memory. In order to gain as much information as possible the interviews were sent towards the participants in advance, with the purpose of reducing limited memory. Furthermore, a case study protocol is documented, therefore someone must be able to produce generally the same results if the procedure is followed, increasing reliability. Though, in both cases mentioned above it must be noticed that inaccuracies due to poor recall and the fact that answers may vary since it depends on the state of mind in which participants will be, is inevitable, affecting the reliability of this research. On the other hand if the exact same research will be performed, the same interview data could be used, since they were recorded, therefore the same data can be used in order to establish repetitions resulting in high reliability. Considering discourse analysis the reliability of findings depends on the verifiability of the researcher's interpretations. These interpretations must be based on the research data in a consistent and identifiable way. Since discourse analysis is the object of research, evidence towards the interpretations will be provided, including the discourses. Therefore, the research can be repeated making it more reliable (Potter and Wetherell 2004; Velde, Jansen et al. 2004).

Three important aspects of validity can be considered namely, internal, external and construct validity. Internal validity is a concern for explanatory case studies, which can be applicable in our research. Since this is an exploratory research internal validity is not applicable in this case.

External validity is concerned with the fact that findings can be generalizable beyond the immediate case study and a single case offers a poor basis for generalizing. This research does not have the intention towards generalizing these results towards a broader sense, since we are intrigued to find out what the challenges are concerning the decision making process between two types of train

safety systems at ProRail. Analytical generalization is applicable here because this study is not generizable to a population of cases, but to a theoretical domain.

Construct validity establishes correct operational measures for the concepts that are studied. For example the decision making process could be influenced by aspects such as power or information asymmetry. Therefore, prior specification of the subject helps towards construct validity since it becomes apparent on which the investigator's impression is based. The three pre-interviews that were performed induced prior specifications towards the subject on which the research was based, therefore increasing construct validity. In addition, construct validity can be increased due to multiple sources of evidence, chain of evidence and third having the report reviewed by key informants. Several sources of evidence have been used by means of method triangulation, thereby our studied data did not only include interviews, however it also enclosed little documentations of the decision making process. In addition, various people in the decision making process, lower management and higher management were interviewed. Because data from multiple sources are more expensive than if data were only collected from a single source, validity was increased. Furthermore, the draft case study report is reviewed by key informants at ProRail reinforcing validity (Yin 2003).

Finally, it is important that the researcher and the interviewee's perception of questions are aligned. The pre-interviews provided definitions (explanations) of particular themes in order to prevent misunderstandings about the questions, increasing validity. Furthermore, several experts were consulted to assess the clarity and quality of the interview protocol, both of the pre interviews and interviews.

9.1.2 Limitations within this research

In general this research has several limitations. First of all, inaccuracies might occur due to poor recall of participants. In order to minimize this feature we sent the interview questions on beforehand in order to increase recall of the participants. Though, limited and or selective memory could not be excluded. Second, the interviewee generally provides what the interviewer wants to hear, influencing the research in a negative way. Furthermore, open-ended questions, which were used in this research allows the interviewee too respond how they wish. Therefore, it may result in too much irrelevant detail.

A limitation of our research considers the fact that some respondents did not feel safe enough to provide honest answers due to the fact that the interview was recorded. One participant literally stated he would not answer the question if it was recorded. It cannot be verified if every participant felt that way, although it states that a limitation towards our research is present. Even though it was stated that this research focused towards the group level (not individuals) and that will be treated with a confidential matter and the fact that names will not be mentioned, it could not prevent this limitation from happening.

Furthermore, it should be noted that interviewees' perception of questions were interpreted in various manners. The range of possible answers to a question depends on the perception of the interviewee. For example high management will regard group decision making as a small group, namely the board of directors, when a question about group decision making is presented. On the other hand lower managers interpreted group decision making as a large group due to all the people

that were involved in their environment. Therefore, it is apparent that participants may vary greatly in the way they formulate their answers, since they have a different perception and scope towards the decision making process. In this research open questions were posed, therefore limiting the influence of the researcher and keeping the research unbiased, which is important in this explorative research. Though, misunderstandings about interview questions might occur. Therefore, due to the open character of the interview questions different perceptions might evolve, limiting the research.

Although the intentions of this research did not include external parties, it can be regarded as a limitation. It is apparent that several external parties are involved and influence the decision making process which is important in order to completely evaluate the course of action. However, this is not established, therefore being a limitation towards this research.

In addition, this research included open-ended interview questions, which is a good strategy to find the richness of detail in order to evaluate the decision making process in a good way. A limitation towards open-ended questions concerns the fact that the interviewee allows participants to respond to what length they answer and how they wish to answer. Therefore, not every participant emphasizes similar subjects about the same question limiting this research in the following manner. If participant A answers the question with a different context compared to participant B, it does not mean they have a different opinion towards this subject of the decision making process. However, this research is unable to postulate general conclusions about certain subjects regarding the fact that not everyone mentioned this issue during the interview. Though, it does not mean that it is not important or that they disagree to one another. It is undecided, limiting this research.

It can also be regarded that the method of analysis is a limitation in this research. As was stated in the conclusion, the second and third research questions are poorly answered because the method of analysis was not appropriate. Other methods, for instance, extensive minute analysis will be a better alternative.

A final limitation elaborates on the fact that the memo-recorder malfunctioned once while conducting an interview. Performing discourse analysis of that particular interview was limited because of this fact. However, it can be noted that the participant repeated and summarized most important and relevant subjects when the recorder was working properly again. Therefore, the context of the interview was guaranteed. Last but not least it should be mentioned that one person could not be interviewed due to personal reasons, namely the president-director. Therefore, it limits our research, since the entire decision making line of people that were involved in this decision making process was not included in this research.

9.2 Future research

This thesis gained a lot of knowledge about one specific decision making process at ProRail. In this section directions for future research will be mentioned, partly addressing some limitations that were cited in the previous paragraph.

The scope of this project was primarily concerned about the evaluation of the decision making process within ProRail. However, external parties, for example engineering companies and suppliers also influence the decision making process. Therefore, it is interesting for future research to involve

external parties in order to complement this research in a broader aspect, to facilitate a complete picture about the evaluation of this particular decision making process.

Furthermore, open-ended questions allowed interviewees how and to what extent they would answer a question. Therefore, not every question has been answered with the same content by all participant and therefore some subject are cited by half of the participants, though the other half did not mention this subject at all. However, this does not implicate that these participants agree or disagree about a subject. In order to increase the reliability of this data future research might establish closed interview questions about all the subjects of matter. In this way every participant answers the same question generating more precise and reliable data.

In addition, findings of this research could not be generalized because it involved a single case and therefore the sample size was not large enough. Future research could focus on multiple decision making cases at ProRail in order to generalize important features that influence the decision making process at this company. Therefore, future research could enhance what is being suggested in this research. The key-points, group decision making, communication, inconsistencies, organisational structure, and culture could be enriched with the help of future research. Future research that elaborates on these key-points may help to identify what aspects of the decision making process are crucial in order to have an efficient and eloquent decision making process. Therefore, as mentioned in the last paragraph, more decision making cases should be investigated at ProRail in order to explore and reveal more general patterns present concerning the decision making process at ProRail.

This research proposed several theories to which the results could be linked, in order to explain or give meaning towards the results acquired about the evaluation of the decision making process. Nonetheless after conducting this research it is apparent that also other theories could be linked towards our research. Extended literature studies as future research may enhance understanding towards the decision making process at ProRail if it is compared with the results that were generated. In addition, this research was of empirical nature, which means that more questions can be raised for future research. This research established possible explanations about factors that influence the decision making process at ProRail. Future research can respond towards this subject, establishing reversed engineered hypotheses which may lead towards further clarifications. A few examples of reversed engineered hypotheses or questions that can be raised for future research will be shortly mentioned. An example of reversed engineered hypotheses that can be raised for future research; “Culture can be considered as an independent variable influencing the decision making process at ProRail”, or, “The efficiency of group decision making and communication are dependent upon one another influencing the decision making process at ProRail”, or “The key-points group decision making, communication, organisation structure, inconsistencies and culture influence the effectiveness of the decision making process at ProRail”. Another example of questions that can be raised for future research; “What does the culture of the railway sector look like?” or, “What is the effect of the entrance of new senior management towards the decision making process?” or, “What are the experiences of other European countries concerning ERTMS?” or “Do leaders adhere to their assigned roles in routine decisions?”.

As was mentioned before, this study was constrained by the fact that the focus relied on one case within a single organisation. Although every management level was interviewed and a lot of information was gained, it is not possible or representative to reveal that these particular features

(such as group decision making and culture) are representatives of more general patterns within ProRail. In the future it would be of tremendous added value to further explore these features which influence the decision making process across a range of other decision making processes within the firm. In order to examine whether the patterns detectible in one case are present in others, generalizing the decision making process within the company. An even better generalization will be accomplished when these patterns are also detected in other (railway) organisations, being a nice subject for future research.

Future research could also focus on other types of analysis in order to gain answers about the second and third research question. In addition, this research mainly focuses towards the question *why* a decision has not been reached yet. The key issue of this project essentially relates toward the decision making process with respect to power relations. Therefore, results that were conducted with the help of interviews normally involved the frustrations towards this decision making process that were shown by the participants. Generally highlighting all the negative points in the decision making process that emerged. Nonetheless, other research methods and perspectives could gain new helpful insights, since the subject is approached from another point of view. Therefore, it would be interesting to perform research about this decision making process regarding a *knowledge management* perspective. This perspective will mainly focus on the fact *how* a decision has been taken, compared to *why* a decision has not been reached yet. Knowledge management is concerned with the representation and processing of knowledge in the decision making process. This may contribute toward different amounts of information, being comprehensive towards the results presented in this research. The added value of *knowledge management* for instance, focuses towards the data and knowledge that were available. Information that was present will be included as well and can be learnt from, approaching the research from another direction inducing new and important insights about the decision making process. Especially since decision making is a knowledge intensive activity it may enhance understanding this decision making process.

10. Recommendations

After conducting this research I gained a lot of knowledge about this subject. I think the decision making process still faces several challenges. Therefore, I would like to provide some recommendations that can be relevant for the company in order to learn from and overcome these difficulties.

Throughout this research it became clear that four keypoints, group decision making, communication, inconsistencies, and organisational structure have a negative effect on the decision making process. Figure 18 it can be seen what factors cause these difficulties. In order to improve the efficiency of the decision making process, these factors have to be changed. One example will be given: in order to prevent that the responsibilities or task-distributions are unclear it is important to have a clear goal and role-distribution in this decision making process. This will positively affect the efficiency because people will not work on the same subject and non-relevant information will not be explored. In order to improve the four key-points that negatively influence the decision making process, I would recommend to carefully read paragraph 7.2. Furthermore, we will elaborate on some issues that, in my opinion, are relevant to address.

Figure 27 shows how this decision making process functions, operates and communicates at this moment. The department TB is responsible to establish a strategic plan concerning the implementation of new train safety systems. This strategy and information is proposed to the manager of asset management. This manager communicates and consults with the manager of "Projectontwikkeling en uitvoering". In joint collaboration a plan is determined and the project manager of Mistral will execute this plan. The process is clear, though I have several comments. First, there is not much interaction between the manager of TB and the project manager of Mistral. In general this does not have to be a problem. Though, this research concluded that communication is a weak point in this decision making process. Therefore, I would suggest that these four persons interact with each other once in a while, because this decreases the "amount of steps in communication". For example, when the project manager of Mistral has a question, it will be posed to the manager of "Projectontwikkeling en uitvoering". It is possible that this question has to be answered by the department TB. In order to go back and forth, it might include ***ten*** steps in communication. The chance that miscommunication or misinterpretation will occur is highly expected. In order to prevent miscommunication and misunderstanding it is necessary to decrease the "amount of steps". This will decrease the iterative character of the decision making process, because re-questioning is less likely to occur, because the quality of information transfer is higher. This also will increase the motivation of employees. Therefore, decreasing the "amount of steps" will increase efficiency in the decision making process. As mentioned in section 3.2.3 the strategic, tactical and operational can be controlled with a PDCA cycle (plan-do-act-check). It seems like the feedback between the strategic (department TB) and operational level (department "Projectontwikkeling en uitvoering") is lacking. However, it is important to get the right balance between the different SOT-levels in order to influence the effectiveness of decision making. It is import to implement the PDCA-cycle to control the decision making process.

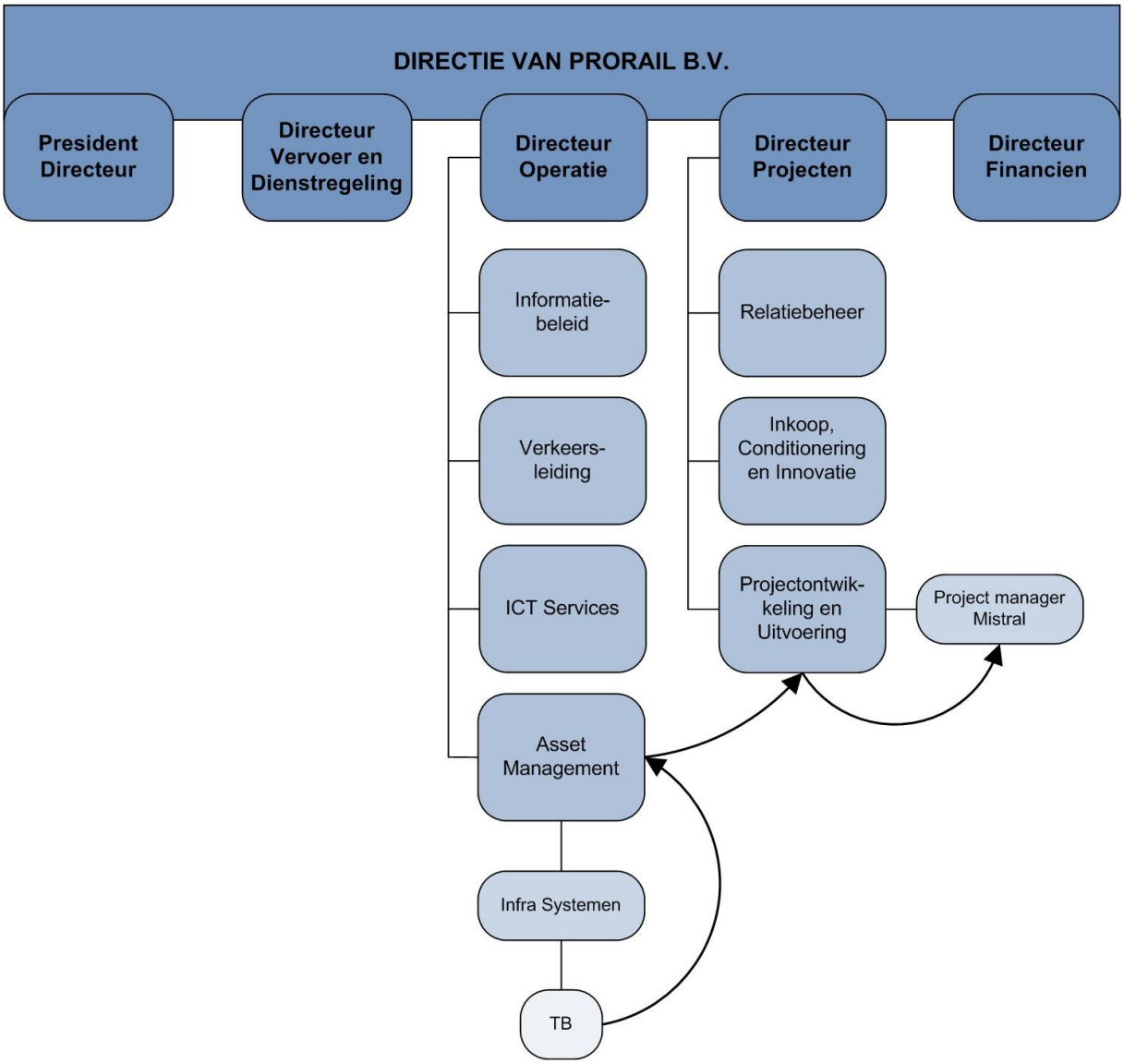

Figure 27 – Current decision making steps.

Other aspects in communication are also important my opinion, the next recommendation will elaborate on that a bit more. My main concern relies in the fact that, at this moment, the business case is not being made. This research showed that the business case was not clear during the past few years, that is one of the reasons why a decision has not been reached. A business case has to be created when an investment will exceed 35 million euro. Mistral also meets this requirement and thus the investment must be evaluated by the investment committee that will advise the board of directors. A business case is required in order to approve or disapprove investments that are proposed. It can be said that the business case must be approved in order to reach or implement a decision. I think developing a business case in this decision making process is of high priority. This research showed that the business case must contain strong evidence and various alternatives about possible train safety systems in combination with costs. These aspects were not clear previous times, therefore it is important to focus on these aspects. It is apparent why the train safety systems need to be replaced, however what needs to be replaced is still uncertain. This needs to be explained in the business case. When the current process of decision making is ongoing, the danger looms that

train safety systems will not be implemented as planned. Given that the investment will be disapproved because a business case is lacking. It takes time to establish a clear business case, slowing down the decision making process.

As can be seen in the figure above the board of ProRail is not directly involved in the current decision making line. Therefore, it is possible that the same problems will occur that happened earlier, namely that new information enters the decision making process that change the course of action. The board of directors should be involved for several reasons. *First,* it is important that the board of directors create a clear strategy about this subject. The tasks and responsibilities also have to be managed and communicated to provide an efficient decision making process. *Second,* ProRail is a one system company and therefore every business units must be involved in order to realise a common goal. When they are involved in a later stage, new information that is important in this decision making process might change the course of this process. *Third,* the sense of urgency to replace conventional train safety systems is not entirely present at the board of directors. It is important that they are involved and that it is communicated why these train safety systems must be replaced. This can be realised by decreasing the amount of steps that must be taken to communicate important information. This improves the quality of information transfer, decreasing misunderstandings, or miscommunication. Furthermore, preparing a clear business case might activate the sense of urgency. It is very important to obtain a sense of urgency throughout the company and especially in the board of directors. Since they do not understand why a decision has to be taken, a decision will not be made. This will delay the decision making process, since it is time-consuming to convince the board of directors that a decision needs to be taken. In addition, new individuals entered the decision making process, therefore it is important to have a clear and concise story and business case about this subject in order to create a sense of urgency that is needed to make a decision. To conclude, good communication (due to decreasing the amount of steps) and a good business case are of prior importance to reach a decision about this subject.

In addition, communication towards external parties is also of prior importance. For instance, ProRail is a state owned company and therefore it is important that the ministry will also understand the decision that is made, because they are responsible for the budgets. When the ministry does not understand why these train safety systems need to be replaced, they may not approve the budget that is needed. This will increase the length and iterative character of the decision making process. In order to prevent these issues good communication (by decreasing the amount of steps) and a good business case will improve the efficiency of the decision making process

Another note that I will mention is about the scope of this decision making process. Everyone is mainly focussed on the year 2018, in this year 17% of the current train safety systems have to be replaced because the reliability will decrease. The goal was to start replacing these systems in 2008. However, this goal was not accomplished. Nonetheless, I would like to mention that in 2019 even more train safety systems, around 30%, must be replaced. This number will exponentially increase during the years that follow. However, everyone is focussed on the year 2018, they do not focus on the years that come, although it is just the beginning of the “replacement-phase”. I would like to mention that it is important to consider the multi-year replacement plan in order to conduct a good strategy and approach to successfully replace and the train safety systems that need replacement in the future. The last point I would like to mention is to use this recommendations. I noticed that

ProRrail's culture has a "think" compared to an "act" culture. During the years multiple reports are established by various people, although it seems that the learning experience of these reports is limited. This is a pity since a lot of useful information is expressed in these reports. For example, in another report it already became visible that train safety systems needed to be replaced, however several individuals questioned *what* components needed to be replaced. When this is apparent, it is important to communicate these issues in a sophisticated way in order to establish a smoothly and efficient decision making process. And learn from the situation in order to improve the process. However, currently a year later, this question still has not been answered. And in a way my research states the same conclusion. Therefore I would like to ask, consider these recommendations and learn from the results, before another research will partly make the same conclusions and the process is repeated again.

11. References

Alchian, A. A. and H. Demsetz (1972). "Production, Information Costs, and Economic Organization." The American Economic Review **62**(5).

Aldrich, H. and M. Ruef (2006). Organizations evolving. London, Sage publications.

Arcadis (2003). Functionele risico analyse B-relais installaties.

Barnes, J. A. (1954). "Class and Committees in a Norwegian Island Parish." Human Relations **7**(39).

Blau, P. (2009). Exchange and power in social life. New Brunswick, New Jersey, Transaction publishers.

Burkhardt, M. E. (1994). "Social Interaction Effects following a Technological Change: A Longitudinal Investigation." Academy of management **37**(4).

Chaddad, F. R., M. L. Cook, et al. (2001). "Integrating supply chain and network analyses: The study of netchains." Chain and network science.

Coase, R. H. (1937). "The nature of the firm." Economica **4**(16).

Courtney, J. F. (2001). "Decision making and knowledge management in inquiring organizations: toward a new decision-making paradigm for DSS." Decision support systems **31**.

Eisenhardt, K. M. (1985). "Control: organizational and economic approaches." Management science **31**(2).

Eisenhardt, K. M. (1989). "Agency theory: An assessment and review." The academy of management review **14**: 19.

Emerson, R. M. (1962). "Power Dependence Relations." American Sociological Review **27**(1): 31-41.

Fiedler, F. E. (1964). "A Contingency Model of Leadership Effectiveness." Advances in Experimental Social Psychology **1**.

Fiedler, F. E. (1970). The Contingency Model: A Theory of Leadership Effectiveness1, New York: McGraw-Hill Book Company.

Frohmann, B. (1994). "Discourse analysis as a research method in library and information science." Labrary & Informationa Science Research **16**.

Gilbert, N. and M. Mulkay (1984). Opening Pandora's box. A sociological analysis of scientists' discourse, Cambrige University Press.

Granovetter, M. (1973). "The Strength of Weak Ties." The American Journal of Sociology **78**(6).

Granovetter, M. (1985). "Economic Action and Social Structure: The Problem of Embeddedness." The American Journal of Sociology **91**(3).

Grant, D., G. Michelson, et al. (2005). "Guest editorial: discourse and organizational change." Journal of Organizational Change Management **18**(1).

Haythornthwaite, C. (1996). "Social Network Analysis: An Approach and Technique for the Study of Information Exchange." LISR(18).

Hersey, P., K. Blanchard, et al. (2007). Management of Organizational Behavior: Leading Human Resources. Upper Saddle River, NJ, Pearson Education.

Hollenbeck, J. R., D. R. Ilgen, et al. (1995). "Multilevel theory of team decision making; decision performance in teams incorporating distributed expertise." Jounal of applied psychology **80**(2).

Homans, G. C. (1958). "Social Behavior as Exchange." The American Journal of Sociology **63**(6).

House, R. J. (1996). "Path goal theory of leadership; lessons, legacy and a reformulated theory." Leadership quarterly **7**(3).

Jensen, M. C. and M. H. Meckling (1976). "Theory of the firm; managerial behaviour, agency costs and ownership structure." Journal of financial economics **3**.

KEMA (2005). Resultaten kabelonderzoek.
Klein, B., R. G. Crawford, et al. (1978). "Vertical Integration, Appropriable Rents, and the Competitive Contracting Process." Journal of Law and Economics **21**(2).
MacNair, C. J. and R. Vangermeersch (1998). Total capacity management: optimizing at the operational, tactical, and strategic levels, St. Lucie Press.
Markus, M. L. and J. Pfeffer (1981). "Power and the design and implementation of accounting and control systems." CISR(78).
Ouchi, W. G. (1979). "A conceptual framework for the design of organizational control mechanisms." Management Science **25**(9): 833.
Parker, I. (1992). Discourse dynamics: Critical analysis for social and individual pshychology. London, Londen & New York: Routlegde.
Pfeffer, J. and G. R. Salancik (1978). The external control of organizations; A Resource Dependence Perspective, Harper & Row, Publishers.
Potter, J. and M. Wetherell (2004). Discourse and social psychology. Beyond attitudes and behaviour. . London, Sage Publications Ltd.
ProRail (2003). Levensduur B-relais interlockings - een inventarisatie.
ProRail (2004). Roll-out Plan Migratie Treinbeveiliging Integraal (MISTRAL).
ProRail (2008a). Leveranciersstrategie en statusweergave actiepunten Mistral.
ProRail (2008b). Programmaplan Mistral.
ProRail (2008c). Afsluitende BB21 Rapportage.
ProRail (2009). Treinbeveiliging - waarom en hoe.
ProRail (2010a). Analyse besluitvorming Mistral.
ProRail (2010b). Aanpak en budget voor vervanging verouderde beveiligingsinstallaties.
Railconsult, H. (2003). Experience with train protection systems in the Netherlands.
Rijnconsult (2003). Knipperend sein - verkenning van het domein van treinbeveiliging en seinwezen.
Scholten, H. and M. v. d. Werff (2003). "Treinbeveiliging in Nederland; Gisteren, vandaag en morgen." B&I Treinbeveiliging.
Selznick (1949). TVA and the grass roots; A study in the sociology of formal organization. New York, Harper & Row.
Simon, H. (1947). Administrative Behavior: A study of Decision making processes in administrative organiztion. new york, The free press, new york.
Technology, A. (2003). Levensduurbepaling componenten B-relaisinstallaties.
Thompson (1967). Organizations in action. San Francisco, McGraw Hill.
Tillquist, J. L. King, et al. (2002). "A Representational Scheme for Analyzing Information Technology and Organizational Dependency." MIS Quarterly **26**(2).
Uzzi, B. (1997). "Social structure and competition in interfirm networks; the paradox of embeddedness." Administrative science quarterly **42**(1).
Vatiero, M. (2009). Understanding Power. A 'Law and Economies' Approach, Saarbrucken BDM-Verslag Publisher.
Velde, M. v. d., P. Jansen, et al. (2004). Guide tot management research methods, Blackwell Publishing Ltd.
Vroom, V. and P. Yetton (1973). Leadership and decision making. Pittsburgh, University of Pittsburgh Press.
Vroom, V. H. and A. G. Jago (1988). The new leadership: managing participation in organizations, Prentice Hall.
Waterstaat, M. V. e. (2000). Wat verwachten we van de personenmobiliteit in 2020?
Weber (1947). De theorie van de sociale en economische organisatie. New York, The free press.

Wetherell, M. and J. Potter (1988). Discourse analysis and the identification of interpretive repertoires. Anylysing everyday experience: A casebook of methods. London, Sage Publications Ltd.

Williamson, O. E. (1979). "Transaction-Cost Economics: The Governance of Contractual Relations." Journal of Law and Economics, **22**(2).

Williamson, O. E. (1981). "The Economics of Organization: The Transaction Cost Approach." The American Journal of Sociology **87**(3).

Williamson, O. E. (1998). "Transaction cost economics: how it works; where it is headed." De Economist **146**(1).

Yates, S., S. Taylor, et al. (2001). Discourse as Data; A guide for analysis. London, Sage Publications Ltd.

Yin, R. K. (2003). Case study research: Design and Methods. California, SAGE Publications.

Appendix A – Protocol pre-interviews

Persoonsintroductie (5 minuten)

- Wat is (of was) uw functie binnen ProRail? (Wie bent u?)
- Hoe bent u betrokken geweest bij dit besluitvormingsproces?
- Welke rol had u in dit besluitvormingsproces?
- In welke periode van het besluitvormingsproces was u aanwezig?

Dat was de laatste vraag van dit onderwerp, nu gaan we verder met de volgende.

Algemeen (15 minuten)

Vervolgens gaan we verder met het algemene gedeelte om gewoon snel een globaal beeld te krijgen van het besluitvormingsproces over de keus waarmee het oude treinbeveiligingssysteem moet worden vervangen.

- Hoe ziet het huidige besluitvormingsproces eruit? (Welke stappen moeten er ondervonden worden voordat er een beslissing is genomen?)
- Welke mensen (factoren & actoren (bijv. externe bedrijven, veiligheidsregels)) zijn er allemaal bij betrokken?
- Besluiten staan vaak in relatie met andere beslissingen, welke zijn dat in dit geval en wat voor een invloed heeft dat op dit besluitvormingsproces?
- Is het duidelijk wie er verantwoordelijk is voor dit probleem? Zo ja, wie is dat dan?
- Wat is de rol van de afdeling TB in dit besluitvormingsproces in uw perceptie?

Dat was de laatste vraag van dit onderwerp, nu gaan we verder met de volgende.

Evaluatie (40 minuten)

Omdat deze kwestie speelt al vanaf 2000, daarom vraag ik me af hoe het besluitvormingsproces de afgelopen 10 jaar is gelopen. Hopelijk krijg ik hierdoor een beeld wat de problemen zijn.

- Hoe is de besluitvorming tussen de twee typen TBS (trein beveiligingssystemen) de afgelopen 10 jaar verlopen?
- Wat waren belangrijke momenten/mijlpalen van het besluitvormingsproces?
- Waarom is er toentertijd geen besluit genomen? Wat was de reden?
- Wat waren de zwakke punten in het besluitvormingsproces?
- Waarom waren dit de zwakke punten volgens u?
- Wat waren de sterke punten volgens u?
- Waarom waren dit de sterke punten volgens u?
- Welke factoren zouden er *wel* nodig zijn geweest om tot een besluit te komen?
- Wat is volgens u het grootste probleem (factor) waarom er nog geen beslissing is genomen?
- Wat is de grootste stap die ze in die 10 jaar hebben gemaakt? Zijn ze überhaupt wel vooruitgekomen?
- Wat is de status van het besluitvormingsproces op dit moment?

Dat was de laatste vraag van dit onderwerp, nu gaan we verder met de volgende.

Thema's (20 minuten)

Dan gaan we nu over op de thema's voordat we beginnen, zijn er nog dingen onduidelijk, zijn alle termen te begrijpen? De complexiteit van besluitvorming kan komen door een aantal thema's, zie onderstaand.

- Veelsoortige criteria; verschillende partijen met verschillende belangen
- Interdisciplinaire invloed; meerdere deskundigen bij één probleem
- Gezamenlijke besluitvorming
- Risico en onzekerheid
- Lange termijn gevolgen
- Waardeoordelen; degene die beslissen hebben verschillende normen en waarden
- Ontastbare zaken; niet alleen geldveranderingen tellen, ook milieu e.d.

- Welke drie van bovenstaande thema's spelen volgens u de grootste rol en waarom?
- Zijn er nog meer aanvullende thema's die ik nog niet heb genoemd hierboven, maar die toch duidelijk aanwezig zijn in dit besluitvormingsproces?

Betekenis asymmetrische informatie;
De situatie waarin één partij meer, betere of andere informatie heeft dan de andere partij. Een voorbeeld is het kopen van een tweedehands auto. In deze situatie beschikt de verkoper over alle informatie, zoals de geschiedenis, van deze auto. De koper heeft deze informatie niet tot zijn beschikking en zal moeten vertrouwen op de verkoper.

- Speelt het thema *asymmetrische informatie* een rol in dit besluitvormingsproces?
- Zo ja, waarom en in hoeverre? Of zo nee, waarom?

- Speelt het thema *macht* een rol in dit besluitvormingsproces?
- Zo ja, waarom en in hoeverre? Of zo nee, waarom?

- *Wat voor een invloed heeft macht volgens u op het besluitvormingsproces?*
- *Speelt macht een rol in het besluitvormingsproces? En op welke manier?*
- *Zijn er mensen die bepaalde strategieën hanteren? Doen ze dat bewust of onbewust?*

Ook zijn er meerdere lagen/niveaus aanwezig (multi levels) in dit besluitvormingsproces, vandaar de vraag:

- Spelen deze *verschillende lagen* een rol in dit besluitvormingsproces?
- Zo ja, waarom en in hoeverre? Of zo nee, waarom?

- *Wat voor een invloed hebben de verschillende levels in het besluitvormingsproces op het gehele besluitvormingsproces?*
- *Hoe verloopt de communicatie en informatiestroom tussen de verschillende actoren? (informeel/formeel en intern/extern?).*
- *Wat voor een invloed heeft dit op het besluitvormingsproces?*

- Wat is de invloed van de bedrijfscultuur op het besluitvormingsproces?

- Hoe zou je het besluitvormingsproces kunnen of willen beïnvloeden?

Dat was de laatste vraag van dit onderwerp, nu gaan we verder met de volgende.

Afsluiting (5 minuten)

- Hebt u nog suggesties voor mensen die ik kan interviewen?
- Is er nog iets wat u wilt toevoegen?
- Hebt u nog tijd voor vragen die nog niet behandeld zijn?

Appendix B – Protocol interviews

Persoonsintroductie (5 minuten)

- Wie bent u? Wat is/was uw functie?
- Hoe bent u betrokken geweest bij dit besluitvormingsproces?
- In welke periode van het besluitvormingsproces was u aanwezig?

Dan gaan we nu over naar het volgende onderwerp. We zullen eerst even wat algemene vragen stellen over het besluitvormingsproces.

Algemeen (20 minuten)

- Kunt u wat vertellen over het verloop van dit besluitvormingsproces (van 2000-heden)?
- Wat is de rol van de afdeling treinbeveiliging in dit besluitvormingsproces, kunt u daar wat over vertellen?
- Welke informatie heb je nodig en ontvang je van de lagen onder je? Waar ligt jouw verantwoordelijkheid omtrent dit besluitvormingsproces? Welke informatie geef je door aan de laag boven je? Krijg je feedback/terugkoppeling van de laag boven je? (gaat dit altijd via de formele weg, of ook de informele?)
  (In welke mate ontvangt u (relevante) informatie
- Hebt u het idee dat de informatie altijd aankomt op de plek van bestemming zoals dit bedoeld is?
- Zijn er nog andere mensen binnen ProRail waar je contact mee hebt tijdens dit besluitvormingsproces? Waarom? (Denk aan horizontale lagen) (Denk ook aan informele en formele informatievoorziening)
- Is het duidelijke welke laag welke rol vervuld en wat de verantwoordelijkheid is?
- Welke factoren (informatie) gebruikte u om een beslissing te nemen? Hoe filtert u/verzamelt u informatie om een goede beslissing te kunnen nemen?
- Komt informatie altijd aan zoals het bedoeld was?
- Dependencies in relaties? Zijn verschillende afdelingen die betrokken zijn afhankelijk van elkaar, zo ja op welke manier?
- Begrijpt iedereen elkaar? Elke laag? Duidelijk welke taak iedereen moet uitvoeren?
- Besluiten staan vaak in relatie met andere beslissingen, welke zijn/waren dat in dit geval. Wat was de prioriteit van de verschillende besluitvormingsonderwerpen en wat voor een invloed had/heeft dat op dit besluitvormingsproces?

Vervolgens gaan we verder met het volgende onderwerp. Uit eerdere pre-interviews kwamen wat thema's naar voren. Graag zal ik willen weten wat uw perceptie is betreffende deze thema's en of u daar wat over kunt vertellen in relatie tot dit besluitvormingsproces.

Thema's (50 minuten)

- Kunt u wat vertellen over de *duur* van het besluitvormingsproces?
- Kunt u wat vertellen over het *doel* van dit besluitvormingsproces?
- Wat voor een invloed heeft de bedrijfscultuur op dit besluitvormingsproces?
- Speelt politiek een rol in dit besluitvormingsproces? Zo ja, op welke manier?

- Kunt u wat vertellen over de groepsbesluitvorming in dit besluitvormingsproces?
- Wat is uw opinie over de samenwerking tussen de verschillende mensen (binnen ProRail) in dit besluitvormingsproces?
- Kunt u wat vertellen over de interesses van de verschillende betrokkenen in het besluitvormingsproces (intern)?
- Kunt u wat vertellen over de hoeveelheid mensen die bij dit besluitvormingsproces betrokken waren?
- Wat is uw opinie over de organisatorische structuur in dit besluitvormingsproces?
- Kunt u iets vertellen over de rolverdeling/verantwoordelijkheid (van de verschillende afdelingen) in dit besluitvormingsproces?
- Hebben de reorganisaties invloed gehad op dit besluitvormingsproces? Waarom wel/niet?
- Kunt u wat vertellen over de consistentie van de besluiten in dit besluitvormingsproces?
- Hebben macht/machtsverhoudingen invloed op het besluitvormingsproces?
- Speelt onzekerheid een rol in dit besluitvormingsproces? Zo ja, in hoeverre en op welke manier?
- Wat is de invloed van de komst van nieuwe mensen op dit besluitvormingsproces?
- Wat voor een invloed heeft de administratie (behandelvoorstellen/ppt) van besluiten op het besluitvormingsproces?

Afsluitende vragen (10 minuten)

- Zijn er thema's waar we het niet over gehad hebben? Zijn deze van belang of niet van belang? En waarom?
- Welke van de thema's die we besproken hebben zijn het belangrijkst in dit besluitvormingsproces?
- Is er nog iets wat u wilt toevoegen?